The Motherhood Training Penalty*

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Abstract

Women experience slower wage growth over their lifetimes compared to men, a gap often attributed to the "motherhood wage penalty," as childbearing reduces lifetime earnings. This paper connects this penalty to differences in on-the-job human capital acquisition using a pseudo-event study of first childbirth in Europe to document a "motherhood training penalty." Before becoming parents, full-time male and female workers follow similar on-the-job training trends, but their trajectories diverge significantly afterward. In the first 1–3 years of parenthood, women are 10%–20% less likely to engage in training, while men are only 1%–5% less likely to do so. Additional evidence suggests this gap is not driven by mothers opting out of training; in fact, they express a stronger desire for additional training than fathers and are more likely to self-finance it rather than rely on employers.

Keywords: On-the-Job Training, Human Capital Accumulation, Lifecycle Wage Growth, Gender Gaps

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1 Introduction

A well-known feature of labor markets across the world is that women earn significantly less per hour on average than men, and experience lower rates of wage growth over their lifetimes (Altonji and Blank (1999); Blau and Kahn (2017)). Extensive empirical research has been conducted to identify the underlying causes of this disparity. Several papers have shown the importance of child-bearing in driving the lifecycle gender wage gap, often labeled the "motherhood wage penalty" (Waldfogel (1998); Lundberg and Rose (2000); Budig and England (2001); Anderson et al. (2002); Bertrand et al. (2010); Goldin (2014); Adda et al. (2017); Kleven et al. (2019); Kleven (2022b); Gallen (2023)). Overall, the research on this motherhood wage penalty suggests that women with children earn less over the lifecycle than men, even after controlling for observable demographic and job characteristics. Several explanations have been proposed for the motherhood wage penalty.[1] However, direct empirical evidence supporting these explanations is sparse, particularly for one of the most frequently singled out factors driving the wage penalty: differences in human capital acquisition between mothers and non-mothers.

In this paper, we directly link the motherhood wage penalty to on-the-job human capital formation by focusing on on-the-job training, a key input to workers' human capital. We use rich cross-sectional worker-level data across all EU countries and adopt the pseudo-event study approach developed by Kleven (2022a) which allows for the estimation of child penalties using cross-sectional data by using matching techniques. Our analysis reveals the existence of a "motherhood training penalty": men and women have similar on-the-job training trends before parenthood, but diverge significantly in the years following. Given the extensive literature documenting the importance of on-the-job training to wages (see Heckman et al., 1999; Kluve, 2010; McKenzie, 2017; Card et al., 2018; What Works - Centre for Local Economic Growth, 2016, for reviews), this training gap plays an important role in driving the motherhood wage penalty in lifecycle wage growth.

We start by describing our data, sample of interest, and definition of on-the-job training, which captures on-the-job learning activities that takes place outside of the formal education system capturing various key sources of workers' human capital acquisition such as participation in courses, seminars or conferences. We then describe the pseudo-event study methodology developed by Kleven (2022a) to study child penalties using cross-sectional data.

[1] These explanations include the loss of mothers' human capital during child-related career breaks, self-selection into occupations that pay less, lower work effort exerted at work by mothers, discrimination by employers, differences in job search effort, and selection into motherhood itself (see Gough and Noonan (2013); Cukrowska-Torzexska and Matysiak (2020) for reviews).

In a nutshell, this approach uses matching techniques to convert cross-sectional data into a pseudo-panel of men and women. In particular, matching on relevant observable characteristics allows for the creation of surrogate observations for parents observed at different event times relative to first child birth, and the inclusion of age, year, and education fixed effects ensures that the effects of lifecycle and time trends are accounted for.

Using this pseudo-panel approach within our European data, we document the existence of a sizeable "motherhood training penalty": men and women have similar on-the-job training trends before parenthood, but diverge significantly in the years following. Specifically, we find that women are 10%–20% less likely to engage in on-the-job training during the 1–3 years after becoming mothers, while men are only 1%–5% less likely to do so. This training gap disappears 4 years after birth.[2] A back-of-the-envelope calculation reveals that, given the sizeable wage returns of on-the-job training,[3] the motherhood training penalty can account for aggregate wage growth losses of 0.3 percentage points per year in the 1–3 years following motherhood, which amounts to a cumulative loss of 0.93 percentage points in wage growth over this period. This suggests that the motherhood training penalty can account for 21.2% of the overall motherhood wage penalty, which has been estimated at around 4% in various settings (Cukrowska-Torzexska and Matysiak, 2020).

We then use additional EU data with information on workers' desire to participate in on-the-job training and how it was financed to assess whether mothers actively choose to engage in less training or if other factors drive the observed patterns. We highlight two key findings. First, among both participants and non-participants in on-the-job training, mothers are more likely than fathers to report wanting to participate, with the gap being especially pronounced among those who did not participate. Second, mothers are significantly more likely than fathers to self-finance their training, while employers are considerably less likely to do so. Taken together, these results suggest that the motherhood training penalty is not due to mothers' choices but is rather driven by employers or the incompatibility of available training opportunities with the demands of motherhood.

The paper is organized as follows. Section 2 reviews the literature and outlines our contribution relative to this. Section 3 introduces our data and sample of interest, providing a precise and harmonized definition of on-the-job training. Section 4 describes the pseudo-event study

[2]We further validate our pseudo-panel approach by showing that it also yields parallel employment and hours worked trends prior to child birth for both men and women.

[3]For example, Frazis and Loewenstein (2005) find that 60 hours of formal training lead to a 3%—5% increase in wages. Similarly, Ma et al. (2020) conduct a comprehensive review of the literature examining the returns to job-related on-the-job training across various settings, and document average wage gains of 5% from typical training programs.

methodology and its implementation in our setting. Section 5 presents our results. Finally, Section 6 concludes.

2 Related literature

Our paper combines intuitions from three different bodies of literature. First, our paper builds on the vast literature on gender inequality in the labor market, and particularly the studies focusing on the role of parenthood in explaining gender wage growth gaps. This includes papers by Waldfogel (1998), Lundberg and Rose (2000), Budig and England (2001), Anderson et al. (2002), Bertrand et al. (2010), Wilde et al. (2010), Fernandez-Kranz et al. (2013) Goldin (2014), Angelov et al. (2016), Erosa et al. (2016) Adda et al. (2017), Kleven et al. (2019), Kleven (2022b), and Gallen (2023), among many others in a variety of contexts and settings. Our paper is particularly related to papers that highlight the importance of human capital in driving the gender wage growth gap (see Gough and Noonan (2013) and Cukrowska-Torzexska and Matysiak (2020) for a review of this evidence). Most of these papers focus on the loss of mothers' human capital during child-related career breaks. In contrast, we highlight the loss of mothers' human capital that occurs even if they remain in the labor force, and as a consequence of reductions in on-the-job training opportunities.

Second, our paper relates to the labor literature examining the impacts of on-the-job learning opportunities on workers' earnings and employment. Numerous studies provide evidence of the effects of on-the-job training, and particularly firm-sponsored training, on worker outcomes in a variety of contexts (see Heckman et al. (1999), Kluve (2010), Card et al. (2018), McKenzie (2017) and What Works - Centre for Local Economic Growth (2016) for reviews on the impacts of on-the-job training generally, and Haelermans and Borghans (2012) and Bassanini et al. (2007) for reviews on firm-sponsored on-the-job training specifically). These studies consistently find that job-related in-firm training has large and significant effects on the human capital acquisition and wages of both men and women. These insights imply that the motherhood training penalty we document in this paper can help explain the motherhood wage penalty.

Finally, our paper relates to the literature that examines the existence of training gender gaps in different countries and contexts (Gronau (1988), Altonji and Spletzer (1991), Royalty (1996), Altonji and Blank (1999), Barron et al. (1993), Hamil-Luker (2005), Blau and Kahn (2017), Blundell et al. (2021)). Some studies find that women receive less training than men; however, the evidence is mixed.[4] A few studies in this literature have also argued that

[4]In Appendix A we provide a comprehensive summary of this literature.

this training gap may contribute to the gender wage gap by limiting women's opportunities for career advancement, and may be partially driven by motherhood. For instance, Blau and Kahn (2017) suggest that one possible explanation for the gender gap in training is that women are more likely than men to take time off work to care for children which may make them less available for training opportunities, while Booth (1991) and Booth (1993) find that child-bearing reduced the probability of receiving training for women in the 1980s. This evidence is primarily correlational, however, and based on older data from a time when the work landscape for women was very different. In this paper, we provide direct evidence using modern methods that the gender training gap is specifically driven by motherhood, and arises not due to mothers' choices, but rather due to employers' decisions or the incompatibility of available training opportunities with the demands of motherhood.

3 Data, sample, and definition of on-the-job training

In this section we describe our data and sample of interest, and provide a precise definition of on-the-job training as it pertains to our study.

3.1 Data description

Our main data corresponds to the EU Labor Force Survey (EU-LFS), a large-scale household survey providing information on labor force participation, unemployment, job characteristics, socioeconomic traits, education, family structure, and training for individuals aged 15 and above. This survey is conducted quarterly in all EU member countries, Norway, Iceland, and Switzerland, and surveys about 1 million people spanning all industries and occupations in every wave. While data collection dates back to 1983 for certain countries, data availability for each country generally coincides with EU membership. Our data thus spans the period 1992–2019. Further details on this data and relevant variables are available in Appendix B.1. We present some summary statistics of this data by gender and parenthood status in Table B.2. Table B.1 presents a list of the years of data availability and number of observations in each country.

A secondary source of data we employ corresponds to the EU Adult Education Survey (EU-AES), which collects data on participation and financing of education and learning activities, including job-related training, with the specific objective of understanding adult education patterns. The EU-AES covers around 666,000 adults aged 25-64 and was conducted during 2007, 2011, and 2016 in 26, 27, and 28 EU member states, respectively. We focus on the 2011 and 2016 waves for our analysis, since the 2007 wave was a pilot containing very different

training definitions. Further details on this data and relevant variables are available in Appendix B.2. We present some summary statistics of this data in Table B.4.

3.2 Definition of on-the-job training

We define on-the-job training following the definition of "Non-formal Education and Training" from ISCED (2011).[5] This definition encompasses two broad types of training: formal training and informal training. Formal training has a defined and structured curriculum and includes classroom work, seminars, and workshops, among other activities. Thus, formal training is typically separate from the active workplace and shows a high degree of organization by a trainer or institution. Informal training involves task-related learning connected to the active workplace and often resulting from coworker instruction. It includes guided on-the-job training, job rotation, exchanges, and other forms of learning arising from participation in learning circles.

Our definition of training has two main features. First, it distinguishes training from schooling. Therefore, training does not include programs such as MBAs that may be a source of human capital for some workers. Second, training activities must have a certain degree of organization and structure, which distinguishes training from learning-by-doing and informal learning activities such as reading journals, visiting museums, or learning through media in an unstructured or unplanned way.

In our main EU-LFS data, and due to data constraints, training captures only formal training by asking about participation in specific activities, namely courses, seminars, conferences, or private lessons outside the regular education system, in the last 4 weeks. For the EU-AES, training captures both formal and informal training by asking about participation in course-based training, seminars or workshops, and guided on-the-job training in the last 12 months. For further details about the definitions of training in each data source please see Appendix B.1 and Appendix B.2.

3.3 Sample of interest

Our sample of interest comprises all currently-employed individuals who are at least 18 years of age. Further, given our interest in the impact of parenthood, our sample is restricted to individuals whose age at first birth is between 25–45.

[5]The International Standard Classification of Education (ISCED) provides uniform and internationally consistent definitions to facilitate comparisons of education systems across countries.

In addition, in order to control for extensive and intensive labor market adjustments following parenthood, we also limit our sample to full-time workers, eliminating those who work less than 30 hours per week. With this, we focus on the effects of parenthood on training for men and women who remain employed full-time.

4 Pseudo-event study methodology

Child penalties have commonly been estimated using traditional event studies leveraging high-frequency and long-running panel data. However, given that this type of data is relatively rare and does not usually collect on-the-job training information, we follow the pseudo-event study methodology developed by Kleven (2022b) and further presented in Kleven et al. (2024), which allows for the estimation of child penalties using cross-sectional data by using matching techniques.[6] In this section, we first describe how the event-time pseudo panel is constructed, and then how it is used to for the event study and the quantification of child penalties.

4.1 Construction of event-time pseudo-panel through matching

The pseudo-panel approach converts cross-sectional data into a pseudo-panel of men and women in order to study their outcomes around the birth of the first child, indexed to occur at event time $t = 0$. In particular, this approach allocates individuals to specific event times t relative to first child birth, where $t = \{-T^-, -T^- + 1, \ldots -1, 0, 1, \ldots T^+ - 1, T^+\}$, indicating that t spans T^- periods prior to the first child birth, and T^+ periods afterward. For individuals who have children, event time t is weakly positive, $t \geq 0$, and easily calculated using the age of their oldest child. Since we cannot directly allocate individuals to negative event times, $t < 0$, as this would involve allocating event times for childless individuals for whom we don't know when or if they will have children, this method relies on creating surrogate observations for individuals who have children at negative event times through matching on observable characteristics. To fix ideas, and similar to the example given by Kleven et al. (2024), consider parent i of age a and demographic characteristics X_i observed at event time $t \geq 0$ in calendar year y. To generate a matching observation at event time $t = -n$, parent i is matched to a childless individual j observed in year $y - t - n$ with age

[6] For example, the German Socioeconomic Panel (G-SOEP) does not have on-the-job training information, while the US Panel Study of Income Dynamics (PSID) only contains on-the-job training information for the period 1968–1972.

$a-t-n$ and the same demographic characteristics X_i.[7] This process is repeated for every parent at every $t \geq 0$ and for every $n \in \{T^-, \ldots, -1\}$, yielding a pseudo-panel capturing T^- years of pre-child event times.

The set of demographic variables used in the matching procedure includes those used by Kleven et al. (2024) to study child penalties in employment, namely gender, education, marital status, urban/rural status, and country; but also includes occupation in our case given our focus on on-the-job training and the fact that much of this is informed by occupation. We provide further information about our matching variables and categories used in Appendix B.1.2.

In order to provide further information about the matching procedure, it is worth discussing how men and women at event time $t = 0$ compare with matches at $t = -1$ in the pseudo-panel. By construction, these samples match exactly on education, marital status, urban/rural status, occupation, and year of birth. Also by construction, individuals at $t = -1$ are exactly one year younger than individuals at $t = 0$, and given that we restrict our sample to full-time workers, individuals in both samples are employed. However, these samples do not match on other labor market outcomes, and particularly on-the-job training status. Some of these differences stem from the effect of parenthood, which is our focus. However, some of these differences stem from the fact that the sample observed at $t = 0$ is one year older and observed one calendar year later. The specification below isolates the child penalty component by including age, year and education level fixed effects.[8]

4.2 Pseudo event-study specification

Using the pseudo-panel data, we estimate the following specification for men and women, respectively:

$$Y_{it}^g = \sum_{t=-T^-}^{T^+} \alpha_t^g D_{it}^{Event} + \sum_{t=-T^-}^{T^+} \beta_t^g D_{it}^{Age} + \sum_{t=-T^-}^{T^+} \gamma_t^g D_{it}^{Year} + \sum_{t=-T^-}^{T^+} \psi_t^g D_{it}^{Educ} + \upsilon_{it}^g \qquad (1)$$

where Y_{it}^g is the outcome variable (on-the-job training in our case) for individual i of gender $g = w, m$ at event time t, where $t = \{-T^-, -T^- + 1, \ldots -1, 0, 1, \ldots T^+ - 1, T^+\}$. In order to

[7] Similar to Kleven et al. (2024), since a parent can have multiple matches in each negative event time, we create an average of all of them to use as the matched observation.

[8] We further validate the matching pseudo-panel approach in our setting by showing in Figure C.1 that it yields parallel employment and hours worked trends prior to parenthood among both men and women, both when we do not restrict the sample employed workers, and when we do. These figures also replicate the significant and enduring child penalties in employment borne by women documented in Kleven et al. (2019); Kleven (2022b); Kleven et al. (2024).

focus narrowly on the time around the first child birth, and given the marked lifecycle effects of on-the-job training (Ma et al., 2023), we set $T^- = 3$ and $T^+ = 5$. The set of dummies for each event time are captured by D_{it}^{Event} (where the base event time corresponds to the year before child birth, $t = -1$), and the coefficients α_t^g measure the impact of event time t on the outcome of interest for gender g, relative to the base year. D_{it}^{Age}, D_{it}^{Year}, and D_{it}^{Educ} capture age, year and education level dummies, respectively, to control for lifecycle trends and time trends.

The estimated level effects are then converted into percentage effects by calculating

$$P_t^g = \frac{\hat{\alpha}_t^g}{\mathbb{E}\left[\tilde{Y}_{it}^g | t\right]}, \tag{2}$$

where P_t^g captures the percentage child penalty effect at event time t, $\hat{\alpha}_t^g$ is the estimated coefficient α_t^g from the regression and above, and $\mathbb{E}\left[\tilde{Y}_{it}^g | t\right]$ measures the predicted outcome from Equation (1) absent the event-time child penalty effects.

5 Results

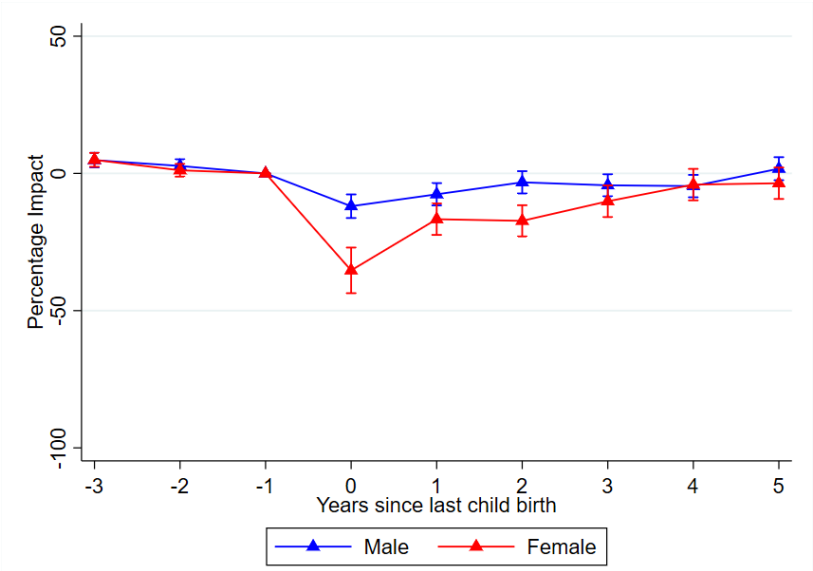
We now present our results. First, we present the results of our pseudo event-study and document the existence of a motherhood training penalty using the EU-LFS. Then, we explore the drivers of this penalty using both the EU-LFS and EU-AES datasets.

5.1 Documenting the motherhood training penalty

We present the results of our pseudo event-study estimating the impact of first child birth on the participation of men and women on on-the-job training activities in Europe in Figure 1. This figure indicates that men and women have similar on-the-job training trends before parenthood, but diverge significantly in the years following, suggesting the existence of a "motherhood training penalty".

Unsurprisingly, the largest effect for both men and women, along with the largest gap between the two, occurs at event time 0, the year when the first child is born. This likely stems from post-natal parental leave, which keeps parents, and especially breastfeeding mothers, away from the office and thus unable to engage in on-the-job training. However, although parenthood continues to reduce both men's and women's participation in on-the-job training in the few years after their first child is born relative to before, this reduction remains much more marked among women: women are 10%–20% less likely to engage in on-the-job training

Figure 1: Impact of first child birth on the participation of men and women on on-the-job training activities (EU-LFS)



Notes: This figure presents pseudo-event studies of the impact of first child birth on the participation of men and women on on-the-job training activities using pooled data from all countries in the EU-LFS following the sample refinements described in Section 3.3. The series depict the percentage impact of child birth (P_t^m and P_t^w in Equation (2)) at each event time t relative to the base event time corresponding to the year before child birth, $t = -1$. The error bars depict 95% confidence intervals based on robust standard errors.

during the 1–3 years after becoming mothers, while men are only 1%–5% less likely to do so. The training penalty for both men and women, along with the gap between the two, disappears 4 years after the first birth.[9]

Given the significant wage returns to on-the-job training documented in various settings, this motherhood training penalty can help explain the broader motherhood wage penalty. To illustrate this, we conduct a back-of-the-envelope calculation to assess the predicted impact of the documented motherhood training penalty on wages. For this calculation, we draw on the results of Ma et al. (2020), who conduct a comprehensive review of the literature on the returns to job-related on-the-job training across different contexts and document average wage gains of 5% from typical training programs. Our results suggest that women are, on average, 15% less likely to engage in on-the-job training in the 1–3 years following motherhood. Meanwhile, 40% of childless workers typically engage in on-the-job training annually, as suggested by the summary statistics in Table B.4. Using these figures, we estimate aggregate wage growth losses of 0.3 percentage points per year for mothers during this period, which amounts to a cumulative loss of 0.93 percentage points in wage growth

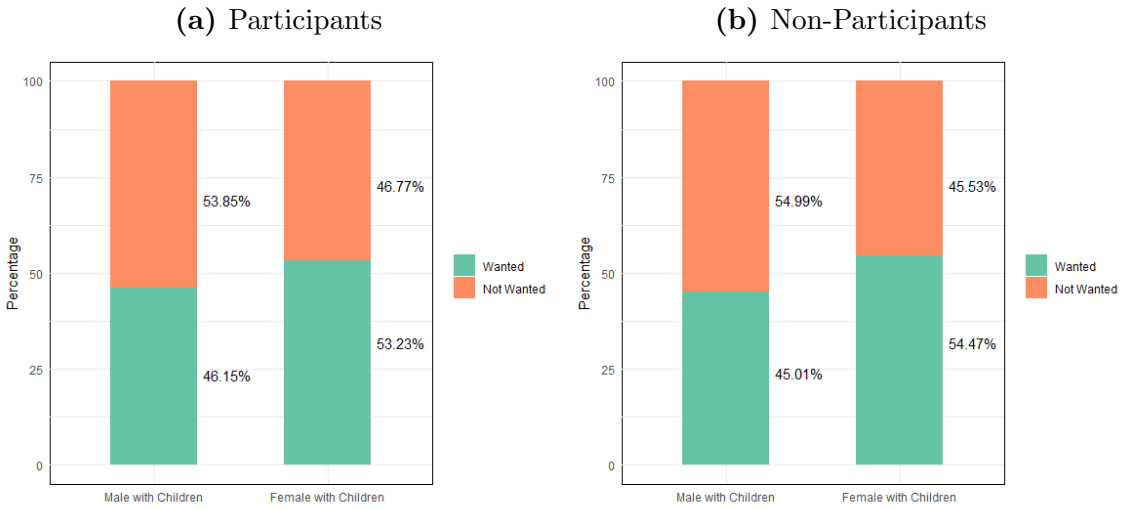
[9]These results are largely echoed, albeit noisier, when we estimate the results for each country individually.

over three years. This suggests that the motherhood training penalty can account for 21.2% of the overall motherhood wage penalty, which has been estimated at around 4% on average (Cukrowska-Torzexska and Matysiak, 2020).[10]

5.2 Drivers of motherhood training penalty

We now investigate the underlying drivers of the motherhood training penalty. Using data from the EU-AES, we analyze mothers' and fathers' desire to participate in on-the-job training and how this was financed.[11] This allows us to assess whether mothers actively choose to engage in less training or if other factors—such as employer decisions or the compatibility of available training opportunities with the demands of motherhood—drive the observed patterns.

Figure 2: Training Desirability among Mothers and Fathers (EU-AES)



Notes: This figure presents the share of mothers and fathers who did or did not want to participate in training, distinguishing between those who engaged in on-the-job training in the past 12 months and those who did not. Data comes from the EU-AES 2011 and 2016 surveys following the sample refinements described in Section 3.3.

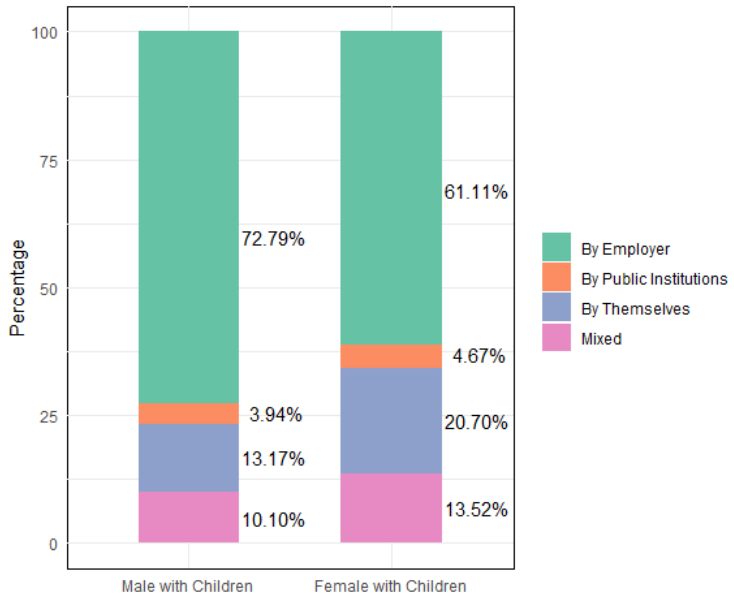
First, in Figure 2, we categorize mothers and fathers based on whether they participated in on-the-job training in the past 12 months, and whether they desired training in each case. We find that, among both participants and non-participants, mothers are more likely than fathers to report wanting to participate in training, with the gap being especially pronounced among those who did not participate.

[10] Furthermore, given the link between job-related on-the-job training and productivity documented by several papers (see Ma 2020 for a review), our documented motherhood training penalty can also help explain the recent findings of Gallen (2023), who documents a sizeable productivity gap between mothers and their counterparts.

[11] Full definitions of these variables are provided in Appendix B.2.1.

In Figure 3, we then focus on mothers and fathers who participated in on-the-job training in the past 12 months and examine how their training was financed. We find that mothers are significantly more likely than fathers to self-finance their training. While public institutions are slightly more likely to support training for mothers, employers are considerably less likely to do so.

Figure 3: Training Financing for Mothers and Fathers (EU-AES)



Notes: This figure presents the share of mothers and fathers with different financing sources for on-the-job training among those who participated in training in the past 12 months. Data comes from the EU-AES 2011 and 2016 surveys following the sample refinements described in Section 3.3.

Taken together, these results suggest that the motherhood training penalty is not due to mothers' choices, but rather driven by employers or the incompatibility of available training opportunities with the demands of motherhood.

6 Conclusions

This paper provides empirical evidence linking the motherhood wage penalty to on-the-job human capital formation by documenting a "motherhood training penalty." Using rich European cross-sectional worker-level data in conjunction with a pseudo-event study of first childbirth, we find that full-time employed men and women follow similar on-the-job training trends before parenthood but diverge significantly in the years following. Specifically, women are 10%–20% less likely to engage in on-the-job training during the 1–3 years after becoming mothers, while men are only 1%–5% less likely to do so. Using additional data on workers' desire to participate in on-the-job training and how this was financed, we provide

suggestive evidence that this gap is not driven by mothers opting out of training, but rather by employers or the incompatibility of available training opportunities with the demands of motherhood.

Our results highlight the importance of addressing the training gap as a means of reducing the motherhood wage penalty and, ultimately, the gender wage gap. They have two key implications. First, policies that encourage on-the-job training may have a disproportionate effect on women, particularly mothers, and could help reduce inequities between men and women in the job market. Second, given the crucial role of firms in offering training, policymakers should consider how to effectively target firms to incentivize the provision of training to mothers. In particular, understanding whether policies such as offering flexibility in on-the-job training or providing training subsidies are effective at fostering gender equality in training and the labor market more broadly is an unexplored and promising avenue for future research.

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Appendix

A Literature Review on Gender Training Gap

This section provides a comprehensive review of the literature on the link between on-the-job training and gender. Our primary focus is on the training gender gap and its evolution over time, while also highlighting similarities and differences across countries.

Table A.1 summarizes this literature. We focus on worker-level outcomes, which generally employ worker-level data. Our main interest is in the literature that tackles the training gender gap in any way, even if it is not the main focus of the paper. For example, we consider studies that examine returns to training by gender and perform a training incidence regression as a first step, as long as a gender dummy is included in the analysis. The table further distinguishes the studies by country, with each country analyzed separately for studies that explore the training gender gap in multiple countries. The studies we review cover a wide range of contexts and time periods, although there are fewer studies analyzing the gender training gap in developing countries than in developed ones. The initial works mainly focused on the United States, United Kingdom, Germany, and France, but there is ample evidence over the last thirty years for other European countries and some developing countries as well.

Several studies conducted in the 1970s and 1980s point to the existence of a gender gap in training, wherein women receive systematically less training than men. This disparity has been reported in developed countries such as the United States (Duncan and Hoffman (1979), Lillard and Tan (1986), Gronau (1988), Lynch (1992), Bishop (1994), Veum (1995)), the United Kingdom (Booth (1991), Booth (1993)), France (Goux and Maurin (2000)), and Germany (Pischke (2001)).[12] During this time period, Booth (1991) and Booth (1993) also find evidence that having children had different effects on the probability of receiving training for women and men in the 1980s. To do this, they examine the incidence of formal on-the-job training for full-time employed people and the incidence of training for college graduates in the United Kingdom. The authors find that having children drastically reduced the probability of receiving training for women, while the effect for men is positive but small and not statistically significant.

The evidence on the gender training gap has become sparser and less clear from the 1990s

[12]It is important to note that all of these studies employ some form of econometric identification that produced coefficients with strong statistical significance. The exceptions were Duncan and Hoffman (1979),Lillard and Tan (1986), and Gronau (1988), who reported the gender gap through descriptive averages.

onwards, with studies analyzing European countries reporting mixed results. For instance, Bassanini et al. (2007) shows that prime-age women in Europe had more opportunities to receive on-the-job training than men in the 1990s. Similarly, Salas-Velasco (2009) finds that among recent college graduates in Europe, women had a higher chance of receiving training than men. However, Dieckhoff and Steiber (2009) find the opposite result: in 2005, a sample of prime-age workers with partners had a lower chance of receiving course training if they were female.

These mixed results prevail even when comparing studies with similar settings and data. For instance, Bassanini et al. (2007) and Albert et al. (2010) use the same time span and dataset to study training in several European countries, but find different results as the former focuses on the incidence of on-the-job training, whereas the latter concerns itself with vocational training. For instance, these studies find opposing effects when focusing on France, Portugal, and Spain, respectively, though these effects are not statistically significant. In addition, the results in these studies also vary greatly across countries. For example, both studies find that prime-age women receive less training than men in Italy, while the opposite is true in the United Kingdom. Moreover, Bassanini et al. (2007) reports negative results for women's training in Austria, Belgium, Greece, and the Netherlands, but positive results in Denmark, Finland, and Ireland.

The prevalence of mixed results also extends to other studies. A study conducted in Sweden by Schøne (2004) finds that women received more training than men in the early 1990s, although the estimates were small and not significant. Conversely, Evertsson (2004) finds that women received significantly less training than men in the late 1990s, also in Sweden. In Germany, Tamm (2018) investigates the incidence of six different training definitions among manufacturing and service workers during the first decade of the new century, and find that women received more training than men in five out of six categories.[13] This finding contrasts with that of Pischke (2001) and Albert et al. (2010), who document that women received less training in Germany in the late 1980s and 1990s, respectively.

Recent results from other countries and the developing world also show mixed results. For instance, Gibson (2003) finds evidence that white women received more training than white men in New Zealand, whereas the opposite was true for non-whites. In addition, studies on manufacturing workers in Tanzania (Biesebroeck (2007)) and Thailand (Almeida and Faria (2014)) reveal that women receive less training than men.

[13] Technical training was the only category in which men received more training.

Table A.1: Studies examining training incidence by gender

Study	Period	Dataset	Sample	Training Definition	Training Incidence	Estimation Method
Austria						
Bassanini et al. (2007)	1995-2001	ECHP	Prime-age	Incidence of OJT	F: -0.017	Probit
Belgium						
Bassanini et al. (2007)	1995-2001	ECHP	Prime-age	Incidence of OJT	F: -0.013	Probit
Denmark						
Bassanini et al. (2007)	1995-2001	ECHP	Prime-age	Incidence of OJT	F: 0.012	Probit
Europe						
Bassanini et al. (2007)	1995-2001	ECHP	Prime-age	Incidence of OJT	F: 0.006**	Probit
Dieckhoff (2009)	2004-2005	ESS2e03	Prime-age workers with partner	Incidence of Course Training	F: -0.20*	Logit
Salas-Velasco (2009)	1999	CHEERS	Recent European college graduates	Incidence of OJT	M: -0.2805** M: -0.1674**	Logit Probit
Finland						
Bassanini et al. (2007)	1995-2001	ECHP	Prime-age	Incidence of OJT	F: 0.016	Probit
France						
Goux and Maurin (2000)	1988-1993	FQP	Prime-age	Incidence of employer-provided OJT	F: -0.081**	Probit
Bassanini et al. (2007)	1995-2001	ECHP	Prime-age	Incidence of OJT	F: 0.002	Probit
Albert et al. (2010)	1995-2001	ECHP	Prime-age	Vocational Training	M: 0.194	Probit
Germany						
Pischke (2001)	1986-1989	GSOEP	Prime-age	Incidence of any training Incidence of employed sponsored training	F: -0.067*** F: -0.061***	OLS OLS
Albert et al. (2010)	1995-2001	ECHP	Prime-age	Vocational Training	M: 0.046	Probit
Burgard and Gorlit (2014)	2000, 2004, 2008	SOEP	Prime-age	Career oriented courses	M: 0.35 F: 0.32 dif=0.04**	T-test
Tamm (2018)	2007-2010	WeLL	Manufacturing or service workers	Incidence of OJT Security or health Technical training Training on computer Administrative training Communication or soft skills	M: -0.0399*** M: -0.0826*** M: 0.0903*** M: -0.0152* M: -0.0288*** M: -0.0244***	OLS
Greece						
Bassanini et al. (2007)	1995-2001	ECHP	Prime-age	Incidence of OJT	F: -0.008**	Probit
Ireland						
Bassanini et al. (2007)	1995-2001	ECHP	Prime-age	Incidence of OJT	F: 0.026***	Probit
Italy						
Albert et al. (2010)	1995-2001	ECHP	Prime-age	Vocational Training	M: 0.264***	Probit
Bassanini et al. (2007)	1995-2001	ECHP	Prime-age	Incidence of OJT	F: -0.001	Probit
Kenya						
Rosholm et al. (2007)	1995	RPED	Manufacturing workers	Incidence of OJT	M: -0.053	Probit
Malaysia						
Almeida and Faria (2014)	2002	WBES	Manufacturing and service workers	OJT	F: - 0.071	Probit
Netherlands						
Bassanini et al. (2007)	1995-2001	ECHP	Prime-age	Incidence of OJT	F: -0.006	Probit
New Zealand						
Gibson (2003)	1996	ETS	Prime-age whites Prime-age non-whites	Incidence of employer-provided OJT	M whites: -1.00 M non-whites: 1.48	Probit
Portugal						
Budria and Telhado Pereira (2007)	1998-2000	PLFS	Men and Women	Incidence of OJT	F: 0.452 M: 0.548	Averages
Bassanini et al. (2007)	1995-2001	ECHP	Prime-age	Incidence of OJT	F: 0.006**	Probit
Albert et al. (2010)	1995-2001	ECHP	Prime-age	Vocational Training	M: 0.162	Probit

Study	Period	Dataset	Sample	Training Definition	Training Incidence	Estimation Method
Spain						
Albert et al. (2010)	1995-2001	ECHP	Prime-age	Vocational Training	M: 0.082	Probit
Bassanini et al. (2007)	1995-2001	ECHP	Prime-age	Incidence of OJT	F: 0.001	Probit
Sweden						
Evertsson (2004)	1994-1998	SSLC	Prime-age	Incidence of OJT	F: -0.22***	Logit
Schøne (2004)	1989-1993	NSOE	Prime-age	Incidence of OJT	F: 0.013	IV first stage
Tanzania						
Biesebroeck (2007)	1991-1993	WBRED	Manufacturing workers	Incidence of OJT	M: 0.055**	OLS
Thailand						
Almeida and Faria (2014)	2004	WBES	Manufacturing workers	Incidence of OJT	F: - 0.072*	Probit
United Kingdom						
Booth (1991)	1987	BSAS	Full-time employed men Full-time employed women	Incidence of Formal OJT	Private Sector (M): -0.587** Children (M): 0.056 Private Sector (F): -0.204 Children (F): -0.733**	OLS
Booth (1993)	1980-1987	BHPS	College-Graduate men College-Graduate women	Incidence of Training	Children (M): 0.037 Children (F): -0.360**	Logit
Bassanini et al. (2007)	1995-2001	ECHP	Prime-age	Incidence of OJT	F: 0.030***	Probit
Albert et al. (2010)	1995-2001	ECHP	Prime-age	Vocational Training	M: - 0.139**	Probit
United States						
Duncan and Hoffman (1979)	1975	PSID	White men Black men White women Black women	Incidence of Training	WM: 0.258 BM: 0.091 WF: 0.141 BF: 0.088	Weighted averages
Lillard and Tan (1986)	1983	CPS	Men and women	Training to get currentor last job Training to improve skills	M: 0.555 F: 0.550 M: 0.38 F: 0.367	Averages
Gronau (1988)	1977-1979	PSID	Women Men	Incidence of OJT	M: 0.741 F: 0.675	Averages
Lynch (1992)	1980-1983	NLSY79	Young non-college graduates	Incidence of off-job training Incidence of OJT Incidence of Apprenticeship	M: -0.17*** M: 0.28*** M: 0.48***	Probit
Bishop (1994)	1982-1987	EOPP-NCRVE and NFIBS	New hires	Log training time	F: -0.105* F: -0.083 F: -139*** F (married): 0.109* M (married): -0.053	OLS-EOPP OLS-NFIB OLS-Augmented NFIB
Veum (1995)	1986-1990	NLSY79	Young	Incidence of company training Incidence of Apprenticeship Incidence of off-job training	M: -0.0208 M: 0.7043*** M: -0.0542	Probit
Krueger and Rouse (1998)	1991-1995	Records for manufacturing co. Records for service co.	Production workers All workers	Incidence of OJT	F: 0.122*** F: 0.057	Probit
Zambia						
Rosholm et al. (2007)	1995	RPED	Manufacturing workers	Incidence of OJT	M: -0.106	Probit

B Data sources

B.1 European Union Labor Force Survey (EU-LFS)

The European Union Labor Force Survey (EU-LFS) is a household survey conducted by the European Union to gather data on employment and labor market activities of individuals aged 15 years and above who live in the EU member states, as well as Norway, Switzerland, and Iceland. The survey is conducted on a quarterly basis and collects information on various aspects of employment, such as hours worked, type of job, employment status, occupation, and sector of activity. The EU-LFS also collects data on educational attainment, gender, age, family structure, nationality, and other demographic information to provide a comprehensive understanding of the EU labor market.

The survey is conducted using a common methodology across all participating countries, allowing for cross-country comparisons and analysis of trends in the labor market over time. While data collection dates back to 1983 for certain countries, data availability for each country generally coincides with EU membership.

B.1.1 Training definition

- On-the-job training:: Participation in non-formal education and training in the last 4 weeks. This variable covers learning activities organized with the intention to improve workers' knowledge, skills and competences, and encompasses participation in courses (classroom instruction, lecture, distance learning), seminars, workshops, or private lessons.

B.1.2 Matching variables

The set of demographic variables used in the matching procedure comprises gender, education, marital status, occupation, urban/rural status, and country. We describe the education, marital status, occupation, and urban/rural status variables variables below.

- Education: Less than primary, primary, lower-secondary, upper-secondary, post-secondary.
- Marital status categories: married and not married.[14]
- Occupation categories: managers; professionals; technicians and associate profession-

[14]Since we do not have a proper "marital status" variable available, we identified married individuals as those adults over 25 years old who live together in the same household and whose age difference is the smallest among all the people in that household.

als; clerical support workers; service and sales workers; skilled agricultural workers; craft and related trades workers; plant and machine operators; and assemblers, elementary occupations.

Table B.1: Data availability and number of observations in EU-LFS by country

Country	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Austria	87576	88840	85060	80433	78036	76366	75758	75033	99316	96938	99325	100495	97329	96611	96799	77557
Belgium	44876	43632	40726	39452	38325	35227	34477	33942	57842	54753	55051	81060	79281	82144	79198	69681
Bulgaria	58925	56119	56733	57341	54541	50877	49339	51063	65154	63609	65688	63357	65320	63475	55203	57209
Switzerland	0	0	0	0	51051	54020	53793	50344	86253	87347	83974	84150	83466	80422	82265	89501
Cyprus	13728	13927	14740	15085	15775	15327	15013	14618	22228	22004	22358	22421	21680	20810	20628	18230
Czechia	136243	133639	125185	118917	115630	111082	106458	101222	120642	117191	115417	113247	109502	106889	101193	99807
Germany	202850	195243	191455	190300	188092	174670	170929	167431	236616	237444	254884	260120	255418	253928	54242	151692
Denmark	20298	40821	35888	37339	42510	46430	46881	45866	66903	66005	54524	54604	56475	55084	54242	45067
Estonia	9398	10942	10126	8784	8694	9151	9890	9561	13961	13491	13482	15527	15329	15278	16423	14483
Greece	112499	107429	104397	105947	107056	94464	82229	81938	107612	104262	111604	107563	100576	92298	79994	68714
Spain	242079	251166	251248	253041	251166	242697	241183	237809	354440	342441	330806	327380	330640	333897	306041	243456
Finland	72529	70294	70300	67549	65036	62104	59845	57493	88300	86057	84150	81327	78050	73929	70113	46706
France	136431	140276	136957	159966	188998	193597	189056	169900	265984	264250	266425	258609	254468	247450	190164	174014
Iceland	5118	6753	6600	6485	6521	6514	6501	6255	8964	8735	8213	7444	8993	8332	9046	8452
Italy	304198	295019	290164	281424	280103	274235	252471	252185	294519	288870	279198	276763	273541	267035	248813	236354
Lithuania	16987	22738	20885	22611	22493	21445	21044	20501	30769	29374	28484	29229	29247	27380	24374	23399
Netherlands	208197	188740	184935	180503	167968	177131	176313	182416	255847	245774	240071	229922	254227	244454	237021	96011
Norway	45109	44220	40974	40329	38438	37896	35295	33931	58620	57162	58115	60605	62232	61490	61465	49658
Poland	110290	103332	101157	100715	190976	189667	183079	165690	197385	171679	158180	145657	131993	117363	128851	127221
Slovenia	36864	35006	32927	32709	31551	29215	26680	27394	36198	34686	35105	35459	35544	33316	33129	36897
Slovakia	62569	59925	59083	54719	53279	52506	49964	48482	56597	53868	52320	49473	47816	45886	45186	42483
United Kingdom	179537	175938	171789	161875	151753	141547	137691	131198	209683	200776	192315	189017	187123	181706	112304	0

Table B.2: Summary statistics in EU-LFS

	Men			Women		
	Child	No Child	**Difference**	Child	No Child	**Difference**
Mean age	34.40	38.72	-4.31	33.92	40.56	-6.64
Fraction married	0.59	0.38	0.21	0.55	0.43	0.12
Fraction urban	0.65	0.66	-0.02	0.66	0.68	-0.02
Mean years of schooling	11.14	12.07	-0.93	11.37	12.37	-0.99
Fraction on parental leave	0.00	0.00	0.00	0.01	0.00	0.00
Fraction employed	0.70	0.75	-0.05	0.55	0.68	-0.13
Fraction engaging in on-the-job training	0.07	0.08	-0.01	0.08	0.11	-0.03
Number of Observations	9,879,261	12,662,648		10,748,353	11,574,763	

B.2 European Union Adult Education Survey (EU-AES)

The European Union Adult Education Survey (EU-AES) collects data on participation in education and learning activities, with the specific objective of understanding adult education patterns. The survey includes information on the type and characteristics of learning activities pursued, along with information on workers skills and demographic information. This survey utilizes harmonized definitions and concepts, and provides a set of methodological documents and guidelines to help countries properly collect data. EU-AES covers individuals aged 25–64, and was conducted during 2007, 2011, and 2016.[15] We focus on

[15]In particular, this survey was deployed as a voluntary survey in 26 EU countries in 2007, and then as a mandatory survey in 27 and 28 countries, respectively, during 2011 and 2016. Information about these

the 2011 and 2016 waves for our analysis, since the 2007 wave was a pilot containing very different training definitions.

Table B.3: Data availability and number of observations in EU-AES by country

Country	**2011**	**2016**
Austria	4,915	4,672
Belgium	4,250	4,148
Bosnia and Herzegovina	0	4,660
Bulgaria	5,045	4,478
Croatia	0	2,417
Cyprus	2,040	2,424
Czech Republic	7,428	8,465
Denmark	3,166	2,912
Estonia	2,873	3,227
Finland	2,952	2,517
France	10,884	12,173
Germany	5,339	5,782
Greece	4,800	4,092
Hungary	6,287	5,856
Ireland	10,377	3,910
Italy	8,026	9,323
Latvia	4,276	4,797
Lithuania	4,311	2,878
Luxembourg	2,743	3,337
Malta	2,218	1,486
Netherlands	2,419	2,283
North Macedonia	0	5,915
Norway	2,773	2,308
Poland	21,093	12,630
Portugal	9,205	9,112
Romania	9,968	10,547
Serbia	3,349	2,988
Slovak Republic	4,387	2,563
Slovenia	3,930	4,321
Spain	14,808	18,112
Sweden	2,627	2,492
Switzerland	8,233	6,922
United Kingdom	2,736	5,324

countries and sample sizes are available in Table B.3.

Table B.4: Summary statistics in EU-AES

	Men			Women		
	Child	No Child	**Difference**	Child	No Child	**Difference**
Mean age	39.40	40.59	-1.19	38.88	42.18	-3.30
Fraction married	0.78	0.52	0.25	0.72	0.57	0.16
Fraction urban	0.63	0.67	-0.04	0.65	0.68	-0.04
Mean years of schooling	12.11	12.38	-0.27	12.34	12.76	-0.42
Fraction employed	0.79	0.73	0.06	0.63	0.69	-0.05
Mean potential experience	21.29	22.21	-0.92	20.54	23.42	-2.88
Fraction engaging in on-the-job training	0.40	0.39	0.01	0.39	0.43	-0.04
Fraction participated in training - not wanted	0.31	0.29	0.02	0.27	0.30	-0.02
Fraction participated in training- wanted	0.16	0.15	0.01	0.19	0.19	0.00
Fraction not participated in training - not wanted	0.40	0.44	-0.04	0.37	0.39	-0.01
Fraction not participated in training - wanted	0.12	0.12	0.00	0.16	0.13	0.04
Number of Observations	91,047	78,681		111,469	75,332	

B.2.1 Training and other relevant variables

- On-the-job training: Participation in any activity (courses, workshops and seminars, guided on-the-job training, or private lessons) with the intention to improve knowledge/skills in any area (including hobbies) during the last 12 months.
- Participated in training - not wanted: Participated in formal or non-formal education and training during the last 12 months, but did not want to participate in more of these activities then.
- Participated in training - wanted: Participated in formal or non-formal education and training during the last 12 months but wanted to participate in more of these activities then.
- Not participated in training - not wanted: Did not participate in formal or non-formal education and training during the last 12 months and did not want to participate.
- Not participated in training - wanted: Did not participate in formal or non-formal education and training during the last 12 months but wanted to participate.
- Training financing for training during the last 12 months:
  - By employer: Training is fully or partially paid for by the employer.
  - By public institutions: Public institutions or the government programs finance the training.

– By themselves: The individual worker self-financed the training.

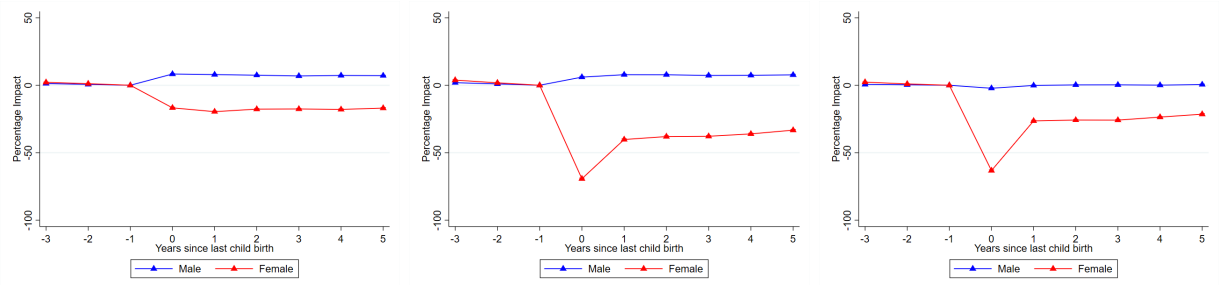
– Mixed: When both the employer and the worker share the costs of the training.

C Additional results

C.1 Validation of pseudo-event study methodology

Figure C.1: Impact of first child birth on the employment and hours worked of men and women on on-the-job training activities (EU-LFS)

(a) Employment status **(b)** Hours worked **(c)** Hours worked (conditional on being employed)



Notes: This figure presents pseudo-event studies of the impact of first child birth on the employment status and hours worked (both conditional and unconditional on working) of men and women on on-the-job training activities using pooled data from all countries in the EU-LFS following the sample refinements described in Section 3.3. The series depict the percentage impact of child birth (P_t^m and P_t^w in Equation (2)) at each event time t relative to the base event time corresponding to the year before child birth, $t = -1$. The error bars depict 95% confidence intervals based on robust standard errors.