Parenthood and the Gender Gap in Commuting

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Abstract

Childbirth raises the opportunity cost of commuting and makes it difficult for both parents to work far away from home. Using detailed Norwegian employer-employee matched register data, we show that the commuting behavior of men and women diverges immediately after childbirth and that those differences persist for at least a decade. This divergence in commuting behavior exposes mothers to more concentrated and rural labor markets with fewer job opportunities and lower establishment quality. These findings uncover a key mechanism underlying the child penalty documented in prior work and have important implications for the design of policies seeking to address the remaining gender wage gap.

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1 Introduction

The gender pay gap has declined dramatically over the past decades. However, substantial differences remain, particularly among individuals in high-paying occupations (see Blau and Kahn, 2017). As females have overtaken males in terms of educational attainment, and closed the work experience gap in most OECD countries, the outstanding gap cannot be explained by differences in traditional human capital inputs. The causes of the remaining gender differences in labor market outcomes, therefore, remain actively debated.

A growing body of work discusses the importance of gender differences in psychological traits such as the willingness to compete or bargain for wages (Azmat, Calsamiglia and Iriberri, 2016; Niederle and Vesterlund, 2007; Tungodden and Willén, 2023). Another strand of literature highlights the importance of gender differences in preferences for job amenities and characteristics, such as flexible work arrangements (Goldin and Katz, 2016; Mas and Pallais, 2017), family-friendliness of establishments (Hotz, Johansson and Karimi, 2017), and commuting distance (Le Barbanchon, Rathelot and Roulet, 2019; Petrongolo and Ronchi, 2020). Hence, part of the remaining gender wage gap may be due to differences in behaviors, and part of the remaining gap may be due to differences in the willingness to trade off higher wages for other types of work amenities.

Gender differences in the career cost of parenthood represent another mechanism behind the persistent pay gap (Adda, Dustmann and Stevens, 2017; Bertrand, Goldin and Katz, 2010; Cortés and Pan, 2023). Specifically, a rapidly expanding field of research shows that childbirth leads to significant long-term declines in earnings for mothers but not fathers (Angelov, Johansson and Lindahl, 2016; Lundborg, Plug and Rasmussen, 2017; Kuziemko et al., 2018; Kleven, Landais and Søgaard, 2019). This phenomenon is true even after accounting for the potential endogenous timing of childbirth (Bensnes, Huitfeldt and Leuven, 2020). While some of the documented child penalty is driven by mothers switching to more family-friendly employers and falling behind in occupational rank, these child penalties might also operate through gender differences in the preferences and opportunity costs of commuting immediately following childbirth.

This paper advances the literature on child penalties by studying the impact of parenthood on the commuting behavior of mothers and fathers. The rationale underlying our analysis is that parenthood increases the opportunity cost of commuting and makes it difficult for both parents to work far away from home. A reduction in a worker's willingness to commute is akin to a narrowing of an individual's job search area and can have substantial effects on the individual's labor market career. Specifically, a decline

in the labor market search area will reduce the number of available jobs and expose the individual to a higher concentration of firms. This will not only increase the likelihood of job mismatch, but it may also push wages down due to increased exposure to concentrated labor markets and firm monopsony power (Dodini et al., 2020). As there are significant gender differences in the willingness to commute – in particular for mothers of young children (Le Barbanchon, Rathelot and Roulet, 2019; Petrongolo and Ronchi, 2020; Borghorst, Mulalic and van Ommeren, 2021) – the increased opportunity cost of commuting may have a considerably larger impact on mothers relative to fathers. The implication of an increased gender difference in commuting following childbirth is that mothers become systematically exposed to worse labor market conditions than fathers. This could represent a core mechanism through which the documented motherhood child penalty operates.

To perform our analysis, we follow the existing literature and adopt a quasi-experimental event study approach around the birth of the first child (see, e.g., Kleven, Landais and Søgaard, 2019). We exploit rich Norwegian register data to identify all first-time parents between the years 1990 and 2000. As we are interested in potential gender differences in the commuting response to childbirth, we restrict our sample to parents with a well-documented attachment to the labor force (mothers and fathers who have been continuously employed during the four years prior to childbirth). We follow these parents for fifteen years: from four years before childbirth to ten years after the year of childbirth. Using Microsoft's BING Distance Matrix API service to measure the driving distance between residence and workplace, we investigate changes in commuting distance and commuting probability around the birth of the first child for mothers as well as fathers.

Examining the relationship between childbirth and parental commuting behavior in the country of Norway is particularly interesting. First, while the country is portrayed as one of the most gender-equal countries in the world, the gender gap in commuting is close to the average commuting gap in the OECD, and there has been little convergence in the commuting behavior of men and women over the past decade. For example, between 1992 and 2019 the gender gap in commuting only decreased by 6 percentage points, from 41 to 35 percent. Second, similar to other OECD countries, Norway has seen a dramatic increase in the average commuting distance over the past decades, potentially augmenting the labor market implications of gender differences in commuting. Specifically, large transportation surveys show that the average commuting distance in Norway has doubled since 1990, from 10 to 20 kilometers (Statens vegvesen, 2019; Hjorthol, Øystein Engebretsen and Uteng, 2014; Stangeby, 1987). Finally, the rich Norwegian employer-employee matched data, and therefore data on commuting distances,

labor market concentration, and establishment quality and characteristics, can be linked to birth records as far back as the early 1980s. Combined with detailed individual-level data on employment, earnings, occupation, and family composition, this enables us to overcome several of the data limitations that have inhibited prior research from analyzing this question.

Our analysis provides four key insights. First, similar to the existing literature, we find large motherhood child penalties in earnings and hourly wages. Specifically, earnings of men and women trend similarly prior to the birth of the first child, quickly diverge after childbirth, and do not converge for at least the first ten years post-childbirth. Second, using the driving distance between residence and workplace as our measure of commuting distance, we uncover a similar effect pattern with respect to commuting. The commuting patterns of men and women evolve similarly prior to the birth of the first child, quickly diverge after childbirth, and do not converge for at least the first ten years after childbirth. Third, we show that this divergence in commuting distance exposes mothers to more concentrated labor markets with fewer job opportunities and lower-quality employers. These findings provide strong evidence for the mechanisms through which the motherhood commuting effect impacts earnings and long-run labor market outcomes. Finally, we provide direct suggestive evidence of the link between the commuting effect and the earnings penalty by examining the earnings penalty effect stratified by the size of the commuting penalty experienced by the individual. These results demonstrate that the size of the earnings penalty is strongly positively associated with the size of the commuting effect. These results provide strong suggestive evidence that changes in the commuting behavior of mothers at the onset of childbirth is closely linked to the motherhood earnings penalty documented in the prior literature.

This paper advances the rich and growing literature on gender differences in labor market outcomes (see Bertrand, 2011; Goldin, 2014; Olivetti and Petrongolo, 2016; Blau and Kahn, 2017). In particular, the paper bridges two strands of the literature on the gender wage gap. First, we contribute to the growing evidence on the presence of child penalties for mothers by uncovering a new mechanism—gender differences in commuting—through which these child penalties may operate (see, e.g., Angelov, Johansson and Lindahl, 2016; Kleven, Landais and Søgaard, 2019; Kuziemko et al., 2018). That is, we show that sharp changes in the commuting behavior of women relative to men after childbirth may explain a significant amount of the child penalty documented in the previous literature. Second, we add to the burgeoning literature that relates gender differences in willingness to commute to the gender wage gap (Le Barbanchon, Rathelot and Roulet, 2019; Petrongolo and Ronchi, 2020). In particular, we show that

childbirth generates a substantial increase in the gender gap in commuting, exposing mothers to more concentrated and rural labor markets with fewer job opportunities and lower establishment quality, and augmenting the gender wage gap. These findings have important policy implications for how we design maternal protection and family policies. It also highlights the importance of carefully designed transportation infrastructure for eliminating gender differences in labor market outcomes among parents.

The rest of this paper proceeds as follows: In Section 2, we describe the institutional background. In Section 3, we introduce the data and provide variable definitions. In Section 4, we present our empirical estimation approach and discuss the assumptions underlying this approach. In Section 5, we show the results from our analysis. Section 6 concludes.

2 Institutional Background

Norway is characterized by a generous welfare system with comprehensive public social insurance. Family policies play a central role in the country's social safety net. These policies serve to protect parents and children from adverse shocks as well as ensure a gender-balanced division of labor within the household. While, for example, cash benefits to poor families aim to shield parents from adverse shocks, an increasing number of maternal protection and paternity leave policies encourage mothers to participate in the labor market and fathers to get further involved with childcare. Among such policies are subsidized and broadly available childcare and after-school programs (Black et al., 2014; Havnes and Mogstad, 2015), generous maternity leave policies with employment protection (Carneiro, Løken and Salvanes, 2015; Dahl et al., 2016), and non-transferable paternal leave (Dahl, Løken and Mogstad, 2014). Moreover, during recent decades, Norway has also introduced laws protecting women against discriminatory employment practices and gender quotas for board representation at public limited liability companies (Bertrand et al., 2019).

Gender differences in labor market outcomes have been greatly reduced during the past decade (Ahrsjö, Karadakic and Rasmussen, 2023). For example, men and women have almost identical labor market participation rates and most women return to the labor force after the birth of a child. Nevertheless, there is still a meaningful and persistent wage difference between men and women in Norway. For example, the median annual earnings of women are only 75 percent of the median annual earnings of men (Bütikofer, Jensen and Salvanes, 2018). In addition, females are much more likely to work part-time than men (36.8 percent compared to 12.5 percent), more likely to work in the public

sector (70.1 percent of public employees are females), and less likely to hold leadership positions (35.3 percent of individuals in leadership positions are females) (Riise, Willage and Willen, 2020).[1] Finally, women in the Nordic countries also face a substantial child penalty when becoming mothers, though this penalty is somewhat smaller than that in the US and the UK (Kleven et al., 2019). Thus, while Norway has come further than most countries in achieving gender equality in the labor market, several challenges remain.

Local labor markets in Norway have expanded over the past decades, and both the average commuting distance, as well as the likelihood of commuting across municipalities, are trending upward. For instance, from 1992 to 2014, the average daily commuting distance for work increased from 13.7 km to 19.1 km for men and from 8 km to 12.5 km for women (Hjorthol, Engebretsen and Uteng, 2014). Furthermore, more than 33 percent of all workers commute across municipality borders in our data. Most of these individuals work across municipalities but within the same aggregated labor market.[2] However, the number of long-distance commuters is also rising. Approximately 70 percent of all cross-municipality commuters commute by car. This share is somewhat smaller for commuters in and around the largest cities, where commuting by bus and train is more convenient. Commuters are predominantly male and are employed in the private sector (see Statens vegvesen, 2019; Hjorthol, Øystein Engebretsen and Uteng, 2014; Stangeby, 1987). Understanding how these trends in commuting behavior interact with the child penalties mothers encounter after parenthood may help us gain insights into which policy tools can be employed to further close the gender pay gap.

3 Data and Definitions

3.1 Norwegian Register Data

Our primary data come from matched employer-employee registers covering the universe of Norwegian residents between 1986 and 2010. These data contain detailed information on every individual's employer and enable us to identify both place of work as well as place of residence. A unique personal identifier enables us to merge this data with information from various administrative registers, such as the education register,

[1] In Figure B5 we show the shares of women and men in different industries defined following the Norwegian adoption of one-digit ISIC codes (Statistics Norway, 1983). This figure shows that a large share of women works in the sector *Community, Social, and Personal Services* which covers public sector employment, teaching, and the healthcare sector.

[2] Labor markets are aggregations of municipalities based on commuting patterns. The 46 local labor markets in Norway cover the entire country and consist, on average, of nine municipalities (Bhuller, 2009).

the family register, the earnings register, and the social security register. The longitudinal nature of the data enables us to follow individuals over time, and unique family identifiers enable us to link parents and children.

Our data provide detailed earnings and employment information for each individual in the country. Labor earnings are measured as annual pre-tax labor income and include regular labor income, income from self-employment, and a limited set of taxable government transfers (sick leave benefits, unemployment insurance benefits, and parental leave benefits). The data further contain information on hours worked in three broad categories (0–19h, 20–29h, 30+h per week). We use this information to construct a proxy for hourly earnings by dividing labor earnings by the median value in the hours worked interval. For individuals in the 30+h interval, we assume they are full-time workers and assign them a value of 37.5h per week. Employment status is defined based on the individual's status in the labor register. The matched employer-employee data also provides unique establishment identifiers and industry affiliations, which we use to construct measures of labor market concentration, outside options, and establishment quality. Education is measured as the length of the highest attained education one year prior to becoming a first-time parent. In addition to labor market characteristics, the data provide us with a broad set of demographic and socioeconomic characteristics.

In terms of sample construction, we start by identifying all individuals who became first-time parents between 1990 and 2000. We then restrict the sample to parents who are observed every year between four years before having a child and ten years after. This is a common restriction in the literature on the child penalty and enables us to construct a balanced panel of parents over a long time period (e.g., Bütikofer, Jensen and Salvanes, 2018).[3] We also restrict our sample to individuals with strong a labor market attachment prior to the birth of the first child (individuals who have been continuously employed during the four years prior to childbirth). We impose this restriction primarily because we are interested in uncovering potential gender differences in the commuting response to childbirth, which requires that the parents work at the time of childbirth, and the restriction ensures that we have a comparable set of mothers and fathers. This yields a total sample of $87,659$ first-time mothers and $110,595$ first-time fathers spanning the period from 1986 to 2010. Summary statistics for our main analysis sample are provided in Table B1.

[3]We place no restrictions on the relationship status of the parents.

3.2 Commuting Behavior

This paper examines the impact of parenthood on the commuting behavior of mothers and fathers. Crucial to this analysis is our ability to observe both the individual's place of residence as well as the individual's place of work. We focus on two commuting measures: (i) the probability of commuting to work and (ii) commuting distance. We use Statistic Norway's definition of commuting. To this end, we classify commuters as individuals whose workplaces are located in municipalities different from their municipalities of residence.[4] Since previous literature has found that commuting distance is inversely related to job satisfaction and subjective well-being (Chatterjee et al., 2020), we use commuting distance as a second measure of commuting behavior. Commuting distance in our analysis is proxied by the distance between individuals' and firms' postcodes. Our data encompass 5,028 unique postcodes. The average postcode spans a very small geographic area, encompassing approximately 115 individuals. For more than 62 percent of our observations, we can assign distances from the postcodes of both the residence and workplace. Nevertheless, some postcodes were discontinued between 1980 and today and some establishments have missing postcodes. Hence, there are firms for which we cannot construct geocoded locations. In these instances, we rely on distance measures that are constructed from municipality center coordinates (see Figure B6). However, this aggregate municipality measure cannot identify within-municipality commuting. This leaves us with two possibilities to measure commuting distance: (i) only consider commuting distance for commuters—individuals that commute across municipality borders, or (ii) limit the sample to firms for which we observe valid postcodes. In our main specification, we follow alternative (i) and set the commuting distance to zero for individuals who do not fall in our commuter definition. We also perform robustness checks where we measure commuting distance both across and within municipalities on a subsample of individuals. As we discuss below, the results are unaffected by these adjustments.

Exploiting information on the longitude and latitude of each postcode from data collected by Bolstad (2020), we use Microsoft's BING Distance Matrix API service to construct distance measures of each individual's commute. This measure is based on the distance between the center of the residence postcode and the workplace postcode (or the administrative center of the municipality if the workplace postcode is missing). The driving distance we measure is based on current infrastructure and assumes that individuals commute by car. This assumption holds for more than 70 percent of Norwe-

[4] As there are a few municipality mergers during our analysis period. We, therefore, harmonized municipalities to the 2019 structure with 422 municipalities.

gian commuters (Statens vegvesen, 2019; Vågane, Brechan and Hjorthol, 2011; Stangeby, 1987).

3.3 Survey Data

In addition to the rich Norwegian administrative data, we run a large-scale survey on a representative sample of mothers and fathers in Norway to capture how men and women trade off commuting for different types of job amenities.[5] This survey was inspired by Mas and Pallais (2019) and asks respondents to make hypothetical choices between two identical jobs with different levels of specific job amenities. While the full survey examines a range of different job amenities, such as flexible work schedules, telecommuting, and career development, we restrict attention to the commuting time and salary trade-off comparison in this paper. The question reads as follows:

Imagine that you are applying to a new job in the same line of work as your last job, and you are offered two positions. Both positions are identical to your last job in all ways, and to each other, except in terms of commuting time and how much they pay. If you currently do not have a job, think about the last job you had.

- ***P1:*** *Commuting time is 20 minutes (one way), the job pays the same as your last job*
- ***P2:*** *Commuting time is 40 minutes (one way), the job pays X more than your previous job.*

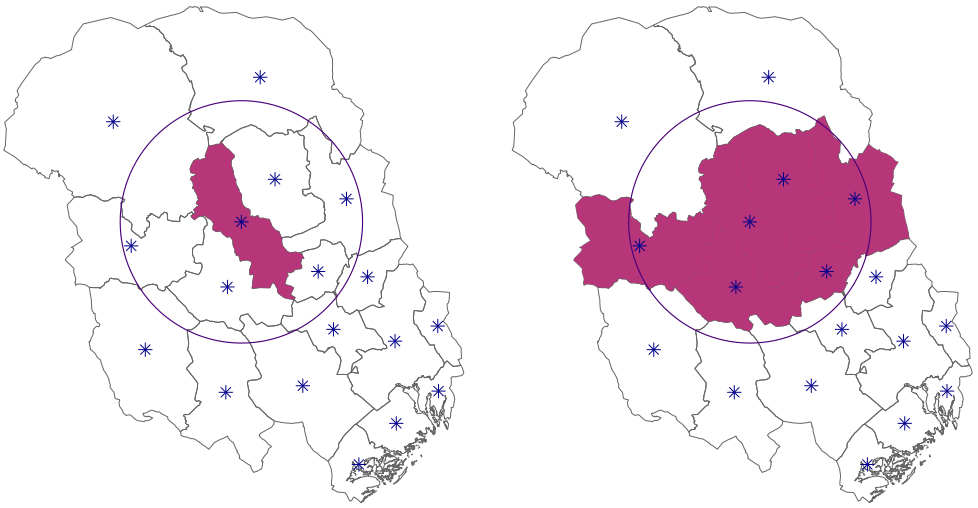
In the above example, X represents a monetary amount calculated as a random percent, in ten-percent bins, of the salary that the respondents have provided in the survey: $\gamma \in [10, 20, 30, 40, 50, 60]$. The overall objective underlying this survey question is to understand better how willing workers are to trade off commuting for salary gains across the earnings distribution. By randomly assigning γ across participants, we are able to orthogonalize salary increases from other covariates in the sample. This allows us to examine the pure effect of a higher salary on the willingness to commute.

3.4 Labor Market Concentration

To examine if the change in commuting behavior has an impact on the job opportunities of workers, we construct three measures of labor market concentration: the number of establishments, the number of jobs, and the Herfindahl-Hirschman Index (HHI). Each of these measures captures slightly different dimensions of labor demand and helps us

[5]Summary statistics for the most important variables and characteristics in the survey are presented in Appendix Table B2.

develop a comprehensive understanding of how changes in commuting distance impact an individual's labor market opportunities and outside options.



(a) Commuting Radius (b) Individual-Specific LLM

Figure 1: Illustration of Individual-Specific Local Labor Markets (LLM)

Note: The figure shows how local labor markets are constructed using the revealed commuting behavior of individuals. The radius around the highlighted area in Panel 1a indicates the observed commuting distance. All municipalities whose administrative municipality center (blue marked stars) falls within this radius are then counted towards the individual's local labor market in the particular year. This is indicated by the highlighted area in Panel 1b.

First, we focus on the number of establishments that employ workers of similar types. Specifically, we calculate the number of establishments within a year-area-industry cell where individuals with a similar level of education are employed.[6] A hypothetical example would be a person who lives in Oslo in 1995, works in construction, and has a high school degree. For this worker, we would simply count the number of establishments in the construction industry that employ individuals with a high school degree and are located in the worker's local labor market. To define an individual's local labor market, we draw a circle between the individual's place of residence and workplace, letting the distance between the workplace and the place of residence act as the radius of that circle. All municipalities with centers that fall inside this circle are considered to belong to the individual's local labor market. A visual illustration of this data-driven

[6]Education is categorized into three groups: high school or less (less than 12 years of education), more than high school (but no Bachelor's degree, 12 to 14 years of education), and at least a Bachelor's degree (15 or more years of education). We include the education dimension in addition to the industry dimension since prior work has shown that industry alone is an imperfect measure for labor market concentration because workers can switch across industries Dodini et al. (2020).

local labor market assignment approach is provided in Figure 1. In other words, we use an individual's revealed commuting preference as a proxy for the individual's local labor market. The geographic boundaries of the labor market will therefore vary across individuals and time depending on the distance between the individual's workplace and place of residence in that year. Hence, this measure provides information on how much employer concentration the individual faces in her labor market. This provides a helpful proxy for how concentrated labor demand is.

Second, we focus on the number of jobs. We calculate the number of newly employed individuals, including job-to-job transitions, at the year-area-industry-education level. This measure complements the above measure and acts as a proxy for the labor market opportunities available to the worker in a specific industry with a specific type of educational degree. Finally, we construct an HHI at the year-area-industry-education level. We construct the HHI by first calculating year t, area a, industry j, and education e specific employment shares for each establishment f. These shares are then used to construct the HHI as the sum of squared employment shares across all establishments within a year-area-industry-education cell:

$$HHI_{jaet} = \sum_{f=1}^{N} s_{fjaet}^2 \text{ where } s = \frac{emp_{fjaet}}{\sum_{f=1}^{N} emp_{fjaet}} \tag{1}$$

The HHI ranges from 0 to 1, where 1 indicates a single monopsonistic establishment in the market. Hence, the HHI measures the concentration of labor demand for a given industry-education group across establishments in the local labor market. Figure B1 shows the average HHI in each municipality in 1995. The figure shows that concentration in the largest cities of Norway is much lower than that in more rural parts of the country. There are also differences across industry-education cells.

3.5 Establishment Quality

To investigate whether changes in commuting behavior and labor market concentration impact the quality of an individual's workplace, we construct measures of establishment quality following measures suggested in the existing literature: establishment size and average establishment earnings (see, e.g. Dustmann et al., 2020). The two measures we focus on each capture slightly different dimensions of establishment quality. Taken together, these measures help us understand the potential mechanisms behind the motherhood penalty in earnings.

First, establishment size has been used extensively to measure establishment quality,

in particular for individuals in the early stages of their careers. For example, Oreopoulos, Von Wachter and Heisz (2012) show that individuals starting their careers at larger employers suffer from fewer negative labor market consequences in comparison to those that start at smaller firms. Additionally, larger firms are associated with higher wages in the short term, as well as better training opportunities which ultimately results in improved career progression and earnings in the long run (Arellano-Bover, 2024). The second measure we use to capture establishment quality is the average hourly earnings of individuals at the establishment. Establishments paying higher wages, controlling for person fixed effects, have been shown to be more productive as well as more profitable (Abowd, Kramarz and Margolis, 1999).

Both establishment quality measures are constructed from the matched employer-employee data. We condition this sample on individuals with non-zero hourly earnings who have non-missing establishment identifiers. To construct the establishment quality measures, we use a leave-one-out approach, which ensures that the measures are net of the impact of the particular individual under investigation. This allows us to abstract from changes in establishment quality due to changes in labor market characteristics of the individual whose establishment quality we want to observe.

In the year prior to childbirth, the median establishment size for men was 57 and the median establishment size for women was 69. The average hourly earnings in establishments for men was 216 NOK and the average hourly earnings in establishments for women was 213 NOK.[7] We provide a more detailed overview of the establishment quality measures in Appendix A. The main difference in establishment characteristics between men and women is the full-time share within the establishment. Men, on average, work at establishments with an average of 86% of employees working full-time. For women, this share is only 71%.

4 Empirical Method

We follow the pre-existing literature and adopt a quasi-experimental event study approach centered around the birth of the first child (Kleven, Landais and Søgaard, 2019; Bütikofer, Jensen and Salvanes, 2018; Kuziemko et al., 2018). Specifically, we estimate versions of the following model separately for mothers and fathers:

[7] In Figure A1 we provide information on the distribution of establishment quality measures for our main commuter sample by sex and time relative to parenthood.

$$y_{ist}^{g} = \alpha^{g} + \sum_{t=-4}^{-2} \delta_{t}^{g} D_{it} + \sum_{t=0}^{10} \delta_{t}^{g} D_{it} + \sum_{k} \beta_{k}^{g} A_{ist}^{g} + \lambda_{s}^{g} + \varepsilon_{ist}^{g} \;\; \forall \, g \in [m, f], \tag{2}$$

where y_{ist}^{g} is an outcome for individual i in calendar year s and relative time t. Relative time is relative to the birth of the child, such that children are born when $t = 0$. The variable D_{it} is a relative time dummy taking the value of 1 if the individual was observed in relative time t, and zero otherwise. The δ_{t}^{g} coefficients identify both relative pre-treatment trends as well as time-varying treatment effects of parenthood. We omit δ_{-1}^{g} such that all estimates are relative to the year prior to childbirth. The variable A_{ist}^{g} is a set of age dummies, which allows us to non-parametrically control for underlying life-cycle trends. Equation 2 also includes a full set of calendar year fixed effects λ_{s}^{g}, allowing us to account for any systematic shocks across years due to factors such as business cycle fluctuations and infrastructure improvements.

After having estimated Equation 2 and obtained a full set of relative time coefficients δ_{t}^{g}, we compute the specific relative time t effect as a fraction of the counterfactual outcome of not entering parenthood. We do this by re-scaling the relative time estimate in year t with predicted values of the counterfactual outcome at the same relative time. The relative time t effect as a fraction of the counterfactual outcome can then be written as $P_{t}^{g} = \hat{\delta}_{t}^{g} / E\left[\hat{y}_{ist}^{g} \mid t\right]$, where $\hat{y}_{ist}^{g}$ is the predicted counterfactual outcome obtained from estimating a modified version of Equation 2 in which the relative time dummies are excluded: $\hat{y}_{ist}^{g} = \hat{\alpha}^{g} + \sum_{k} \tilde{\beta}_{k}^{g} A_{ist} + \lambda_{s}^{g}$. Provided that the unobserved variables that determine labor market outcomes evolve smoothly over time, P_{t} can be interpreted as the effect of parenthood on the outcome relative to the year before parenthood (Kleven, Landais and Søgaard, 2019).

$$\text{Child Penalty} = \mathbb{E}[P_{t}^{m} - P_{t}^{f} \,|\, t \geq 0] - \mathbb{E}[P_{t}^{m} - P_{t}^{f} \,|\, t < 0]. \tag{3}$$

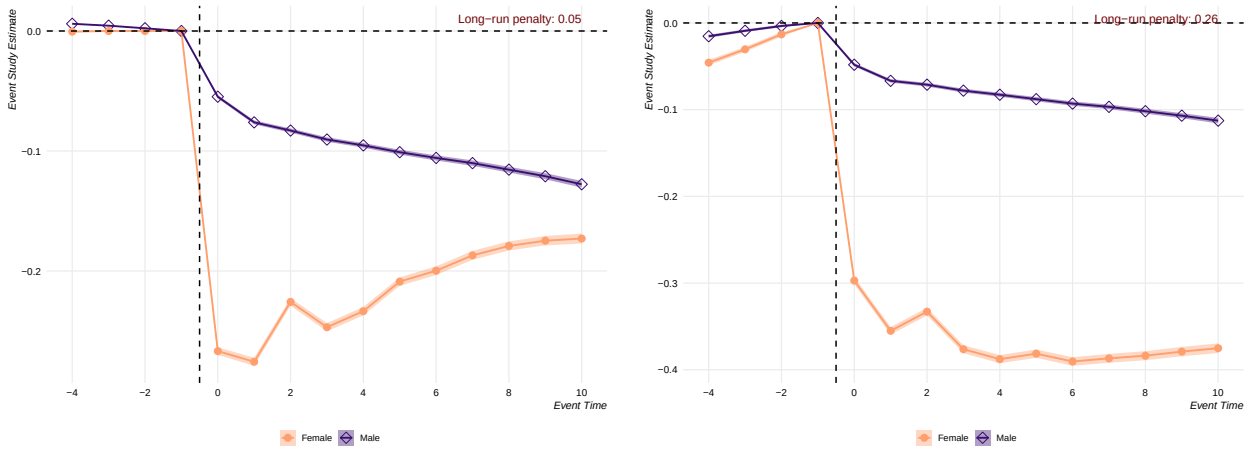
In addition to the main event study figures, we provide an overview of the overall child penalty following Kleven (2022). The child penalty is defined as the difference between the relative male and female parenthood effect averaged separately over the post-parenthood and pre-parenthood time. The difference between these two averages is then defined as the overall child penalty, as presented in Equation 3.

5 Results

In this section, we present our main results. We start by showing results on employment and earnings, which we discuss and compare with prior work on the motherhood penalty in Scandinavia (Angelov, Johansson and Lindahl, 2016; Kleven, Landais and Søgaard, 2019), the United States, the United Kingdom (Kuziemko et al., 2018; Kleven, 2022), and to a broader set of OECD countries (Kleven et al., 2019). We then introduce our results on the parenthood gap in commuting and discuss how they are corroborated by the results from our survey. Finally, we investigate the implications of changes in commuting behavior for the type of labor market that the individual is exposed to, both in terms of labor market concentration as well as in terms of establishment characteristics and quality.

5.1 Employment and Earnings Responses to Parenthood

In Figure 2, we show event studies for the effect of childbirth on the extensive (Panel 2a) as well as the intensive margin (Panel 2b) of labor supply for both men and women.



(a) Extensive Margin

(b) Intensive Margin

Figure 2: Labor Supply Relative to Parenthood

Note: The figure shows the estimated coefficients of the event time dummies, obtained from Equation 2, as a fraction of the predicted outcome, when omitting the contribution from event dummies in each year relative to the birth of the first child. Coefficients are estimated separately for men and women. The shaded areas indicate the 95% confidence band using robust standard errors. The samples include men and women who became first-time parents between 1990 and 2010, and who have been continuously in employment in the years prior to childbirth. Long-run penalties represent the difference between the male and female estimate at $t = 10$ and are indicated in the top-right corner of each panel. Intensive margin employment is hours worked which are available in three broad categories: 0, 10, 25, and 37.5 hours per week.

Similar to the findings in other OECD countries, Panel 2a shows that there is an immediate and discontinuous drop in the extensive margin of labor supply for women immediately following childbirth, while there is only a very modest decline in the extensive margin of labor supply for men. Although the immediate post-childbirth gender gap in employment (20 percentage points) shrinks over time, it remains economically meaningful even ten years after childbirth (5 percentage points).

In terms of the intensive margin of labor supply (hours worked), Panel 2b reveals an immediate and discontinuous drop for women following childbirth, while there is very little change in the hours worked for men. In contrast to the extensive margin result, however, the initial post-childbirth gender gap in hours remains stable over the entire ten-year post-childbirth period, showing only small signs of convergence during our sample period. That the gender gap in hours worked relative to childbirth does not converge over time suggests that the employment gap is not only driven by the extensive margin response shown in Panel 2a, but also by a strong shift from full-time to part-time work. Overall, women reduce their hours by over 30% relative to their pre-parenthood labor supply in the years immediately post childbirth.

Figure 3 shows event study plots for annual earnings (Panel 3a) and hourly earnings (Panel 3b) for both men and women. Panel 3a confirms the results from the existing literature: the earnings of men and women are trending similarly before childbirth, and diverge abruptly following childbirth. Specifically, there is a sharp discontinuous drop in female earnings at the onset of parenthood while no such drop is observed among men. This differential drop in earnings across genders persists even ten years after childbirth and results in a long-run penalty of approximately 28%. Even though the initial earnings response is smaller than what has been found for neighboring Sweden, the long-run penalty is slightly larger (Kleven et al., 2019).[8] Relative to other non-Scandinavian countries, Norwegian women experience a slightly smaller earnings penalty compared to women in the US and the UK, and a much smaller earnings penalty compared to women in Australia and Germany (Kleven et al., 2019). This difference is usually attributed to differences in gender norms with respect to women in the labor market and gender-specific housework expectations.

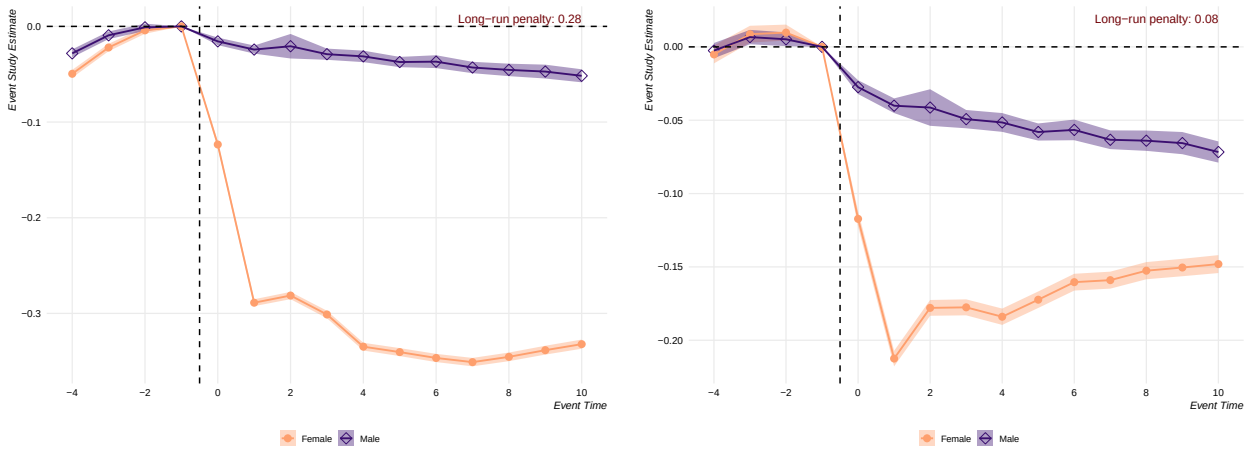
Panel 3b demonstrates that the general pattern of results with respect to annual earnings extends to hourly earnings as well, though the long-run gender gap in hourly earnings is considerably smaller (about 6 percentage points).[9] This implies that the large

[8]The overall child penalty in Norway for our main sample also aligns very closely with findings by Andresen and Nix (2022) that find a long-run penalty of approximately 24% for Norway.

[9]The hourly earnings penalty is similar if we restrict the sample to individuals who are employed throughout the entire sample period (Figure B3).

drop in female earnings following childbirth is not only driven by females dropping out of the labor market and working fewer hours but also by females earning less conditional on hours worked. This is consistent with prior literature, which has found that both extensive and intensive margin effects are important for explaining the child penalty in earnings; particularly in the Scandinavian countries with a high overall female labor force participation rate (Kleven et al., 2019; Bütikofer, Jensen and Salvanes, 2018).

As discussed above, the intensive margin earnings effect could operate through several different channels. One such channel relates to differential changes in preferences for job amenities and characteristics such as commuting. In the next subsection, we turn to examine this potential commuting mechanism in detail.



(a) Earnings

(b) Hourly Earnings

Figure 3: Earnings Relative to Parenthood

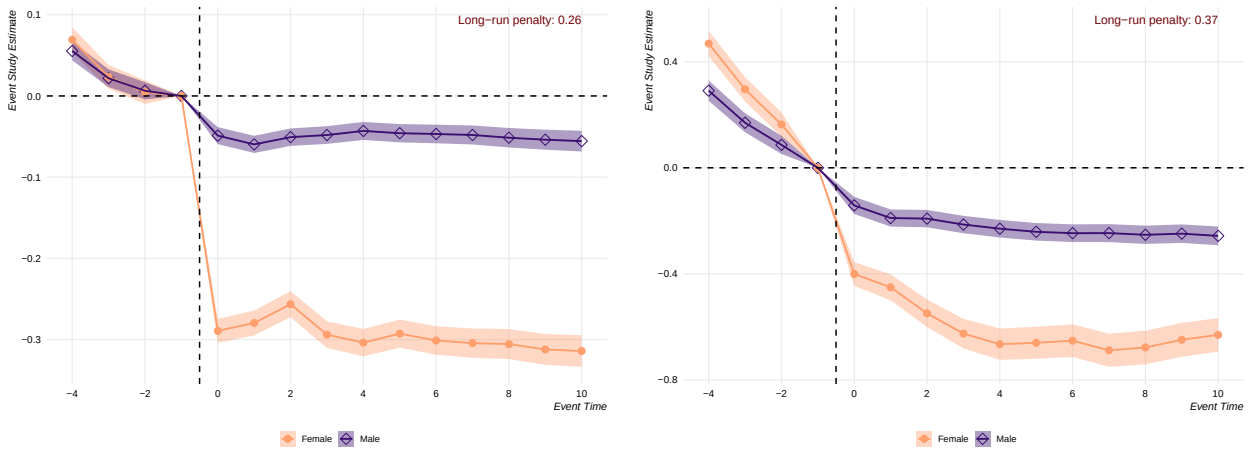
Note: The figure shows the estimated coefficients of the event time dummies, obtained from Equation 2, as a fraction of the predicted outcome, when omitting the contribution from event dummies in each year relative to the birth of the first child. Coefficients are estimated separately for men and women. The shaded areas indicate the 95% confidence band using robust standard errors. The samples include men and women who became first-time parents between 1990 and 2010, and who have been continuously in employment in the years prior to childbirth. Long-run penalties represent the difference between the male and female estimate at $t = 10$ and are indicated in the top-right corner of each panel.

5.2 Commuting Behavior in Response to Parenthood

To disentangle the commuting effect of childbirth, Figure 4 shows event study results for the full set of P_ts with respect to the probability of commuting (Panel 4a) and commuting distance (Panel 4b), both for men and women.

The results from the commuting analysis mirror the earnings effects documented in Figure 3. Specifically, the probability of commuting (Panel 4a) is trending similarly for

men and women prior to childbirth and diverges abruptly following childbirth. There is a sharp discontinuous drop in female commuting at the onset of parenthood (approximately 30 percentage points) while only a very small drop is observed among men (approximately 5 percentage points). This differential drop in commuting across genders persists throughout our ten-year post-childbirth analysis window. The commuting effect is partially explained by the extensive margin labor supply effect shown in Figure 2. However, the long-run gender gaps in commuting are also present for individuals who are employed throughout the entire analysis period (see Table B3). The commuting effect we identify is, therefore, not only a mechanical effect driven by extensive margin employment effects.



(a) $\mathbb{P}$(Commuting) (b) Commuting Distance

Figure 4: Commuting Behavior Relative to Parenthood

Note: The figure shows the estimated coefficients of the event time dummies, obtained from Equation 2, as a fraction of the predicted outcome, when omitting the contribution from event dummies in each year relative to the birth of the first child. Coefficients are estimated separately for men and women. The shaded areas indicate the 95% confidence band using robust standard errors. The samples include men and women who became first-time parents between 1990 and 2010, whom we observe three years prior to childbirth and 10 years after, and who are employed for at least 8 out of 15 years around childbirth. Long-run penalties represent the difference between the male and female estimate at $t = 10$ and are indicated in the top-right corner of each panel.

In addition to examining the effect of parenthood on the gender gap in commuting probability, Panel 4b provides estimates for the gender-specific parenthood effect on commuting distance. Combined with the extensive margin commuting analysis, this provides us with a comprehensive understanding of the gender gaps in commuting following parenthood. Although women cut back on very long commutes already in the year before childbirth (which in most cases coincides with the year of conception and pregnancy), the trends in the commuting distance in relative time -4 through -2 are

very similar for men and women. Commuting distance drops both for men and women in the year of childbirth. However, this drop is significantly larger for mothers than for fathers, and the difference persists throughout the ten-year post-childbirth period that we examine. The commuting distance effect is partly a reflection of changes in labor supply, but similar patterns are found also among individuals who are employed throughout the entire analysis period. The drop in commuting for always-employed mothers is one-third of the size of the total effect, implying a relatively sizable commuting effect *not* driven by changes in labor supply. It is also important to bear in mind that always-employed mothers represent a select sample of highly ambitious career women, meaning that this likely represents a lower bound of the non-labor supply share of the commuting effect.

We also test whether the commuting distance effects are sensitive to top coding, dropping, or replacing particularly large commuting distances. We do this to ensure that our findings are not driven by a small set of outliers. In Appendix Figure B7 we show that the parenthood gender gap in the commuting distance is unaffected by how we treat these large commuting distances (Panels B7a - B7c). Furthermore Panel B7d shows that for the subset of individuals who we observe postcodes to postcode distances the commuting drop is even more pronounced. This suggests that the commuting distance penalty presented in Figure 4 likely underestimates the true distance penalty. Note that the widening gender gap in commuting distance after the birth of the first child has also been documented in a contemporaneously developed paper in the context of Denmark (Borghorst, Mulalic and van Ommeren, 2021). Taken together, Figure 4 suggests that both mothers and fathers reduce their commuting distances in response to parenthood, but women do so much more strongly than men.

To better understand the mobility dynamics of the commuting effect—whether it is driven by mothers moving to jobs closer to their residences or by mothers moving residences closer to their jobs—we focus on individuals who were commuting before having their first child and who stopped commuting during the two years after the birth of the first child.[10]

Among the still-employed mothers who were commuting before having their first child and who stopped commuting during the two years after the birth of the first child, 45 percent changed residence municipality in the two years after childbirth and 60 percent changed their workplace municipality (relative to the year before childbirth). With respect to fathers, 45 percent changed their residence municipality in the two years after

[10]Note that a non-negligible share of individuals who stopped commuting after childbirth are no longer employed. Two years after childbirth, this share is 28 percent among women and 16 percent among men.

childbirth and 50 percent changed their workplace municipality. The changes in commuting behavior observed in Figure 3 are, therefore, primarily driven by individuals shifting workplace municipalities closer to their residence municipality. However, the commuting effects (and the share of workers who change their commuting behavior) are much larger for women than for men. Moreover, men are substantially more likely to move their residence while keeping their job location constant (55% of men and 37% of women in the second year after childbirth).

In addition to the evidence in Figure 4, the results from our survey suggest that there is a change in the way women and men trade off commuting versus earnings after they become parents. Utilizing the survey data presented in Section 3, we run the following regression to determine gender differences in willingness to commute:

$$y_i = \alpha + \beta_1 \text{Female}_i + \beta_2 \cdot (\gamma_i \times \text{Male}_i) + \beta_3 \cdot (\gamma_i \times \text{Female}_i) + \tau X_i + \varepsilon_i \tag{4}$$

where y_i is a dummy variable equal to one if individual i selected a salary increase of γ percent in exchange for a doubling in commuting time.[11] *Male* and *Female* are dummy variables equal to one if a person is male and female respectively. The variable γ_i is the continuous threshold variable, which was randomized across individuals as described in the data section. To improve the precision of our estimates, Equation 4 also includes a vector of control variables: residence county, baseline commuting time, level of education, and the monthly salary of an individual.[12]

The results obtained from estimating Equation 4 on the full sample, a sample consisting exclusively of childless individuals, and a sample consisting exclusively of individuals who have at least one child, are presented in Table 1. The table provides three main results. First, the results show that women on average are significantly less likely to accept an increased commute for higher monetary compensation, suggesting that women have a lower elasticity of commuting distance with respect to monetary compensation. Second, the results reveal a substantial parenthood effect on the willingness to accept a longer commute. Both men and women are significantly less likely to opt for increased commute time to secure a higher monetary payoff in the presence of a child. Childless men (women) are approximately 13 (17) percentage points more likely to accept a doubling in commuting time compared to individuals with children. Both the relative and the absolute reduction in the probability of choosing a longer commute for higher

[11] In Figure B2 we provide results for the share of men and women choosing a salary increase of γ percent in exchange for a doubling in commuting time for each of the different γ threshold values. The graph indicates a general gender difference, but no significant difference in the trend of the fitted lines.

[12] All control variables are balanced across the randomized threshold γ.

compensation in the presence of children is statistically significantly and economically meaningfully larger for women than men. Third, the interaction of the gender dummies with the threshold variables indicates that increasing the compensation does not have significantly different effects for men and women. That is, men and women do not differ in their responsiveness to commuting changes as a function of the amount of monetary compensation that they receive, but they differ in their willingness to commute conditional on their income compensation.

Table 1: Survey Results: Commuting Preferences

	Full Sample	**No Children**	**With Children**
Constant	0.385***	0.451***	0.325***
	(0.038)	(0.059)	(0.050)
Female	-0.103***	-0.076**	-0.122***
	(0.022)	(0.033)	(0.029)
Threshold × Male	0.007***	0.006***	0.007***
	(0.0004)	(0.0006)	(0.0005)
Threshold × Female	0.008***	0.007***	0.008***
	(0.0003)	(0.0005)	(0.0005)
N	10,008	4,210	5,798
R^2	0.104	0.092	0.118

Note: The table presents results from estimating Equation 4 for different sample specifications. The full sample consists of 10,008 representative Norwegians in the age range 25 to 50 who where individually surveyed about their labor market preferences and conditions during late June 2021. Column one includes the full sample, column two only individuals without children and column three those with at least one child. Significance thresholds: ***: 0.01, **: 0.05, *: 0.1.

Taken together, our results suggest that women are restricting their local labor markets to a much smaller geographic area after childbirth relative to men. Such geographic restrictions may mechanically result in females facing a more concentrated market with fewer job options, reducing the probability of finding high-paying jobs, high-quality firm matches, and moving up the career ladder. To examine this in detail, Figure 5 provides estimates of the full set of P_ts with respect to the three concentration measures discussed in Section 3: the number of establishments, the number of jobs, and the Herfindahl-Hirschman Index (HHI). Each of these measures captures slightly different dimensions of labor demand and helps us develop a comprehensive understanding of how changes in commuting distance impact an individual's labor market opportunities and outside options.

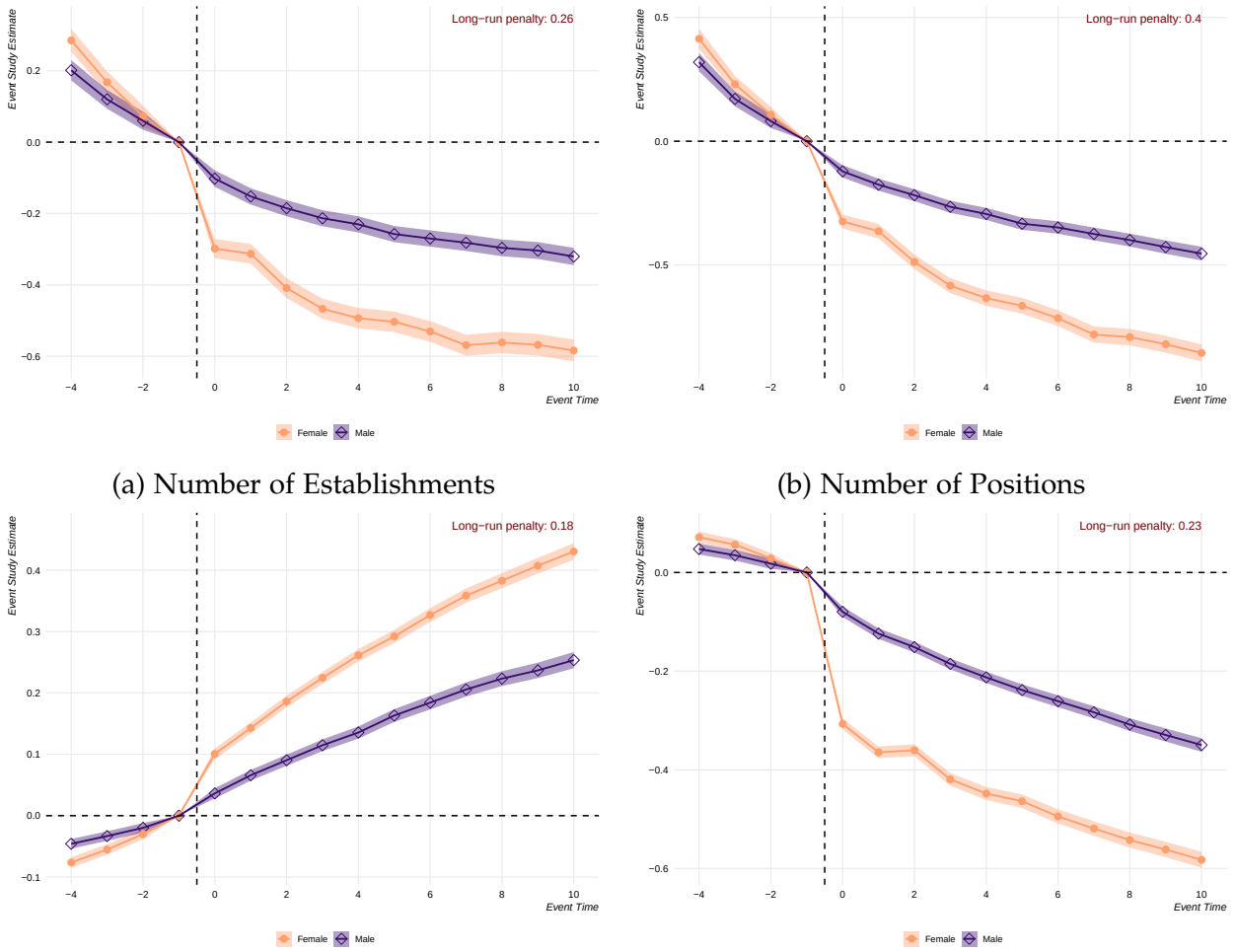
In Panel 5a, we examine the effect of parenthood on the number of establishments within the individual's education-industry-area cell, in which we proxy the local la-

bor market area using the revealed commuting distance of individuals. Similar to the commuting distance effect, the number of establishments evolves similarly for men and women prior to parenthood and then drops abruptly for both. However, the discontinuous drop after childbirth is significantly larger for women. This means that the outside options available to mothers and fathers, as measured by the number of establishments in their industry-education-area cells, decline substantially following parenthood. Importantly, this decline is considerably larger for women than for men. For example, five years post-childbirth, mothers have experienced a 50% reduction in the number of potential establishments where they can work, while the reduction is 25% for fathers.

In Panel 5a, we examine the effect of parenthood on the number of job positions that were filled within the individual's industry-education-area cell. The number of positions is used as a proxy for the job opportunities within an education-industry cell in a given local labor market. There is an abrupt and immediate reduction in the number of positions within the local labor market for women and a much smaller drop for men. This result mirrors the gender-specific effect on the number of establishments shown in Panel 5a. Five years after childbirth, women have experienced a significantly larger reduction in the number of potential positions filled in their education-industry-area cell. In addition, there is no indication of the gender-specific effects converging over our sample period, suggesting that the reduction in suitable labor market opportunities for women relative to men remains substantial for a very long period of time.

In addition to the number of establishments and the number of positions filled within the industry-education-area cell, we also construct individual-specific HHIs as discussed in Section 3. The main advantage of this measure is that it captures supply and demand side factors simultaneously.

The results from estimating our event study specification using the HHI as the outcome variable are shown in Panel 5c. Labor market concentration evolves similarly for men and women prior to childbirth. Immediately after childbirth, we observe a strong and monotonic divergence in the gender-specific HHIs. Specifically, at the onset of childbirth, females start becoming exposed to much more concentrated labor markets relative to men. Ten years after childbirth, women are exposed to a labor market concentration that is 18 percentage points greater than that of men. This effect is comparable to moving from the median labor market concentration to the 40th percentile of labor market concentration in our main sample. Dodini et al. (2020) estimate that a 10 percentage point decline in the HHI generates a negative wage effect of 9,298 NOK, which in our case would correspond to a pure concentration penalty of 16,736 NOK in annual earnings for women.



(a) Number of Establishments

(b) Number of Positions

(c) Herfindahl-Hirschman Index

(d) $\mathbb{P}$(Urban Workplace)

Figure 5: Labor Market Conditions Relative to Parenthood

Note: The figure shows the estimated coefficients of the event time dummies as a fraction of the predicted outcome, when omitting the contribution from event dummies in each year relative to the birth of the first child. Coefficients are estimated separately for men and women and the regressions include industry-fixed effects. The shaded areas indicate the 95% confidence band using robust standard errors. The samples include men and women who became first-time parents between 1990 and 2010, whom we observe 4 years prior and 10 years after childbirth, and who were continuously employed in the years prior to childbirth. Municipalities defined as urban are the following (ordered by size): Oslo, Bergen, Trondheim, Stavanger, Fredrikstad, Drammen, Kristiansand, Tromsø, Bodø, and Hamar

A substantial part of the reductions in labor market concentration is driven by the fact that women are much less likely to work in urban municipalities (see Panel 5d). Urban municipalities offer a significantly larger amount of jobs, have considerably more establishments, and have lower labor market concentration (Dodini et al., 2020). Taken together, the results in Figures 4 and 5d imply that parenthood leads mothers to change their commuting behavior and that this has a negative effect on the labor market op-

portunities available to them, providing strong suggestive evidence of an additional pathway through which the child penalty operates. In terms of continuing policy attempt to close the gender wage gap and limit the motherhood wage penalty, this result is particularly important, highlighting that policies serving to improve the labor market opportunities for new mothers may be especially valuable.

5.3 Parenthood and Establishment Quality

In the previous section, we showed results suggesting a link between women's change in commuting behavior and their local labor market opportunities. Those results can be interpreted as extensive margin measures of job opportunities. An additional margin is how commuting potentially impacts the quality of the job opportunities available to mothers and fathers (i.e., the intensive margin of job opportunities).

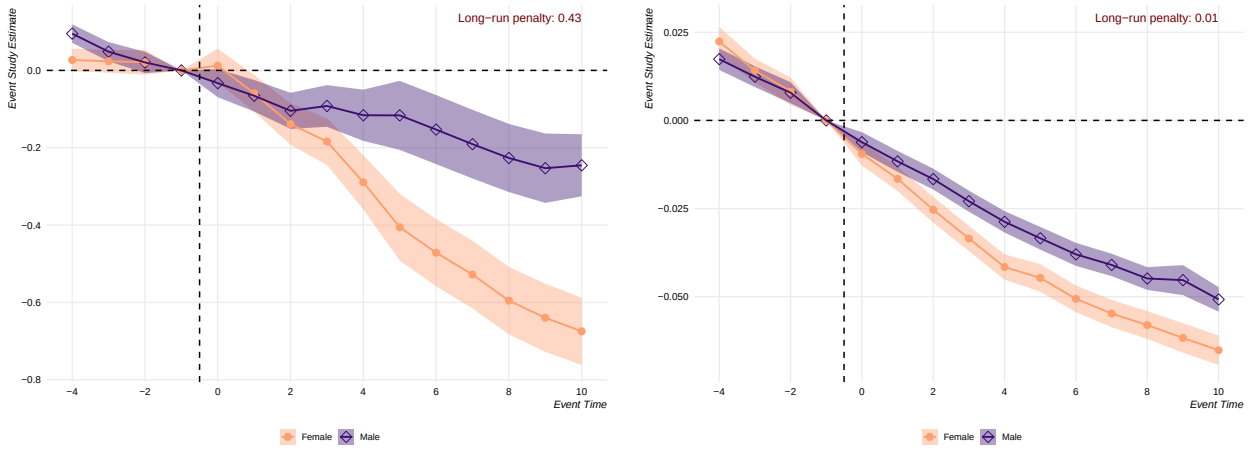
The impact of parenthood on the quality of employers could operate through two main channels. First, the overall reduction in the number of jobs and establishments identified above could lead to fewer high-quality labor market options and matches. Second, an increase in labor market concentration will improve the employers' bargaining power over employees and potentially lead to a decline in the quality of the workplace (e.g., as measured by average hourly earnings within the establishment). The effects we present in this subsection should be viewed as the total aggregate effect of these two channels.

In Figure 6, we present event study results of the full set of parenthood effects (P_ts) for two different measures of establishment quality: establishment size, and average hourly earnings.

Panel 6a shows that the size of the establishments that men and women work at declines in response to parenthood, both for men and women. However, two years after childbirth, the decline in the size of the establishments that men and women work at begins to diverge. This divergence generates a long-term gender-specific establishment size gap of 43 percentage points. This is an important finding because the size of the establishment at which a worker is employed has been found to be particularly important for future earnings. For example, larger firms offer better on-the-job training (Lynch and Black, 1998), and apprenticeship training in larger firms protects workers from unemployment later in life (Müller and Neubäumer, 2018). Arellano-Bover (2024) provides IV estimates suggesting a 10% increase in the size of a worker's first employer is associated with a lifetime earnings premium of 1.17%. The gender-specific change in establishment size due to parenthood may, therefore, be an important pathway through which the child

penalty in earnings operates.

The second measure of establishment quality we consider is the average hourly earnings at the establishment. This measure represents the average compensation that workers can receive at the establishment and will be a function of factors such as firm profitability, productivity, worker value-added, and rent-sharing propensity (Abowd, Kramarz and Margolis, 1999). It is also likely that this measure is strongly correlated with the quantity and quality of other job amenities available to workers at the establishment.



(a) Establishment Size

(b) Average Hourly Earnings

Figure 6: Establishment Quality Relative to Parenthood

Note: The figure shows the estimated coefficients of the event time dummies, obtained from Equation 2, as a fraction of the predicted outcome, when omitting the contribution from event dummies in each year relative to the birth of the first child. Coefficients are estimated separately for men and women and the regressions include industry-fixed effects. The shaded areas indicate the 95% confidence band using robust standard errors. The samples include men and women who became first-time parents between 1990 and 2010, whom we observe three years prior to childbirth and 10 years after, and who are continuously employed in the four years prior to childbirth. Long-run penalties represent the difference between the male and female estimate at $t = 10$ and are indicated in the top-right corner of each panel.

Panel 6b demonstrates that there is no significant differential trend in the average hourly earnings at the establishment of men and women prior to parenthood. Following parenthood, both men and women experience a drop in the average hourly earnings at the establishments in which they are employed. However, this drop is considerably larger for women, leading to a long-run gender parenthood penalty of approximately 1%. Taking the pre-parenthood average hourly establishment earnings of the mother as a base, the female penalty in the establishment's average hourly earnings at the end of the sample period corresponds to a salary reduction of around 13 NOK per hour or approximately 25,000 NOK annually for a full-time worker.

Taken together, this subsection demonstrates that the quality and characteristics of the establishments that men and women work at decline sharply at the onset of parenthood. However, these declines are considerably larger for women, and this pattern is robust to focusing only on always-employed individuals. Thus, not only does the gender-specific parenthood effects on commuting result in a reduction in outside options and increased exposure to concentrated markets, but it also leads to a widening of the gender gaps in terms of the quality of the employers. While speculative, we argue that the overall reduction in establishment quality is likely a combination of both a decline in labor market options due to a preference for shorter commutes as well as due to a higher demand for family-friendly employers, both meant to accommodate the increased demand for household work that comes with childbirth.[13] The fact that our results persist as we restrict the sample to always-employed individuals strongly suggests that these effects are not only driven by a reduction in gender-specific labor supply at the onset of parenthood.

Table 2: Child Penalty by Quintile of Commute (Distance) Penalty

	Bottom Quintile of Commute Penalty **(1)**	**Top Quintile of Commute Penalty** **(2)**	**Difference** **(3)**
Earnings Penalty	0.220	0.267	0.047
Hours Worked Penalty	0.138	0.169	0.031
Herfindahl Hirschman Index Penalty	0.302	0.399	0.097
Number of Establishments Penalty	0.004	0.138	0.133

Notes: The table presents the overall child penalty for different outcome variables and sample specifications by following the procedure presented in Equation 3. Column (1) presents results for the child penalty for individuals with a distance penalty in the bottom quintile of their respective sex. Column (2) presents analogous child penalties for the top quintile. Column (3) presents the difference.

How much of the child penalty can be attributed to the changing labor market conditions induced by the commuting effect found in this paper? Even though we cannot directly link the commuting effect to the earnings penalty, we provide suggestive evidence of their connection by examining whether the wage penalty is larger for individuals who experience a larger commuting effect. To do so, we divide individuals into (gender-specific) quintiles of the parenthood commuting penalty and re-estimate our main results for individuals in the top and the bottom quintiles. The results from this exercise

[13]The argument regarding a higher demand for family-friendly workplaces would additionally contribute to a reduction in establishment quality disproportionately affecting women after parenthood if establishment quality and family friendliness are negatively correlated. This has been documented in a very similar setting (see Hotz, Johansson and Karimi, 2017).

are shown in Table 2. Individuals who experienced the smallest commuting effect also experienced fewer adverse job opportunity effects, smaller adverse establishment quality effects, a smaller change in labor market concentration, and a significantly smaller child wage penalty. These results provide strong suggestive evidence that changes in the commuting behavior of mothers at the onset of childbirth are closely linked to the motherhood wage penalty documented in the prior literature.

6 Conclusion

A burgeoning literature has shown that differences in the willingness to commute between males and females represent an important reason for the persistence of the gender wage gap (Le Barbanchon, Rathelot and Roulet, 2019). We advance this literature by investigating whether these differences in commuting behavior increase with parenthood and can help explain the large motherhood child penalty documented in prior work (e.g., Kleven, Landais and Søgaard, 2019). Using administrative data from Norway and a quasi-experimental event study approach, our paper documents that the large wage drops mothers face after the birth of the first child coincides with a sharp decline in the probability of commuting and commuting distance.

First, we document large reductions in earnings for women relative to men after the birth of the first child. Although this effect is partly explained by changes in labor force participation and hours of work, mothers' hourly wages also decrease significantly after childbirth, and the earnings result is robust to restricting the sample to always-employed individuals. Second, we show a sharp discontinuous drop in female commuting probability and commuting distance at the onset of parenthood while no such drop is observed among men. This differential drop in commuting behavior by gender persists even ten years after childbirth. Third, we discuss how these differential changes in commuting behavior among men and women result in mothers facing a more concentrated labor market with fewer job options. We find that by reducing the commuting distance, women start working in labor markets with fewer jobs and firms in their industry-education cells after childbirth, and their labor markets are becoming increasingly more concentrated relative to that of fathers. In addition, we show that establishment quality also declines sharply after childbirth for women. To link these findings to the motherhood wage penalty results in prior work, we show that mothers who experienced the largest commuting effect also experienced more adverse job opportunities and firm quality effects, and a significantly larger child earnings penalty. Together, these results imply that parenthood leads mothers to change their commuting behavior and that this has a

negative effect on the labor market opportunities available to them.

Our results suggest that gender differences in commuting behavior represent a likely mechanism underlying the child penalty in earnings. Hence, when designing policies aimed at eliminating gender differences in labor market outcomes in general, and the motherhood wage penalty in particular, gender differences in willingness to commute should be considered. Such policies could include the planning and collocation of transportation and childcare infrastructure as well as incentive schemes for remote work and telecommuting.

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Appendix

A Establishment Quality

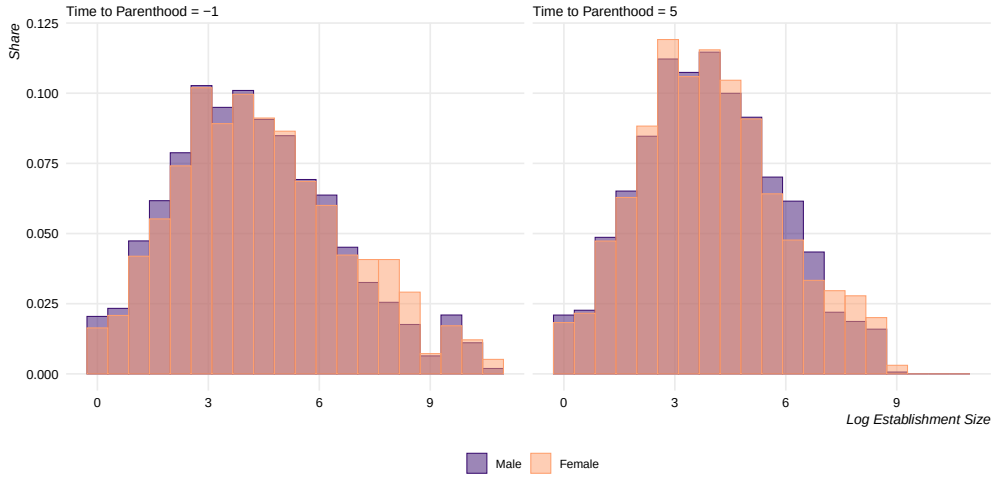
Besides changes in labor supply and skill mismatch, establishment quality is an additional pathway through which parenthood potentially alters earnings differently for men and women after they become parents for the first time. Women might choose to switch to more family-friendly establishments, but these firms impede career progression and ultimately hinder climbing the career ladder (Hotz, Johansson and Karimi, 2017). We are agnostic about the family friendliness of the workplace directly but think about a different dimension in which parenthood could impact the quality of a work establishment. Through a lower willingness to commute and an increased burden for childcare, women have a) fewer outside options and b) the options they might have are of lower quality, resulting in a disproportionate reduction of establishment quality for women after the onset of parenthood.

We will present results using two different measures of establishment quality, which have been suggested in the previous literature (see, e.g. Dustmann et al., 2020). The first measure is establishment size. Establishment size has been used extensively to measure establishment quality, in particular for individuals in the early stages of their careers. Oreopoulos, Von Wachter and Heisz (2012) show that individuals starting their careers at larger employers suffer from fewer negative labor market consequences in comparison to those who start at smaller firms. Additionally, larger firms are associated with higher wages and better training resulting in improved opportunities for career and earnings progression (Arellano-Bover, 2024). The second measure used is the average hourly earnings of individuals at the establishment. Establishments paying higher wages, controlling for person fixed effects, have been shown to be more productive, more profitable, and more professional-labor intensive in the context of France (Abowd, Kramarz and Margolis, 1999).

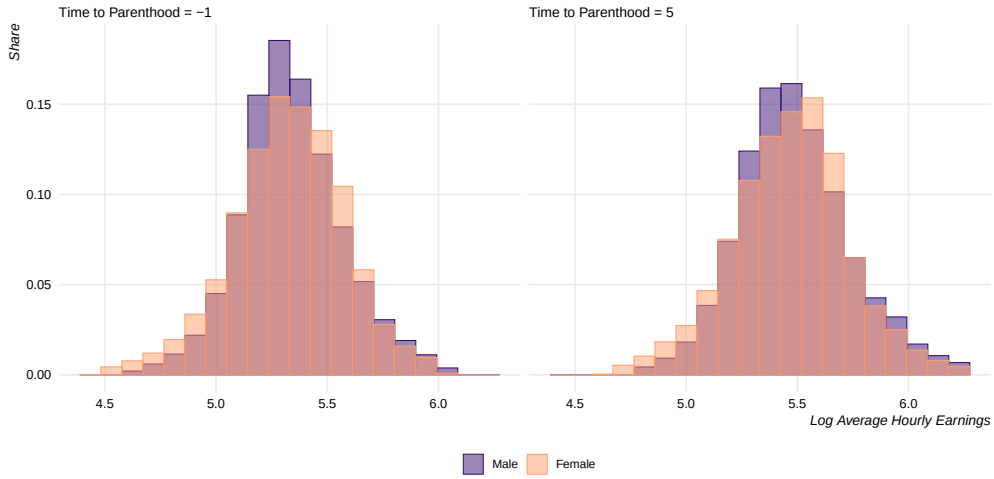
All establishment quality measures are constructed from the linked employer-employee data available between 1986 and 2010. We condition this sample on individuals with non-zero hourly earnings and who have non-missing establishment identifiers as well as reported hours worked.[14] The average hourly earnings are then constructed from annual earnings data divided by the number of weeks and hours of work. This is only an approximation of actual hourly earnings, but due to data limitations, it is the best

[14]Hours are reported only in three broad categories which we approximate with 10, 25, and 37.5 hours of work per week.

measure of hourly earnings we can provide consistently for the sample. Establishment size is simply defined as the number of employees at a given establishment.



(a) Establishment Size



(b) Log Average Hourly Earnings

Figure A1: Distribution of Establishment Quality Measures by Sex and Time to Parenthood

Note: The figure plots the distribution of two establishment quality measures in our main sample. Each measure is plotted separately for the year $t = -1$ and $t = 5$ and by the sex of the parent. Panel a shows establishment size, and panel b the logarithm of the average hourly wage in the company winsorized to exclude the top one and bottom percentile of the average hourly wage distribution.

To construct the establishment quality measures we follow a leave-out mean approach, which ensures that we construct average hourly earnings, and establishment size net of the impact of the particular individual herself. This will take care of sensitivity for cases where the number of individuals within an establishment is small and allows us

to abstract from changes in establishment quality due to changes in labor market characteristics of the individual whose establishment quality we want to observe. In Figure A1 we present the distributions of establishment quality measures for our main sample separately by time relative to parenthood and sex. To conveniently plot the distributions the establishment size variable and average hourly earnings within an establishment are transformed using the natural logarithm. We additionally winsorize the top and bottom percentile of the distribution for the average hourly earnings mainly for ease of visualization.[15] The main difference in the distributions is coming from differences between men and women, rather than differences due to the time relative to parenthood.

[15]The right tail of the hourly wage distribution is relatively long because we are constructing hourly earnings from annual earnings data. This income variable includes incomes from self-employment and governmental transfers. Particularly the first income source can be substantial and result in very large hourly earnings.

B Additional Figures and Tables

Table B1: Summary Statistics: Main Sample

	Mean	SD	Min	Median	Max
Panel A: Women (N = 87,659)					
Annual Earnings (1,000 NOK)	311.73	113.45	0.92	300.72	4798.23
Hourly Earnings	189.50	99.99	0.54	165.19	2454.02
Hours Worked	34.11	8.15	10.00	37.50	37.50
Employment	1.00	0.00	1.00	1.00	1.00
Public Sector Employment	0.41	0.49	0.00	0.00	1.00
Age	27.92	4.16	19	27.00	48
Years of Education	12.31	2.55	0	12.00	20
Commuting	0.34	0.47	0.00	0.00	1.00
Distance (km)	28.65	128.16	0.00	0.00	2412.09
HHI	0.15	0.15	0.00	0.11	1.00
Full Time Share	0.71	0.25	0.00	0.77	1.00
Average Earnings at Plant	213.75	71.99	2.09	206.93	4987.22
Residence Urban	0.40	0.49	0.00	0.00	1.00
Workplace Urban	0.49	0.50	0.00	0.00	1.00
Panel B: Men (N =110,595)					
Annual Earnings (1,000 NOK)	396.40	193.84	0.16	367.66	26044.81
Hourly Earnings	218.41	125.00	0.08	193.25	13320.45
Hours Worked	36.07	5.71	10.00	37.50	37.50
Employment	1.00	0.00	1.00	1.00	1.00
Public Sector Employment	0.16	0.37	0.00	0.00	1.00
Age	29.71	4.71	19	29.00	64
Years of Education	11.93	2.77	0	12.00	20
Commuting	0.40	0.49	0.00	0.00	1.00
Distance (km)	40.53	155.08	0.00	0.00	2494.71
HHI	0.17	0.17	0.00	0.11	1.00
Full Time Share	0.86	0.20	0.00	0.94	1.00
Average Earnings at Plant	216.23	72.73	1.02	204.99	6393.20
Residence Urban	0.35	0.48	0.00	0.00	1.00
Workplace Urban	0.42	0.49	0.00	0.00	1.00

Note: The table presents summary statistics for first-time parents, women (Panel A) and men (Panel B), in the year prior to their first child. The sample includes all men and women who became first-time parents between 1990 and 2000, whom we observe four years prior to and ten years after childbirth, and who are employed at least seven out of 15 years.

Table B2: Summary Statistics: Survey

	Mean	SD	Min	Median	Max
Male	0.42	0.49	0	0.00	1
Any Child	0.58	0.49	0	1.00	1
Cohabiting	0.67	0.47	0	1.00	1
Primary School	0.03	0.16	0	0.00	1
High-School	0.18	0.38	0	0.00	1
Vocational School	0.16	0.37	0	0.00	1
Bachelor	0.29	0.46	0	0.00	1
Master	0.33	0.47	0	0.00	1
Other	0.01	0.10	0	0.00	1
Threshold	3.50	1.71	1	3.00	6
Age	38.27	7.64	25	39.00	60
Monthly Salary	32.71	14.58	3.00	30.00	150.00
Commuting Time	23.28	29.51	1.00	15.00	180.00

Note: The table presents summary statistics for the full sample of surveyed individuals ($N = 10,008$). Monthly salaries are reported in 1,000 NOK. The variables presented are a subset and only variables used in the analysis for this article.

Table B3: Child Penalty Overview

	Main	**Main** $t \leq 5$	**Always Employed**
Average Hourly Earnings	0.01	0.01	0.01
Commuting Distance	0.48	0.45	0.28
Earnings	0.26	0.24	0.22
Establishment Size	0.19	0.07	0.11
Herfindahl-Hirschman Index	-0.14	-0.12	-0.07
Hourly Earnings	0.11	0.13	0.08
Hours Worked	0.27	0.27	0.10
Number of Establishments	0.28	0.26	0.12
P(Commute)	0.25	0.24	0.09
P(Workplace Urban)	0.24	0.24	0.08

Note: The table presents the overall child penalty for different outcome variables and sample specifications by following the procedure presented in Equation 3. The second column uses our main sample, the third column also uses the main sample but only for relative time periods $t \leq 5$ and the last column is computed on estimates from the always employed sample.

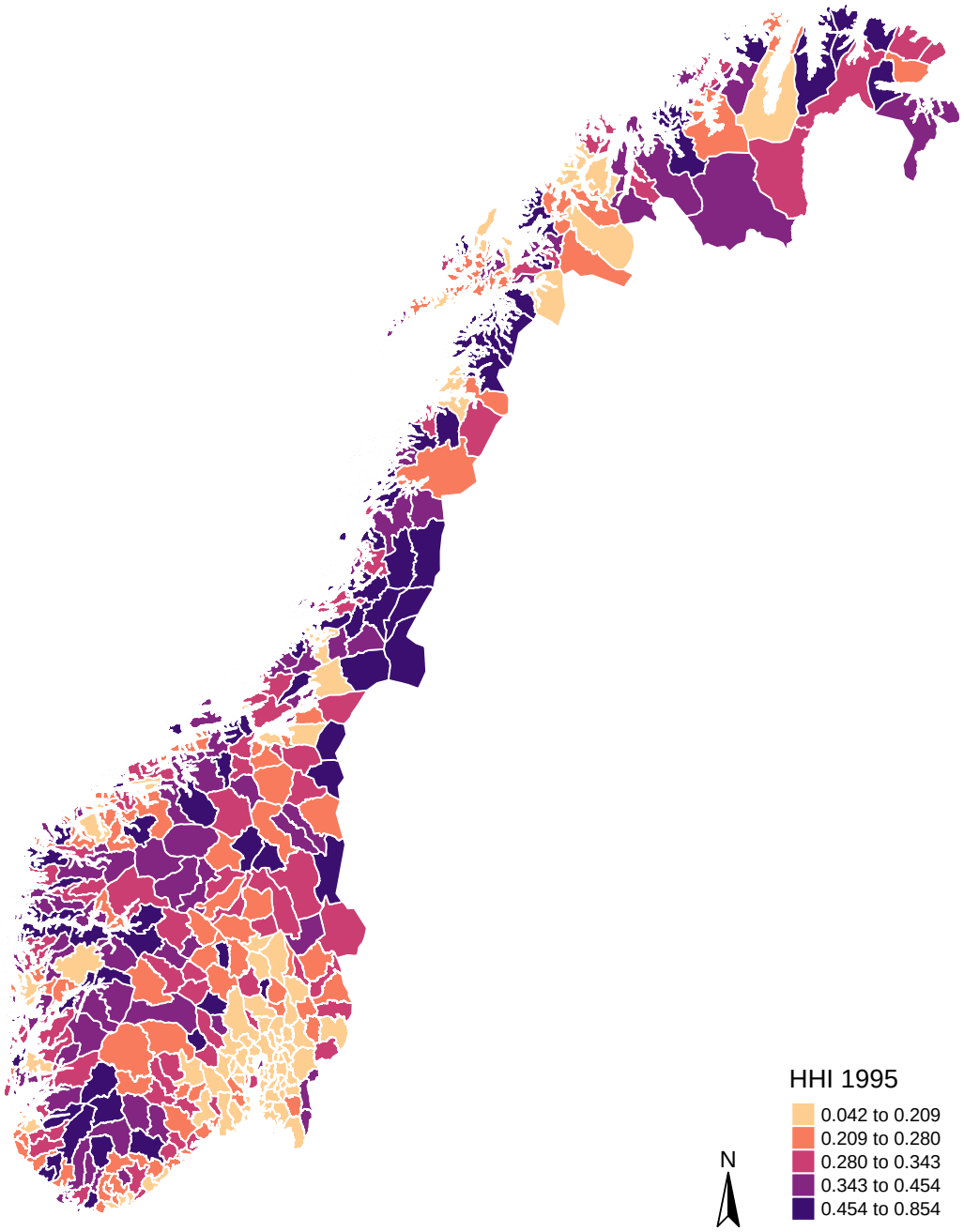


Figure B1: Herfindahl-Hirschman Index in 1995

Note: Average Herfindahl-Hirschman Index in 1995 in each municipality. The HHI is calculated based on the on the main commuter sample using the actual commuting distance of individuals to define the local labor market (see Figure 1). It includes all individuals who became first-time parents between 1990 and 2010 who were employed at least 8 out 15 years in the 15 years around childbirth.

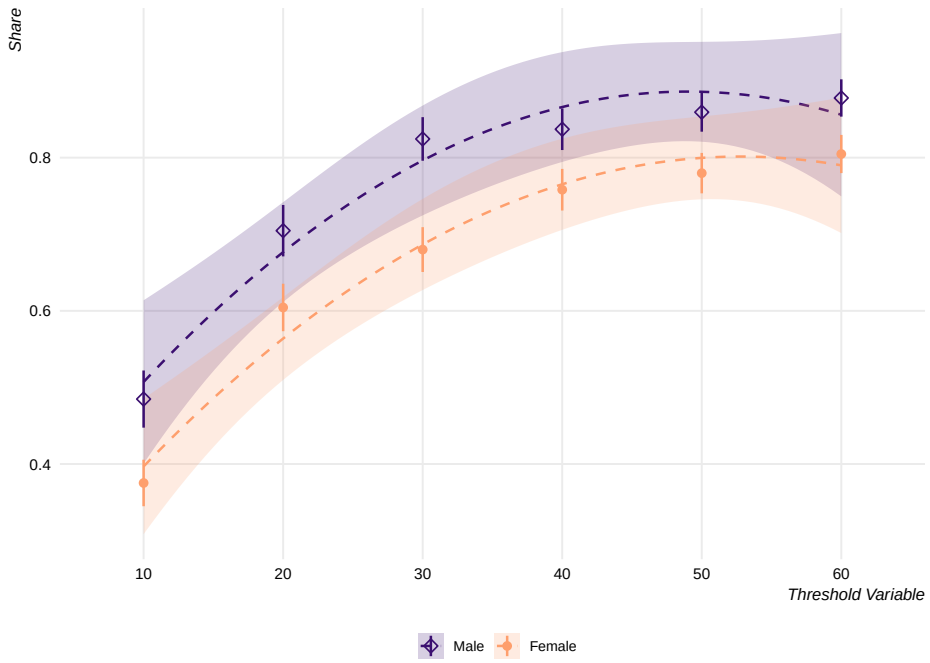


Figure B2: Survey Results: Willingness to Commute

Note: The figure separately shows the share of men (purple diamond shapes) and women (orange point shapes) choosing to select position two in a question referring to the trade-off between a salary increase and doubling of the commuting distance. The shares were obtained by regressing a dummy variable equal to one if a person chooses to position two on the full set of threshold dummies $\gamma \in [10, 20, 30, 40, 50, 60]$ separately for men and women. The 95 % confidence intervals are based on robust standards. Fitted lines are regression lines of second-order polynomials through the shares estimates.

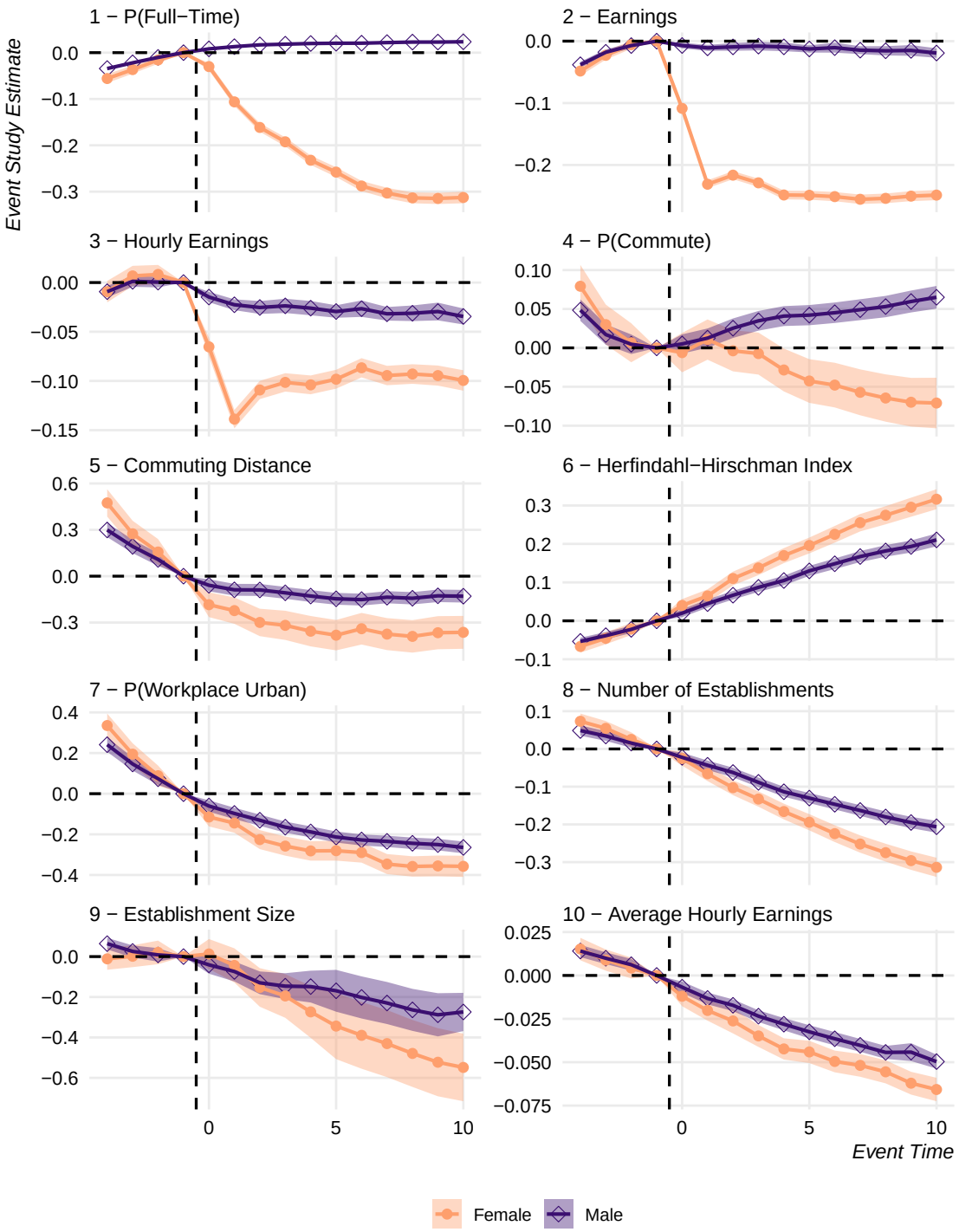


Figure B3: Always Employed Sample

Note: The figure shows the estimated coefficients from Equation 2, as a fraction of the predicted outcome, when omitting the contribution from event dummies in each year relative to the birth of the first child. The figure presents results for a sample of first-time mothers ($N = 26,109$) and first-time fathers ($N = 74,037$) who are employed throughout the 15 years surrounding childbirth. Each panel presents results for a different outcome separately for men and women.

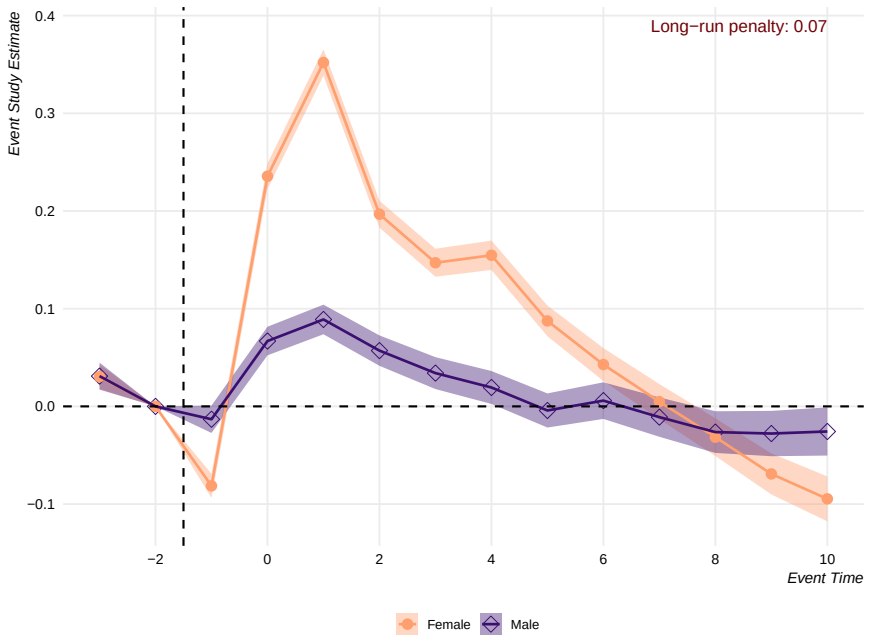


Figure B4: $\mathbb{P}$(Labor Market Mobility)

Note: The figure shows the estimated coefficients of the event time dummies, obtained from Equation 2 with $t = -2$ as the omitted category, as a fraction of the predicted outcome, when omitting the contribution from event dummies in each year relative to the birth of the first child. Coefficients are estimated separately for men and women and the regressions include industry fixed effects. The shaded areas indicate the 95% confidence band using robust standard errors. The samples include men and women who became first-time parents between 1990 and 2010, whom we observe three years prior to childbirth and 10 years after, who are employed for at least 8 out of 15 years around childbirth. Long-run penalties represent the difference between the male and female estimate at $t = 10$ and are indicated in the top-right corner of each panel.

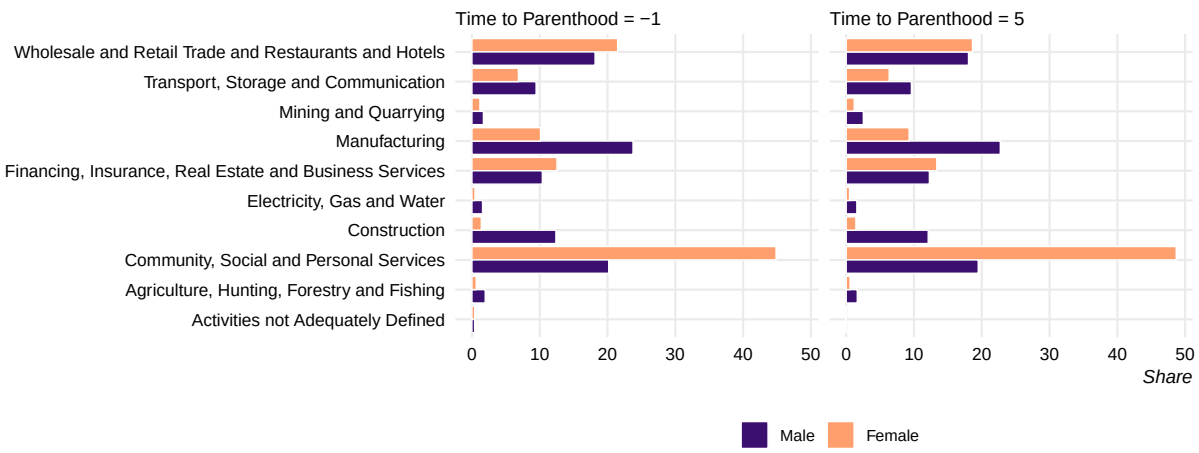


Figure B5: Industry Affiliations by Sex and Time Relative to Parenthood

Note: The figure shows the share of men and women working in different industries defined as one-digit codes following the Norwegian adoption of ISIC codes (Statistics Norway, 1983). The left panel shows the industry shares for individuals in our main commuter sample for the year prior to childbirth ($t = -1$), while the right panel shows the same for the time period five years post-childbirth ($t = 5$).

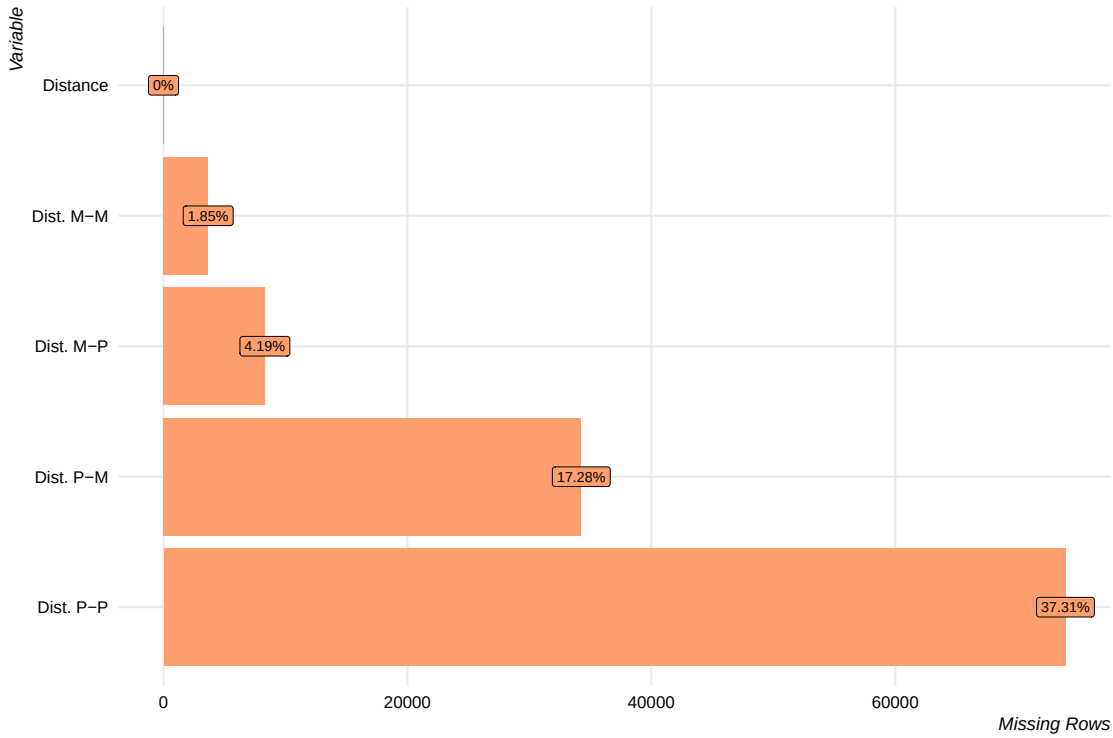
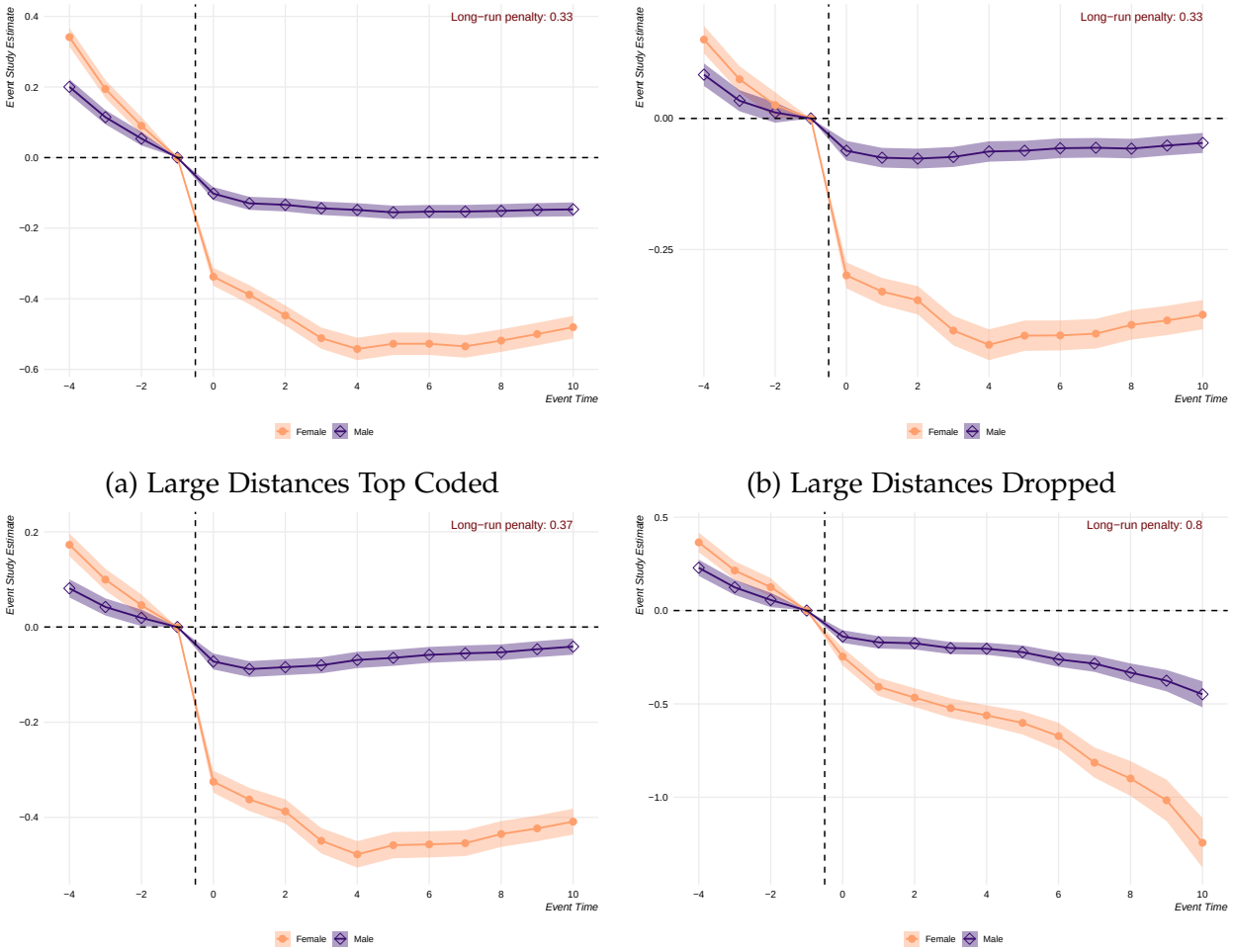


Figure B6: Distance Assignment

Note: The figure shows the share of missing distance values for different combination of postcodes and municipalities in the period prior to childbirth ($t = -1$). Dist. M-M indicates the share of missing values for distances constructed where workplace and resident municipality are available. Dist. M-P indicates workplace municipality to residence postcode, Dist. P-M indicates workplace postcode and residence municipality and Dist. P-P indicates postcode to postcode distances.



(a) Large Distances Top Coded

(b) Large Distances Dropped

(c) Large Distances Replaced

(d) Postcode to Postcode Distance

Figure B7: Sensitivity of Distance Results to Alternative Distance Measures

Note: The figure shows the estimated coefficients of the event time dummies as a fraction of the predicted outcome, when omitting the contribution from event dummies in each year relative to the birth of the first child. Coefficients are estimated separately for men and women for our main sample specification. The shaded areas indicate the 95% confidence band using robust standard errors. Panel (a) shows results when top coding all distances above 200 km to 200 km, panel (b) shows results when dropping distances above 200 km, panel (c) provides results where we replace distances above 200 km with the average gender and time-to-treatment specific distance and panel (d) shows results for the distance measure based on distances where we measure postcode to postcode commuting distances.