

Article

Commuting and the Motherhood Wage Gap: Evidence from Germany

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Received: 29 May 2020; Accepted: 3 July 2020; Published: 15 July 2020



Abstract: In the present study, we analyze how childbirth-related changes in commuting contribute to the motherhood wage gap, which in turn accounts for a large part of the gender pay gap. Derived from human capital theory and job search theory, we examine various mechanisms that might explain why reduced commuting distances after childbirth come along with wage reductions for mothers. The empirical analyses are based on data from the German Socio-Economic Panel (GSOEP) 2001–2017, which are analyzed within a fixed effects (FE) panel framework ($n = 41,111$ observations from 7183 persons). Firstly, the results show that the transition to first parenthood is associated with a 33% decrease in the commuting distance of women, while the transition to fatherhood has no effect. Secondly, mothers who substantially reduce their commuting distance after the transition to parenthood (who amount to 30% of all mothers in our sample) show an increased wage penalty (−18.4%), compared to mothers who do not reduce their commuting distance (−8.7%). Accordingly, 23% of the motherhood wage penalty can be attributed to wage losses related to the reduction in commuting distance. Thirdly, wage penalties for mothers who change to a job closer to their place of residence can be partly explained by the loss of firm-specific human capital. In addition, the wage penalty for commuting is a consequence of women taking jobs that are less suited to their skills profile and moving to smaller companies.

Keywords: commuting; motherhood wage gap; gender pay gap; human capital theory; job search theory; gender commute gap; household responsibility hypothesis; gender inequality

1. Introduction

The unequal wages of men and women have been the subject of an ongoing scientific debate. The gender wage gap (or gender pay gap) has declined over the second half of the twentieth century in many modern countries [1], but this convergence has slowed down or even stopped over the past years or decades (for the USA: [2]). In Germany, for instance, the pay gap between women and men has remained almost constant since the beginning of the 2000s. According to the Federal Statistical Office's recent analyses, women in Germany still earn 20% less compared to men in terms of average gross hourly wages [3].

Numerous studies have attempted to identify the possible causes of the gender wage gap. A variety of factors, like gender-specific areas of activities with regard to occupation and sector or gender differences regarding certain psychological attributes, have been considered as potential drivers of the wage differential between the sexes [2,4]. In Germany and other countries, however, a gap of around 10% remains after controlling various factors [5].

Previous research suggests that a large part of the gender pay gap can be attributed to women's wage and career penalties, which start to evolve with family formation [6,7]. The motherhood wage penalty (or motherhood wage gap) is a well-documented phenomenon in many countries [8,9].

Within the German context, career losses for mothers have been documented based on register and survey data [9–11]. Various international comparative studies indicate that in Germany, the motherhood wage penalty is especially large. For instance, Gangl and Ziefle [9] showed that the motherhood wage gap for West German women in the 1960–1969 birth cohorts was between 16% and 18%, while in the same cohorts for Great Britain and the US the gap was 13% and between 9% and 16%, respectively. When entering parenthood, women typically interrupt their careers for a while, and subsequently, reduce their activity level in the labor market to meet the increased domestic workload and emerging care responsibilities. Men's time allocation, in contrast, is largely unaffected by the transition to parenthood [12–14]. Accordingly, child-related employment interruptions, as well as subsequent changes to more family-friendly working conditions of mothers, were previously found to be crucial drivers of both the motherhood wage gap [9,15] and the gender pay gap [16,17].

One factor that has been occasionally examined in the context of the gender pay gap is commuting behavior, with mixed results [18–25]. These studies often take their starting point in the consistent finding that women, on average, have shorter commutes than men (for the USA: [26]; for the Netherlands: [27]; for Germany: [28]). According to the household responsibility hypothesis, the unequal distribution of household and childcare responsibilities within couple-relationships in which women assume the main responsibility for housework and childcare is a major cause for these gender differences in commuting. At the same time, various studies have demonstrated that women's commuting distances are especially short once they are mothers, while most studies did not find a negative effect of parenthood on commuting distance for men [28–30]. In this context, it has been suggested that shorter commutes reflect a spatially more restricted labor market, which comes along with reduced opportunities to find high-paying jobs and undergo significant career progressions.

Even though the transition to motherhood appears to be crucial for the explanation of the gender pay gap, as well as for the gender commute gap, the association between the transition to parenthood, changes in commuting behavior and the motherhood wage gap has not been examined so far. Hence, we aim to analyze how child-related changes in commuting behavior contribute to the emergence of the motherhood wage gap. By focusing on the motherhood wage gap, we are able to study in more detail the phase of life around the event of childbirth and the mechanisms that might link the reduced willingness to engage in longer commutes with wage losses for mothers.

The present study pursues three major objectives: First, to research how the transition to parenthood is associated with changes in the commuting distances of men and women. Second, to examine whether reduced commuting distances of mothers are accountable for a part of the motherhood wage gap. Third, to analyze the mechanisms that might explain why reduced commuting distances come along with wage decreases for women. These mechanisms are derived from human capital theory and job search theory. The empirical analyses are based on data from the German Socio-Economic Panel study (GSOEP) that are analyzed within a fixed effects (FE) panel framework.

2. Background and Hypotheses

2.1. Transition to Parenthood and Commuting Behavior

We begin with a discussion of theoretical arguments and empirical findings regarding the influence of parenthood on the commuting behavior of women and men. Subsequently, in the following section, we argue why a reduction in commuting distances related to parenthood could increase the motherhood wage penalty.

Many theory-based explanations of commuting behavior rest on the assumption that the home-to-work commute is ultimately the result of rational (i.e., utility maximizing) decisions regarding workplace and place of residence [31]. In the course of decision-making on whether to accept a job or a residence offer, people take the costs of commuting into account. Increasing commuting costs are accepted if they are compensated by benefits like higher wages or lower rents [31]. Commuting is typically associated with monetary costs due to travel expenses [32] and may cause non-monetary

costs, like travel-related stress [33]. Moreover, commuting limits the available time for other beneficial activities, and therefore, causes opportunity costs. While standard microeconomic theory typically relates these opportunity costs to the foregone income [34], various studies have argued that the opportunity costs of commuting may especially result from time constraints due to household responsibilities [35–37].

The starting point of our considerations is the finding that—although some change has taken place—in most countries, including Germany, women are usually still mainly responsible for housework and childcare [38,39]. From a life-course perspective, the transition to parenthood has been identified as a crucial driver for the establishment of a gendered division of labor in couple relationships [12,40]. The main responsibility for housework and childcare often comes along with high time budget restrictions at certain hours throughout the day, for example, when children have to be supervised or when meals have to be prepared. Since these hours coincide with the typically commuting hours, we assume higher opportunity costs of commuting time for women than for men [36]. Moreover, geographical studies point out that household responsibilities are typically associated with the need for various other out-of-home activities, like childcare drop-off or visiting the doctor, which further restrict the temporal and spatial flexibility [41]. Lengthy commuting, in contrast, makes it difficult to meet these demands. Therefore, mothers are especially reliant on having short commutes to work, so that the demands of work and family life can be more easily combined. Consequently, women and particularly mothers are expected to reject remote job offers more often than men [35]. Moreover, we assume that women are generally more likely to reduce their commute when the birth of a child is realized or planned.

As mentioned before, numerous studies show that women, on average, commute shorter distances to work than men. According to the so-called household responsibility hypothesis, this gender gap in commuting is primarily due to the gender-specific division of household tasks that reduce commuting willingness among women. Various studies have aimed to test the household responsibility hypothesis and focused on a range of household characteristics, like the presence of a spouse in the household [42] or breadwinner status [26], to gain proxies of the domestic workload of men and women. The presence, number and ages of children in the household, however, turn out to be the most frequently examined indicators in this context [43,44].

A fraction of these studies drew on data from cities and regions of the United States [45–47] and found no support for the assumption that maternal childcare responsibilities contribute to gender differences in commuting behavior. In contrast, other studies from the US using nationally representative data confirmed the hypothesized negative effect of children on the female commuting time or distance [44,48]. With regard to contexts beyond the US, Fagnani [49] found a negative relationship between the number of children and the commuting time of women living in the agglomeration of Paris. Likewise, Lee and McDonald [50] observed a negative association between the number of children (under the age of 16) and female commuting by examining the Korean census of the year 1995. For Korean men, in contrast, only the presence of three or more children seems to have a negative effect on commuting length.

Moreover, with regard to Germany, research has revealed an existing gender gap in commuting, with women engaging in shorter commuting distances and times than men [22,28,51]. Research on the gender-specific association between parenthood and commuting based on data from Germany, however, is scarce. Analyzing the link between job-related spatial mobility and family structure in Germany based on two representative surveys, Rüger et al. [28] revealed that women's engagement in time-consuming commutes is positively associated with childlessness in partnerships, but not men's engagement. Drawing on data from the GSOEP for the year 1998, Abraham and Nisic [52] found support for the assumption that the coordination of parental tasks becomes more demanding with an increasing number of children, as this variable was shown to be negatively associated with commuting time. This analysis, however, was not differentiated by gender. The descriptive findings by Auspurg and Schönholzer [22], based on data from the GSOEP for the years 2001–2009, offered some additional support for the household responsibility hypothesis, as mothers were found to have shorter

average commuting distances than fathers and childless women. The presence of children under 15 in the household, however, did not show any effect on the commuting distance of women and men in the subsequent fixed-effects panel regression models. Using data from the same panel study (GSOEP for the years 2001–2013) and the same method (fixed-effects panel regression), but a different operationalization of parenthood, Skora [53] found strong statistically significant effects of the transition to parenthood on the commuting distance of women, but not for men. According to these estimates, women reduce their commuting distance on average by about 24% after the birth of a first child, even after accounting for the negative effect of reduced working hours on the willingness to commute in the regression model.

To sum up, previous research shows that women, when entering parenthood, reduce their activity in the labor market in order to meet the increased domestic workload and emerging care responsibilities. Men's time allocation, in contrast, seems largely unaffected by the transition to parenthood. According to the theoretical considerations and empirical findings, this unequal distribution of household and childcare responsibilities is accompanied by a reduced willingness of mothers to engage in lengthy commutes. Therefore, we expect that the transition to parenthood will have a negative effect on the commuting distance of women, but not on the commuting distance of men (hypothesis 1).

2.2. Reduction in Commuting Distance and the Motherhood Wage Gap

There are at least two main theories offering different theoretical mechanisms that may explain why reduced commuting distances are associated with wage penalties for mothers: The human capital theory and the job search theory. While the human capital theory [54] is dominant in the literature on the factors explaining the motherhood wage gap (see, for an overview, [55]), the job search theory [56] plays a prominent role, for instance, in explaining the relationship between commuting distance and income.

According to the human capital theory, a worker's productivity—given by formal skills as well as sector-specific and firm-specific knowledge and routines—is an important determinant of their wage. A reduction in the commuting distance can be achieved either by moving or changing workplace, which often implies changing employer. However, both options may not be available to all individuals to an equal extent. For example, a move may not be considered as an option, if the decision to settle down in one place has already been made or if the partner's commute to work would become significantly longer. Furthermore, studies demonstrate that couples tend to base their choice of residence primarily on the professional interests of the male partner, while the female partner is dependent on finding a job close to their place of residence (for Germany: [22]). Overall, we assume that women more often reduce their commuting distance by changing their employer. This assumption is supported by findings for Germany, demonstrating that long commutes prior to the birth of a child significantly increase the probability of changing employer once women return to work [53]. In line with the human capital theory, changing employer is expected to be associated with the loss of accumulated firm-specific human capital, which is associated with wage losses.

The job search theory states that wage levels do not only depend on the human capital endowment of the workers, but also on the extent to which individual skills match the job requirements. Widening the geographical radius for job search increases the number of available jobs, and therefore, the chance of finding jobs that match well with individual qualifications [57]. This requires a correspondingly high willingness to be mobile, as people have to migrate or engage in long-distance commuting to reach distant workplaces. Spatial inflexibility, in contrast, ties people to the local labor market and enhances the risk of not being adequately employed [58,59]. The theory of differential overqualification, originally proposed by Frank [60] as an explanation for the gender wage gap, draws on these considerations. The theory posits that married women have a higher risk of working in jobs they were not trained for compared to men, because of the prioritization of the husband's career when it comes to family location decisions and the subsequent restriction of the wife's job search to the local labor market. Even in the absence of any bad matches between employee's qualifications and job

requirements, however, mobility constraints lead to worse income opportunities if different wages are paid for the same occupations [61]. In this respect, studies show that larger firms, which are often concentrated in urban areas, offer higher wages (i.e., urban wage premium) [62]. Overall, we expect additional wage losses for mothers who reduce their commutes which are caused by a narrowed search radius and the resulting lower chances of finding suitable high-paying job offers.

Various empirical studies have examined how spatial flexibility is instrumental in career advancement [58,63,64]. In this context, studies found positive effects of commuting on wages [22,52,65]. Moreover, Büchel and Battu [59] show that longer commutes are associated with a lower probability of being overeducated. In addition, some studies investigated whether gender differences in commuting behavior contribute to explaining the gender wage gap, but provide mixed results. For example, the findings of Madden and Chiu [18], based on 1980 Census Data for Detroit and Philadelphia, reveal that shorter commuting times among women do not account for the gender pay gap. In contrast, based on Census data for the Tel Aviv metropolitan area, Semyonov and Lewin-Epstein [19] concluded that gender differences in commuting and labor market conditions contribute significantly to the gender pay gap. The reason for this is that married men living in suburban areas more often commute to attractive labor markets in urban areas, while married women are more likely employed in local suburban labor markets. Recently, Nisic [66] drew similar conclusions based on German data. According to her estimates, the gender wage gap between partnered women and partnered men is considerably smaller (around 6%) in bigger cities than in less urbanized areas. Both studies, therefore, indicate that men overcome poor local labor market conditions by accepting longer commutes, while women, due to their role as secondary earners, apparently remain stuck in the local labor market. Under the conditions of such mobility restrictions, women benefit in particular from a high concentration and diversity of job opportunities near home, which is mainly the case when they live close to city centers. While these two studies emphasize the relevance of gender-specific commuting patterns to explain the gender wage gap, other studies conclude that the pay gap is only marginally explained by gender differences in commuting [20–22]. These studies also find only weak positive effects of commuting distance on wages. For example, Auspurg and Schönholzer [22] (pp. 148–149) show with German data that women in partnerships could expect a salary increase of 1.2% if they doubled their commuting distance to the level of partnered men. Correspondingly, their analysis indicates that gender differences in commuting behavior explain only 1 percentage point of the gender wage gap among women and men living with a partner, which after controlling for commuting distance is still about 19%. Studies investigating the influence of child-related commuting restrictions are by contrast, largely lacking. Gutierrez [23] conducted the first study in this direction using pooled data from the American Community Survey. Focusing on within-couple comparisons, this examination shows that 10% of the gender wage gap among childless couples, and more than 23% of the wage drop attributed to being a mother, can be explained by differences in commuting patterns.

In the following analyses, we also focus on the influence of child-related commuting restrictions on the motherhood wage gap. In this regard, we expect that reducing the commuting distance after the transition to parenthood will be associated with wage penalties for mothers (hypothesis 2). In addition to providing estimates of the effects of child-related commuting adjustments on the motherhood wage gap, we will empirically test the different theoretical mechanisms described above.

3. Data and Methods

3.1. Data

The empirical analyses are based on data from the German Socio-Economic Panel (GSOEP, version 34, SOEP, 2019, doi:10.5684/soep.v34.) that are analyzed within a fixed effects (FE) panel regression framework. The GSOEP is a representative longitudinal survey of randomly selected and yearly interviewed households in Germany, starting in the year 1984 [67].

The analyses are restricted to the waves 2001–2017 as detailed information on commuting distances was not regularly collected until 2001. We focus on the transition to the first child and the associated consequences on male and female commuting behavior, as well as on female wage trajectories. The inclusion of higher parities would make the following analyses more extensive and complicated, and therefore, go beyond the scope of this paper. Accordingly, as soon as respondents report having a second child, their respective observations are excluded from the analyses (i.e., right-censored). Furthermore, since the effect of parenthood in the context of FE regressions is based on a before-and-after comparison, persons who already had a child at their first valid observation, as well as persons who provided only one observation, are excluded from the sample. In addition to our treatment-group (i.e., women and men transitioning to parenthood during the observation window), persons who remained childless (but were at risk of having a child) during their observation window were kept in our sample in order to obtain accurate estimates of age and period effects [68]. To follow women and men during their fertility period, both remaining groups (i.e., the ‘treated’ as well as the ‘non-treated’) were restricted to the birth cohorts 1965–1994 and limited to the age of 18 to 49. Furthermore, we restricted our sample to persons who work at least 1 h per week, who are not currently studying (or attending general school), who earn at least one euro per hour and not more than 50 euros per hour, and whose commuting distance does not exceed the threshold of 149 km. We decided to introduce this upper commuting distance bound to reduce the risk of our results being affected by extremely long distances. Respondents with commuting distances of 150 km or more are often weekend (or weekly) commuters. The restrictions that this type of commuting imposes on family life can differ markedly from those imposed by daily commuting. After additionally dropping observations with missing values our sample finally comprises 41,111 observations (women—18,726; men—22,385) from 7183 persons (women—3294; men—3889).

3.2. Measures

Dependent variables. The dependent variable of the first part of the analysis in which we examine hypothesis 1 is the *commuting distance to the workplace in kilometers*. As is usual in studies on commuting, the information on the commuting distance is *log-transformed* to account for the right-skewed distribution of commuting distance [22,42]. For this, commuting distances of 0 kilometers were set to the value 0.1. The effect coefficients of such semi-logarithmic regression models reflect an approximation of the percentage change in the dependent variable when the independent variable increases by one unit [69].

In the subsequent analyses of the motherhood wage gap, we deploy the *hourly wages* as the dependent variable. We calculate hourly wages by dividing the monthly gross income (in euros) by 4.35 times the reported actual weekly working hours. The wages were then deflated by the consumer price index (to 2010) provided by the German Statistical Office and finally transformed by calculating their *natural logarithm* (for analogous reasons as already discussed above).

Parenthood. The key biographical event in our study is the transition to parenthood (i.e., the birth of the first child). This event is indicated by a binary variable whose value changes from 0 to 1 when the first child is born (to determine birth events, biographical data on the birth of biological children were used). A transition to parenthood can be observed for 535 women and 863 men in the sample.

Explanatory variables for the motherhood wage gap. In our analyses, we pay special attention to the influence of child-related reductions in commuting distances on the motherhood wage gap and the underlying mechanisms. More specifically, our study aims to determine the effect of the *first substantial reduction of the commuting distance after the transition to parenthood*. A reduction in commuting distance was considered substantial if it involves a reduction by at least a third of the previous distance (but was also at least 5 km). We have decided to introduce such a threshold to ensure that our variable mainly captures reductions that were actually intended to improve the compatibility of commuting and parenthood. In the course of robustness checks, we applied various other thresholds, but these did not lead to substantially different results (see Section 4.5). Thirty-point-one percent ($n = 161$) of all women

who gave birth to a first child during the observation window reduced their commuting distance according to our criteria.

We included several variables with the aim to examine the link between commuting and maternal wage penalties. We used work experience, as well as firm tenure, to account for differences in human capital. For our measure of *work experience*, available information on the months spent in full-time and part-time employment was used and converted into a single indicator by summing up both variables. To account for the lower human capital accumulation in the context of part-time work, months spent in part-time were multiplied by 0.5 (i.e., down-weighted). In addition, we used *firm tenure* as a measure of firm-specific human capital. This variable is of particular interest in the context of this study as wage penalties, which are associated with a reduction in commuting distance, might be partly caused by the loss of firm-specific human capital and seniority after changing to a job closer to home.

We additionally examined a mechanism that can be derived from job search theory. According to this mechanism, wage losses are also caused by the restriction to the local labor market and the associated poorer chances of finding suitable, well-paid jobs. We tested this explanatory approach by investigating whether poor job matches resulting from distance reductions in commuting explain maternal wage deductions. To establish the *adequacy of the job matches* we draw on the respondents' corresponding subjective assessments (the wording of the item is: "Does this job correspond to the occupation for which you were trained?"). However, qualification mismatches might not be the only reasons why spatial restrictions lead to wage losses. Wage penalties can also arise if firms located in suburban labor markets pay less than firms in the central business districts [23]. In this context, the findings of Lehmer and Möller [62] indicate that *firm size* plays a crucial role in explaining higher wage levels in urban compared to those in suburban areas. For this purpose, we deploy a variable that indicates the firm size based on six categories. Finally, we examined the possibility that reductions in the commuting distance are achieved by becoming *self-employed*, which may often also lead to wage losses [70,71]. Findings show that self-employed persons have shorter commuting distances on average (for Germany see, for instance, [51]).

Control variables. All regression models included control variables for partnership status (not living with a partner; cohabiting union; married), two regional indicators (living in Eastern Germany vs. living in Western Germany, as well as living in a rural region vs. living in an urban region) and the yearly GDP growth (in%) in order to account for period effects relevant to wages. Furthermore, all models included the age (and age squared) of the respondents. Such modelling enables us to assess the wage penalties after taking into account the age-related wage increases.

Table 1 presents a description of the sample differentiated by gender and parental status.

Table 1. Descriptive statistics.

	Mothers		Childless Women		Fathers		Childless Men	
	M	SD	M	SD	M	SD	M	SD
Commuting distance in km	14.56	16.09	16.88	18.67	18.74	18.49	17.82	19.73
Deflated hourly wages in Euro ^a	14.73	6.96	13.32	6.78				
Reduction of commuting distance after childbirth ^a	0.29							
<i>Human capital</i> ^a								
Work experience full-time and part-time (years)	20.39	10.43	17.70	15.09				
Firm tenure (years)	6.80	5.75	5.93	6.23				
<i>Qualification (mis-)match</i> ^a								
poor job match	0.22		0.23					

Table 1. Cont.

	Mothers		Childless Women		Fathers		Childless Men	
	M	SD	M	SD	M	SD	M	SD
<i>Job characteristics^a</i>								
Firm with 1–4 employees	0.10		0.09					
Firm with 5–19 employees	0.21		0.20					
Firm with 20–99 employees	0.20		0.18					
Firm with 100–199 employees	0.09		0.09					
Firm with 200–1999 employees	0.19		0.21					
Firm with 2000 or more employees	0.22		0.23					
Self-employment	0.04		0.03					
<i>Control Variables</i>								
Single (not living with a partner)	0.13		0.50		0.04		0.60	
Cohabiting	0.24		0.28		0.22		0.22	
Married	0.63		0.22		0.74		0.19	
Living in Eastern Germany	0.34		0.16		0.21		0.20	
Living in a rural region	0.39		0.29		0.30		0.31	
Age	34.61	5.25	31.09	8.12	35.79	5.60	31.83	8.22
<i>n</i> Observations	1649		17,077		2792		19,593	

^a Variable(s) analysed only for the subsample of women.

3.3. Analytical Approach

In our empirical analysis, we first tested the hypothesis that parenthood primarily restricts the commutes of women (hypothesis 1) by means of within-person fixed effects regression. For this, we estimated the effect of the transition to parenthood on the commuting distance differentiated by gender. Second, we investigate whether the reduction of mothers' commuting distance is associated with wage losses and whether this restriction on mobility can (partly) explain the motherhood wage gap (hypothesis 2). Third, we analyzed the underlying mechanisms of this relationship. For this purpose, we first determined the wage penalties associated with a reduction of the commuting distance due to a job change. Then, we examined how the extent of wage disadvantages—resulting from switching to a workplace nearer to home—can be explained by loss of firm-specific human capital, by an increase in skills-related mismatches, or by moving to certain jobs (i.e., smaller companies and into self-employment).

We used linear fixed effects (FE) panel regression models [68,72], which are widely used in the analysis of the motherhood wage gap. These models estimated the effect of x not by taking other persons as counterfactuals (between-comparison), but each person with him- or herself (within-comparisons). The advantage of this approach is that estimates are not biased by person-specific unobserved heterogeneity. Such a bias could, for example, arise if career-oriented women had a higher willingness to accept lengthy commutes and lower ambitions to have children than family-oriented women. In this case, the correlation between parenthood and commuting would at least partly be caused by the inter-personal variance regarding the career/family-orientation in the sample. As a result, our causal inferences can be made with less uncertainty.

4. Results

4.1. Descriptive Findings

Figure 1 presents the means of wage levels and commuting distances differentiated by sex and family situation. While wages do differ very slightly between childless men and women who are not living with a partner in a household, the estimates show a gender pay gap among childless and cohabiting couples. The gender wage gap, however, becomes much wider when comparing mothers

and fathers. The analysis reveals that the gender pay gap is largely based on a motherhood wage gap, which is characterized by the stagnation of wage growth after the transition to motherhood. The fact that women with children in Figure 1 even show slightly higher wages than women without children is due to the age difference between these two groups (mothers are on average older than childless women) and the positive correlation between age and wages. Consequently, additional analyses show lower wages for the group of mothers after the adjustment for age (results not shown). With regard to commuting, the analyses point to a decrease in commuting distance due to parenthood for both sexes. However, a stronger reduction is apparent for women.

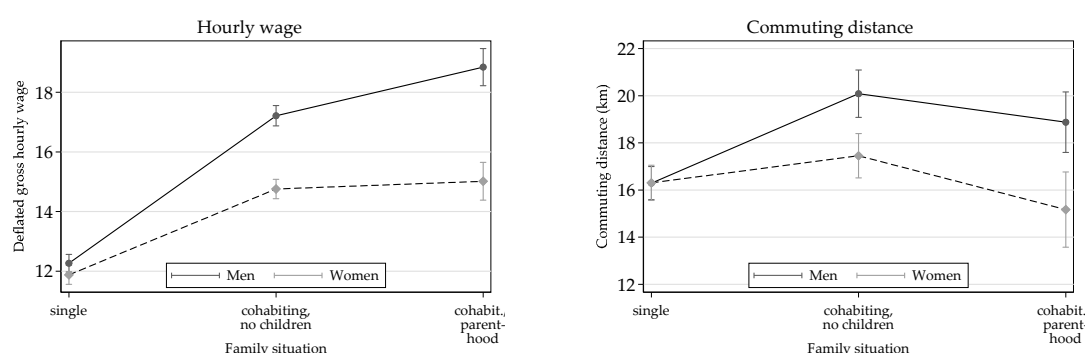


Figure 1. Means of wage levels and commuting distances by sex and family situation.

4.2. Transition to Parenthood and Commuting Distance of Women and Men

Table 2 shows the effect of the transition to first-time parenthood on commuting distance, differentiated by gender and accounting for controls. The analyses reveal a substantial negative effect of the transition to motherhood. According to the model estimates, the birth of a first child reduces the commuting distance of women on average by about 33% (hypothesis 1). In contrast, no significant or substantial effect of fatherhood on commuting distance can be observed. The results furthermore point to a parabolic relationship between age and commuting distance. With regard to the other controls, only the partnership status shows significant effects. The positive effects of the categories ‘cohabiting’ and ‘married’ are consistent with previous findings that the establishment of a joint household tends to be accompanied by a lengthening of commuting distances [42]. For women, the effect of being married becomes even stronger than the cohabitation effect if the model simultaneously accounts for the strong negative effect of parenthood.

Table 2. Fixed effects regressions of women’s and men’s log-transformed commuting distances on parenthood and controls.

	Women	Men
Transition to parenthood	−0.327 ***	−0.026
Age	0.036 +	0.032 +
Age squared	−0.001 +	−0.000 +
GDP growth	0.001	−0.000
Living in East Germany	0.127	−0.181
Living in a rural region	0.170	0.215
Partnership status (ref. = single)		
Cohabiting	0.110 **	0.130 **
Married	0.168 **	0.111 *
Within-R squared	0.010	0.004
Observations	18,726	22,385
Persons	3294	3889

Note: + $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

To get a more detailed picture of how women's commuting to work evolves in the course of family formation, we additionally estimated a distributed fixed effects model [73] that controls for the same variables as in the previous model. In this model, we also distinguished between different points in time prior to birth to assess whether the reduction occurs primarily before or after the transition to parenthood. To examine the development of the commuting distance after the birth event, the time since returning to work after the child-related employment break was modelled. Observations made 25 months or earlier prior to birth serve as the reference. This reference category also captures the observations of all women who have not entered parenthood during the observation window. Figure 2 illustrates that women's reductions in commuting distance occur mainly after the transition to parenthood. More specifically, it becomes evident that the negative parenthood effect largely reflects a reduction in commuting distance upon returning to work after parental leave. Furthermore, the estimates reveal that the commuting distances do not re-increase substantially in later years after the birth event, pointing to a long-lasting effect of parenthood on women's commuting distances.

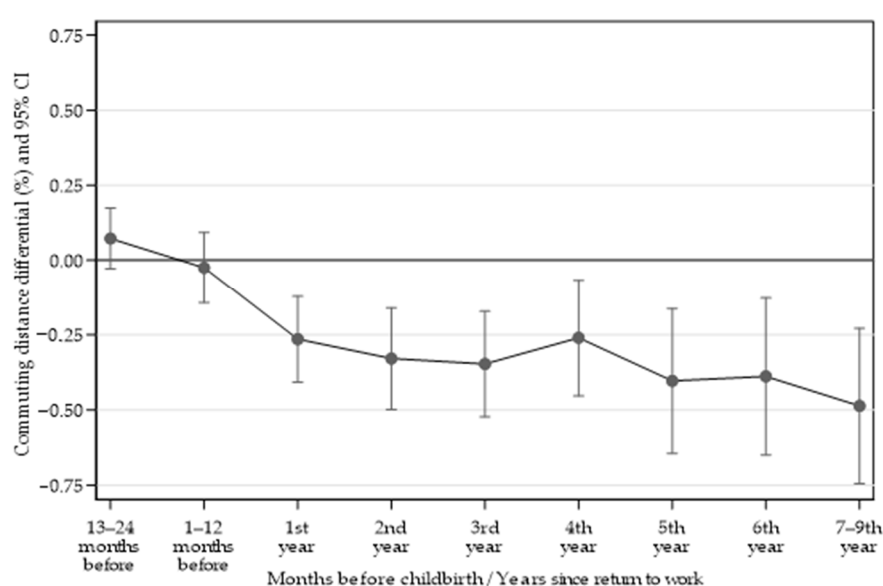


Figure 2. Female commuting distance differentials before and after the first birth. Note: Ref. (horizontal line) = 25 months or earlier before birth event.

Overall, the findings confirm our first hypothesis that the transition to parenthood is associated with a substantial reduction in commuting distance for women, whereas this is not the case for men.

4.3. Transition to Parenthood, Commuting Distance Adjustments and the Wage Penalty for Motherhood

In the next step of the analysis, we examined whether reducing the commuting distance after the transition to parenthood is associated with wage penalties for mothers (hypothesis 2). For this purpose, we first estimated a model without accounting for commuting behavior to assess the motherhood wage gap associated with having a first child (Table 3, model 1). Our analyses reveal a wage penalty of approximately −11.3% for having a first child, controlling for potentially confounding variables. In model 2, we additionally included a dummy variable that considers the substantial reduction in commuting distance after childbirth. The effect of this variable, thus, reflects the *additional* wage losses associated with a substantial reduction in commuting distance after the transition to parenthood, while the effect of the variable 'transition to parenthood' now reflects the wage losses of women who do not substantially reduce their commuting distance after childbirth. The adding of both coefficients gives the *total* loss of pay for women who substantially reduce their commuting distance after the transition to parenthood. Alternatively, an interaction model can be specified in which the multiplicative term 'parenthood' X 'reduction of the commuting distance after childbirth' and

the main effect term of the variable ‘parenthood’ are considered. It should be noted that the main effect term of the variable ‘reduction of the commuting distance after childbirth’ cannot be included, since it is a nested variable that is only meaningful in the presence of parenthood. Such a model specification yields identical results. Model 2 reveals large differences in wage declines between women who reduce their commuting distance after the transition to parenthood and those who do not (i.e., whose commuting distance stays rather unchanged or increases). For the latter group, the model shows a wage penalty of -8.7% . The reduction in the commuting distance additionally increases the motherhood wage gap by 9.7 percentage points, which implies a total motherhood wage gap of -18.4% for women who reduce their commuting distance. Hence, we can conclude that the relative wage losses are roughly twice as high for women who substantially reduce their commuting distance after the transition to parenthood compared to those who do not decrease their commuting distance after childbirth. Moreover, our results suggest that the reduction of the commuting distance of women after the transition to parenthood actually contributes substantially to explaining the motherhood wage gap, as the pay gap is 23% smaller once only those women are considered who do not reduce their commuting distance after childbirth (i.e., -8.7% from model 2 in relation to -11.3% from model 1).

Table 3. Fixed effects regressions of women’s log-transformed hourly wages on parenthood, commuting behavior and controls.

	Model 1	Model 2
Transition to parenthood	-0.113^{***}	-0.087^{***}
Age	0.200^{***}	0.201^{***}
Age squared	-0.002^{***}	-0.002^{***}
GDP growth	-0.001	-0.001
Living in East Germany	-0.163^{**}	-0.164^{***}
Living in a rural region	-0.041	-0.039
Partnership status (ref. = single)		
Cohabiting	0.054^{***}	0.053^{***}
Married	0.032^{+}	0.030^{+}
Reducing commuting distance after childbirth ^a		-0.097^{**}
Within-R squared	0.217	0.218
Observations		18,726
Persons		3294

Note: ^a By at least one third and at least 5 km (see Section 3.2). ⁺ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

4.4. Tracing the Mechanisms behind the Wage Penalty for Mothers Who Reduce Their Commuting

Our previous results demonstrate that mothers who substantially reduce their commuting distance after entering parenthood incur substantial additional wage losses. In this section, we aim to shed more light on the mechanisms through which mothers’ adjustments of commuting distance promote the motherhood wage penalty. We will examine two arguments. The additional wage losses suffered by mothers who reduce their commuting distance after childbirth might be due to (a) the loss of firm-specific human capital and/or (b) being restricted to the local labor market and the resulting poorer job opportunities. Both arguments imply a change in the workplace. Hence, it is reasonable to expect additional wage penalties only for women who reduce their commuting distance after childbirth by changing their job, but not for women who reduce their commuting distance by moving. In the following, the event ‘change of job’ means both a change of employer and a change from an employee relationship to self-employment or vice versa. By contrast, internal job changes are not considered job changes, since most of them should not involve a change of job location. As Table A1 in the Appendix A shows, additional wage penalties can only be found for women who reduce their commuting distance by means of changing their job. These women suffer from particularly high wage losses which amount

to −30.1%. In contrast, reducing the commuting distance by means of moving is associated with particularly low wage losses which amount to −2.1%.

In the following, we especially focus on reductions of commuting distances associated with job changes to specify the mechanisms that lead to wage losses. More specifically, we will concentrate on the first job change after the transition to parenthood. In the following regression models, we differentiate this change according to whether it is associated with a reduction in commuting distance or not. This allows us to differentiate the wage penalties between women, who (a) keep their job after the transition to parenthood; (b) change their job after childbirth and thereby *reduce* their commuting; and (c) change their job after childbirth and thereby *do not* reduce their commuting. Furthermore, we successively extend the models by explanatory factors derived from our theoretical considerations to empirically determine the explanatory contribution of these factors: Human capital-variables (labor force experience, firm tenure), a measure of the qualification (mis-)match, as well as job characteristics (firm size, self-employment). The results of this analysis are presented in Table 4.

Table 4. Fixed effects regressions predicting women’s log-transformed hourly wages: Motherhood wage penalties differentiated by events ‘job change’ and ‘commuting reduction’ (Models stepwise extended by explanatory variables).

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
No job change after childbirth	−0.092 ***	−0.029	−0.038 +	−0.037 +	−0.037 +	−0.037 +
Job change with reduction of commuting after childbirth ^a	−0.223 **	−0.196 **	−0.155 *	−0.104	−0.091	−0.021
Job change without reduction of commuting after childbirth	−0.037	−0.009	0.032	0.041	0.047	0.088 +
<i>Controls and explanatory variables</i>						
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
<i>Human capital variables</i>						
Labor force experience	No	Yes	Yes	Yes	Yes	Yes
Firm tenure	No	No	Yes	Yes	Yes	Yes
<i>Qualification (mis-)match</i>						
Changes to poor job matches	No	No	No	Yes	Yes	Yes
<i>Job characteristics</i>						
Changes into self-employment	No	No	No	No	Yes	Yes
Changes to smaller companies	No	No	No	No	No	Yes
Within-R squared						
Observations			18,726			
Persons			3294			

Note: ^a By at least one third and at least 5 km (see Section 3.2). + $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Model 1 shows small and not significant additional wages penalties for women who change their job without changing commuting distance (increase of the wage penalty by 3.7 percentage points; the total motherhood wage penalty for this group is $[-9.2] + [-3.7] = -12.9\%$). In contrast, strong additional wage penalties can be found when a job change is accompanied by a reduction of the commuting distance (increase of the wage penalty by 22.3 percentage points; total motherhood wage penalty: -31.5%). This finding suggests that the wage penalty resulting from a reduction of the commuting distance after entering parenthood is not caused merely by the loss of firm-specific human capital. In this case, mothers that changed their job without a reduction of commuting distance should also show significant additional wage penalties.

In model 2, work experience is included as an additional explanatory factor. This variable explains much of the wage losses for mothers who keep their jobs after birth. Therefore, the wage penalty for this group becomes statistically insignificant and is reduced from 9.2% in model 1 to 2.9% in model 2. Moreover, also the additional wage penalty resulting from a job change is slightly reduced.

However, a closer look at the data reveals that job changes are positively correlated with longer periods of employment interruption (results not shown), which may be the reason for this effect reduction.

Model 3 additionally controls firm tenure. As expected, this factor only provides an explanation for the additional wage penalties associated with a job change. Given the fact that the reduction in maternal commuting is frequently accompanied by a job change, we can therefore conclude that the wage losses linked to a reduction in commuting distance are also partly caused by a loss of firm-specific human capital. At the same time, a substantial additional wage penalty of 15.5 percentage points remains for women who reduce their commuting distance by changing their job, after controlling for the human capital endowment.

Moreover, model 4 includes an additional dummy variable that is assigned the value 1 if the job change is associated with a shift to a job that no longer matches the individual qualification. Considering the qualification (mis-)match leads to a significant reduction in the additional wage penalty. The remaining value (−10.4%) can be interpreted as the additional wage penalty for women who reduce their commuting distance by changing their job, but switch to a job that still matches their individual qualifications. We further find evidence that the wage penalty for mothers who reduce their commuting distance is associated with a change from dependent employment to self-employment (model 5) and a switch to smaller firms (model 6), with the latter explaining considerably more of the wage penalty. Overall, our analyses reveal that a considerable proportion of the motherhood wage penalty associated with a reduction in commuting distance can be explained by changes to smaller companies and to jobs that do not match the individual qualification profile.

4.5. Robustness Checks

Additionally, we have performed a series of robustness checks. First, we have checked whether the findings depend on the threshold value used to identify substantial reductions in the commuting distance. When using lower thresholds (e.g., −10%), a slightly lower additional wage penalty was found. However, the additional wage penalties always remained substantial in their extent and statistically significant. Second, instead of using a dummy variable to indicate a substantial reduction in the commuting distance after the transition to parenthood, a metric measure of the commuting distance (log-transformed commuting distance in km) was included. This approach corresponds to the strategy of several previous studies examining the contribution of gender-specific commuting patterns to the emergence of the gender pay gap [21,22]. As in these studies, this approach resulted in only marginal changes in the variable reflecting the motherhood pay gap, which in the previous studies was interpreted as only a minor explanatory contribution of commuting to the emergence of wage disadvantages (see model 1 vs. model 2 in Table A2 in the Appendix A). However, including commuting distance as a metric measure does not consider that a reduction in commuting is not necessarily associated with wage declines to the same extent as an increase in commuting is with wage increases. Further analyses show that there is indeed no such symmetry in our sample with regard to the relationship between commuting and wages. Among childless female workers, substantial increases *and* substantial reductions in commuting distance are associated with wage increases. In contrast, after the birth of a child, increases in commuting distance are no longer associated with wage growth. Rather, increases in commuting distance after the birth tend to be associated with some additional wage penalties (see model 3 in Table A2 in the Appendix A). Thus, the coefficient of the metric commuting variable does not correctly reflect the wage drops associated with a reduction in the commuting distance after childbirth. Rather, the coefficient largely reflects the relationship between commuting distance and wage level in the context of childlessness, since the group of childless women quantitatively dominates our sample.

5. Discussion

In this study, we investigated the assumption that the transition to parenthood negatively affects women's commuting distance and that this reduction in commuting is associated with wage penalties during the transition to motherhood. We used data for the years 2001–2017 from the German Socio-Economic Panel Study as a basis for our analyses, which were carried out in a fixed-effects framework.

The analyses first demonstrated that the transition to (first) parenthood is associated with a significant decline in the willingness of women to commute longer distances (hypothesis 1). According to this, we find that starting a family leads women to reduce their commuting distance by an average of 33%. In contrast, the transition to fatherhood has no significant influence on the commuting behavior of men. A more detailed analysis of the negative effect of parenthood on the commuting distance revealed that the reduction primarily occurs once women return to work after parental leave and that this reduced commuting distance is then sustained over the long term. This is in line with findings showing that women's job adjustments towards more family-friendly working conditions usually take place immediately after returning to work [15]. Overall, our study thus supports the assumption that the spatial restriction of women, due to their higher responsibility for household and childcare within couple-relationships, is a major cause of the gender differences in commuting between men and women.

Subsequently, we investigated whether the restriction of spatial mobility for mothers is associated with wage penalties. For this, we first estimated the motherhood wage penalty, which amounts to −11.3%, without taking into account commuting behavior. However, for almost every third mother in our sample (i.e., 30.1%) a substantial reduction of the commuting distance (i.e., at least −33.3%) was observed after the transition to parenthood. Moreover, our analysis reveals that mothers who reduce their commuting distance after the transition to parenthood show an increased wage penalty (−18.4%) compared to those mothers that do not reduce their commuting distance (−8.7%). Our findings, thus, illustrate that 23% of the motherhood wage penalty is based on wage losses associated with corresponding reductions in commuting distance (hypothesis 2).

We finally examined various mechanisms that might explain why reduced commuting distances come with wage decreases for mothers. These mechanisms were derived from human capital theory and job search theory: The loss of (firm-specific) human capital, the loss of adequate employer-employee matches, the move to smaller firms, and the move to self-employment. For the subgroup of mothers who reduce their commuting distance by changing jobs, our estimates yield particularly high wage penalties of around −30%. In contrast, mothers who change their job without a reduction of commuting distance suffer only marginal additional wage penalties. Subsequent analyses showed that additional wage penalties for mothers who change to a job near their place of residence can be partly explained by the loss of firm-specific human capital. However, even after controlling for this factor, a significant wage penalty due to commuting remained. As our analyses further showed, this is largely due to mothers taking jobs that are less suited to their skills profile in favor of shorter commuting distances, and moving to smaller companies that tend to pay less than the larger companies that are further away from home. Changes into self-employment, which are accompanied by a reduction in the commuting distance, but at the same time are associated with wage losses, also appear to be a cause of the 'spatial dimension' of the wage penalty, but explain it to a much lesser extent.

In summary, the limitation of women's commuting during the transition to first parenthood makes a substantial contribution to the emergence of inequalities between childless women and mothers in the labor market. If mothers (have to) change employers in favor of a shorter journey to work, this leads to a loss of firm-specific human capital and company seniority, which, in turn, leads to reduced wage gains and opportunities for career advancement. Moreover, the necessity and/or preference to find employment close to one's home comes with a reduced job search radius that limits the choice of suitable and well-paid work opportunities. Since men are not affected by the career-related disadvantages of parenthood to the same extent as mothers, parenthood will also contribute to gender inequality [8]. Our study clearly shows that parenthood does not restrict the spatial mobility of fathers

to the same extent as that of mothers. Therefore, our results offer indications of the explanatory potential of the increasing gender differences in commuting in the context of parenthood for explaining the gender pay gap.

The evidence to date on the relevance of gender-specific commuting patterns for explaining the gender wage gap is mixed. Some studies conclude that gender differences in commuting can only explain a small part of the pay gap (for the US: [18,20,21]; for Germany: [22]). Other studies, however, find indications of a more substantial contribution. For example, Le Barbanchon et al. [24], based on data from France, conclude that around 10% of the gender wage gap can be attributed to gender differences in the willingness to commute. Although the negative effect of children on women's willingness to commute could be a mechanism for the motherhood wage penalty, which in turn is known to contribute to the gender pay gap (see Section 1), the link between commuting and the motherhood wage gap is still almost unexplored. An exception is a study by Gutierrez [23], based on data from the U.S., which found that sex differences in commuting patterns account for 10% of the gender wage gap among childless couples and more than 23% of the additional wage gap due to the birth of a child. Despite the differences in the country context and the statistical method used, our study also points to a relatively high relevance of commuting behavior. In Section 4.5, we have discussed methodological reasons why the impact of commuting on the emergence of the gender pay gap may have been underestimated in some previous studies.

Our study has certain limitations that must also be addressed. Like other studies on the motherhood wage gap and its explanatory factors, we cannot exclude the possibility of endogenous selection bias. Consequently, it cannot be ruled out that women will become mothers more often if they anticipate a lack of career progression in the near future. By changing their focus away from the realm of the professional career towards home and children, these women might additionally have a high willingness to reduce their commutes. While we cannot rule out such anticipatory effects, it should be noted that the wage disadvantages associated with a reduction in commuting distance arise primarily after a *change* of employer, so that we consider the relevance for our findings to be limited.

Our study also offers a variety of starting points for further research. The link between commuting and the motherhood wage penalty is an important topic that deserves more attention. Future studies on the causes underlying the overall gender pay gap should also examine the role of mothers reducing their commuting distance. By additionally including higher birth parities, future studies could provide an even more detailed picture of the relationship between parenthood, commuting and wage disadvantages. Furthermore, it would greatly enrich the state of research if the associations shown here could also be investigated for other country contexts. In this regard, drawing on data from France, Germany, Spain and Switzerland, Rüger and Viry [74] found that the relationship between fertility and commuting is shaped by national contexts. In addition, comparative studies showed that the factors influencing the motherhood wage gap vary between countries [9].

As a final point, our results also have practical implications. They indicate the potential of two strategies, both of which could contribute to reducing wage disadvantages due to spatial mobility restrictions during the transition to parenthood. According to this, policies, on the one hand, could aim to support the spatial mobility of parents so that breaks in their employment histories are avoided. The expansion of a childcare infrastructure that is adapted to the needs of commuting parents is particularly promising in this respect. On the other hand, measures could be aimed at creating attractive job opportunities close to where families live, so that parents who reduce their commuting distance do not have to accept too great a loss of income in return.

Author Contributions: Conceptualization, T.S. and H.R.; Formal analysis, T.S.; Methodology, T.S. and N.S.; Writing—original draft, T.S. and H.R.; Writing—review & editing, T.S., H.R. and N.S. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Fixed effects regressions that predict women's log-transformed hourly wages: Additional wage penalties differentiated by different modes of commuting distance adjustments (moves vs. job changes).

Transition to parenthood	0.087 ***
Age	0.201 ***
Age squared	−0.002 ***
GDP growth	−0.001
Living in East Germany	−0.167 ***
Living in a rural region	−0.040
Partnership status (ref. = single)	
Cohabiting	0.053 ***
Married	0.030 +
Distance reduction after childbirth via moving ^a	0.066
Distance reduction after childbirth via job change ^a	−0.214 **
Distance reduction after childbirth, whereby both events (moving and job change) may have contributed to this change ^a	−0.123
Distance reduction after childbirth, but neither a move nor a job change is connected to it in the data ^a	−0.061
Within-R squared	0.220
Observations	18,726
Persons	3294

Note: ^a By at least one third and at least 5 km (see Section 3.2). + $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table A2. Fixed effects regressions of women's log-transformed hourly wages on different measures of commuting distance adjustment and controls.

	Model 1	Model 2	Model 3	Model 4
Transition to parenthood	−0.113 ***	−0.110 ***	−0.064 ***	−0.087 ***
Age	0.200 ***	0.200 ***	0.189 ***	0.201 ***
Age squared	−0.002 ***	−0.002 ***	−0.002 ***	−0.002 ***
GDP growth	−0.001	−0.001	−0.001	−0.001
Living in East Germany	−0.163 **	−0.164 ***	−0.161 **	−0.164 ***
Living in a rural region	−0.041	−0.042	−0.044	−0.039
Partnership status (ref. = single)				
Cohabiting	0.054 ***	0.053 ***	0.048 ***	0.053 ***
Married	0.032 *	0.030 +	0.024	0.030 +
Commuting distance (log)		0.009 +		
Increasing commuting distancebefore parenthood ^a			0.063 ***	
Reducing commuting distancebefore parenthood ^a			0.034 *	
Increasing commuting distanceafter childbirth ^a			−0.038	
Reducing commuting distanceafter childbirth ^a			−0.092 **	−0.097 **
Within-R squared	0.217	0.218	0.221	0.218
Observations			18,726	
Persons			3294	

Note: ^a By at least one third and at least 5 km (see Section 3.2). + $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

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