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**The Motherhood Penalties :
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The Motherhood Penalties: Insights from Women in UK Academia

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Abstract

We use an original survey of academic women in the UK to investigate different dimensions of the motherhood penalty. Being a mother has no effect on salaries, but still slows down career progression even in such a high-skilled sector. Motherhood has an ambivalent impact on women's perception of their working environment: improving satisfaction, but reducing perception of salary fairness relative to men. Our paper also explores how different policies can mitigate the motherhood penalties. We find that more generous maternity provisions are associated with higher salary, potentially because generosity reduces the crowding out of research activity. Better availability of childcare and an even distribution of responsibilities within the household correlate positively with earnings. Our findings also highlight the importance of a supportive work environment for mothers' career and well-being at the workplace. Taken together, these findings suggest the necessity of a multi-faceted policy response to the motherhood penalties.

Keywords: satisfaction, salary, career, exclusion, gender pay gap, academia

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1 Introduction

Sociologists call it the “motherhood penalty”: the earnings and career gaps between women with and without children. Such gaps can be substantial, as much as 20% for income over the long-run (Kleven et al., 2019), to the point that existing research recommends women to wait until they are about 31-34 years old before having children (Leung et al., 2016). But how widespread is the “motherhood penalty”? Does it only affect the salary and career paths of women, or does it also touch on other aspects of their working life, such as their satisfaction and perception of being treated fairly compared to men? In other words, how many *penalties* do women bear for becoming mothers?

In this paper, we leverage a unique survey, answered by more than 9,000 women working in the UK academic sector, to shed light on these questions. We show no obvious motherhood penalty on salaries and an ambivalent effect on their careers. Compared to non-mothers, mothers are more likely to be in permanent positions (having tenure), but take longer to reach top roles (becoming professors). The first result is possibly due to the common practice of postponing childbirth until getting a secure contract. These effects appear to be driven by “recent” mothers, who became pregnant after 2012, even after controlling for age. These “new” mothers also experience lower earnings. These results suggest that while women may eventually catch up with their peers after pregnancy, there is a short-term negative effect of becoming mothers.

Our survey also allows us to measure the spillovers of motherhood on other, often overlooked, dimensions. Compared to childless women, mothers spend more time commuting to work at the time of the interview, possibly due to the necessity of moving to areas with affordable housing and better-quality schools. Furthermore, while mothers exhibit higher levels of job satisfaction compared to women without children, they are more likely to report feelings of unfairness in salary vis-à-vis their male colleagues.

How are we to interpret these ambivalent effects? The existing literature denouncing the under-representation of women in top positions (i.e. the so-called “leaking pipe”) suggests one possible interpretation. With a permanent contract, mothers are more secure and, consequently, more likely to be satisfied. Yet, reaching permanency, though an important step, is not the end of an academic career. Mothers, like all other academics, seek to become professors. The under-representation of women at the top now becomes more salient, which heightens feelings of unfair treatment relative to male academics.

We then go beyond documenting the multiple-faces of the motherhood penalty in academia and try to disentangle which factors aggravate or mitigate the difficulties moth-

ers experience at work, with particular attention to maternity provisions. There is in fact no consensus in the economic literature on the effectiveness of more generous leaves in helping retaining mothers in employment or preventing a drop in their salaries in the long-run, due to the ambivalent impact of a longer absence from work on mothers' human capital. We rely a novel dataset (Troeger et al. 2020) containing the current and previous occupational maternity packages offered across 160 UK Higher Education Institutions (HEIs) to contribute to this debate. We exploit a fine-grained measure of the maternity leave provisions available at the time of each childbirth for the academic mothers in our sample. We document a positive and significant relationship between the generosity of the leave provisions available at the time of the most recent childbirth and current salaries. We also find no evidence suggesting a reduction in research activity while on leave (i.e. a depreciation in - broadly defined - human capital). Maternity leave is negatively correlated with teaching activities in the first months after giving birth. Mothers benefiting from generous packages appear to face less financial pressures and are able to devote more time to their newborn and, possibly, to their research activity at a crucial stage of their personal and professional lives.

Our extensive questionnaire allows us to look at further dimensions known to be relevant in the aftermath of a maternity leave: family arrangements, availability of childcare provisions and informal practices at the workplace. We uncover three important patterns in our data.

First, the distribution of child-rearing tasks within the household strongly affects mothers' salaries. Mothers with supportive partners (who share equally parenting chores) earn significantly more than mothers who take on most of the child-raising duties. Similarly, mothers who have access to less than thirty hours of weekly childcare in the two years following childbirth have lower salaries than those who can rely on more childcare services. Time allocation of mothers between family and career may again offer one possible rationale for these results. Leave generosity, an involved partner, and childcare assistance all contribute to freeing up some time to devote to research, decreasing the risk of a depreciation of human capital of mothers.

Second, the working environment matters. Upon returning from their latest maternity leave, mothers who felt excluded from important work-related activities and decisions, earn lower salaries and are less likely to have achieved professorial status (by the time of the survey), compared to those who did not. Subjective feelings of discrimination in the departmental life appear to reflect into actual, objective difficulties in climbing the academic ladder.

Third, support from line managers appears crucial. Mothers who can rely on helpful Head of Departments (HoD) upon returning to work report higher satisfaction and fairness in the allocation of tasks and wages relative to men. This operates in stark contrast to feelings of exclusion, suggesting a persistent, positive impact of a working environment adapted to the needs of mothers.

We establish our results in a sector - UK academia - that is quite specific: employees are highly specialised and educated and can often benefit from flexible working arrangements. Yet, finding any career impact of motherhood, as we do, in an environment where we would arguably least expect it, provides reasonable grounds for policy intervention. How informative are our findings for policymakers? Our paper is possibly the first to document the widespread effect of motherhood at the individual level, with a representative sample of respondents from virtually all establishments in a particular sector, UK academia. Our paper complements the existing literature by giving voice directly to women. Furthermore, our results might sometimes be the best evidence available (e.g. a randomization of Head of Department support might not be a feasible option).

For all these reasons, despite the risk of reverse causality (e.g., higher satisfaction today leading to reinterpret past experiences in a favourable light), despite the risk of self-selection (e.g., women putting less weight on their career would tend to select less supportive partners), we believe our findings hold useful lessons for policy-makers. To improve satisfaction, it is best to intervene at the line manager level, offering Head of Departments training opportunities to increase awareness of the complexity of the motherhood experience. In turn, generous maternity policies, reliefs, and childcare assistance allow mothers to best allocate their time between research, teaching, and family life so as to minimize the depreciation of their human capital and increase their earning and career perspectives in the long run. Finally, for the same reasons, removing stereotypes on who “should be” the primary caretaker, rethinking how child-rearing tasks are distributed within the household, appears to be key.¹ A task, we recognize, easier said than done.

The rest of the paper is structured as follows. In the next section, we frame our work within the scholarly contributions advanced by the literature. We describe our data in Section 3 and our empirical approach in Section 4. We look at the effect of motherhood on academic careers and satisfaction in Section 5, while the role of formal maternity provisions, informal practices in the workplace and family/childcare arrangements is dis-

¹The 2018 British Social Attitude Survey documents that only 7% of respondents felt that mothers of young children should work full time. A depressing number when put into perspective with our findings.

cussed in Section 6, with particular attention to the activities academic mothers perform while on leave. We conduct a number of robustness checks in Section 7 while the last section concludes.

2 Literature Review

One of the conditions that has been shown to hold back women from equal access to jobs and pays, compared to men, is becoming a mother (Correll et al., 2007; Sigle-Rushton and Waldfogel, 2007). In sharp contrast with fathers, women experience a decline in their earning capacity once they give birth (Bertrand et al., 2010; Kleven et al., 2019). The reasons for such penalty are usually ascribed to the career breaks associated to motherhood (Aisenbrey et al., 2009; Arun et al., 2004; Bröckel, 2018; McIntosh et al., 2012), the depreciation of human capital that follows (Albrecht et al., 1999; Anderson et al., 2002; Stratton, 1995) and the tendency to switch to part-time schedules and/or lesser paid jobs in its aftermath (Budig and England, 2001; Waldfogel, 1997). While the effect is driven in significant part by mothers who exit the labor market altogether (Ejrnæs and Kunze, 2013), it is still apparent among those who return to work (Joshi et al., 1999).

Our work speaks to the latter category of mothers, who are highly educated and work in a highly specialized environment, that is the UK academic sector. In this sense, our paper relates to Lutter and Schröder (2020), who focus on the effect of having children on productivity in one discipline (i.e. Sociology) in German academia. Our paper, in turn, considers a different range of outcomes and mechanisms, within a broader pool of respondents and wider range of disciplines. Our sample, by construction, comprises exclusively of highly-educated, autonomous mothers, allowing us to hold education constant.² This represents a relevant advantage, as educational levels appear to play a significant role in explaining the motherhood penalty, due to the higher cost of career breaks in high-skilled professions (Anderson et al., 2002; England et al., 2016) and in fields characterised by long and job-specific working hours (Bütikofer et al., 2018; Goldin, 2014). The same holds true for professions with low autonomy, high emphasis on teamwork and competitive pressure (Yu and Kuo, 2017).

In the paper, we look at the effect that maternity leave provisions have on careers, which is the subject of a large debate in the literature. The short-term effect of an increase in the pro-rata payment and/or in the duration of the offered leave is mechanical,

²In our analysis, we exclude those respondents who did not complete a PhD, in order to further increase homogeneity across the sample.

especially if the maternity leave is well paid (Hanel, 2013): a drop in female wage and employment (Hanratty and Trzcinski, 2009; Ondrich et al., 2003), as mothers are encouraged to pause working in the weeks following delivery. In the long-run, though, the picture is more blurry. Research on the relationship between maternity leave and wages is usually conducted looking at the extensive margin, namely comparing women who have access to paid (or more generous) leave to those who do not, generally finding a weak relationship between maternity provisions and wages (Dahl et al., 2016; Hashimoto et al., 2004; Klerman and Leibowitz, 1999; Schönberg and Ludsteck, 2014). Among others, a recent study by Girsberger et al. (2019) shows how the introduction of paid maternity leave in Switzerland exerted a small impact on mothers' wages (negative in the short-run and slightly positive after four years). Our results are partly in line with this literature. Maternity provisions exert a small but significant positive effect on women's salaries in the long-run, even in the high-skill sector under scrutiny.

Like salaries, findings on the impact of more generous leaves on career progression are overall mixed. While several scholars argue that generous leaves help women retaining firm-specific human capital and, in turn, improving their career opportunities (Dex et al., 1998; Lalive and Zweimüller, 2009; Waldfogel, 1998, 2001; Zveglic and Rodgers, 2003), others reach the opposite conclusion (Lai and Masters, 2005; Ondrich et al., 2002; Rønsen and Sundström, 2002). In this paper, we do not find any significant relationship of more generous leave and career advancements. We then go one step further, looking at the impact on women's ability to remain active in the weeks following childbirth. Some authors have in fact argued that a longer leave might negatively affect women's careers by generating a depreciation of their human capital (Low and Sánchez-Marcos, 2015), a reduction in working hours (Dechter, 2014) and, possibly, work-related training (Puhani and Sonderhof, 2011). We show that, in our setting, the availability of more generous maternity provisions does not seem to crowd out research activity at a delicate stage of mothers' academic careers. Rather, with adequate financial support, mothers do not have to take on extra teaching to supplement their income after giving birth.

Institutional forms of support are also regarded as factors that can alleviate the spillovers of motherhood in the workplace. Assistance from line managers, flexible working hours, childcare facilities and, more generally, a family-friendly workplace culture are all reputed as "*critical elements in making work-family or work-life efforts effective*" (Galinsky et al., 1996, p. 112). As stressed in Thompson et al. (1999), a supportive work-family culture is closely related to the employees' perception of how "acceptable" it is to make use of the family-oriented programs offered formally. Informal practices at the workplace, while benefiting all employees, are therefore particularly relevant for mothers. Women in a sup-

portive working environment are in fact more likely to be still active during their third trimester and attend their job responsibilities immediately after delivery (Glass and Riley, 1998). This, in turn, is likely to affect their attachment and commitment to the job (Bailyn, 2003; Greenberger et al., 1989; Grover and Crooker, 1995; Lyness et al., 1999). For work-life balance provisions to be effective in retaining and supporting women, they need to account for the specificity of the sector. Mentoring and support programs, flexible work schedules, daycare centers and family leaves have been advanced as desirable for women's thrive in the IT sector (i.a. Jepson and Perl, 2002; Wentling and Thomas, 2009). Sponsorship from senior colleagues and access to leadership positions are among the practices identified as crucial for the retention/progression of women in the medical field (i.a. Bates et al., 2016; Travis et al., 2013). As for the academic sector, well paid maternity leave, norms regulating tenure decisions, promotion systems taking family responsibilities into account, along with a working environment that values diversity and equality, are all factors that contribute to the presence and place of female academics (Blum, 1991; Finkel et al., 1994; Finkel and Olswang, 1996; Isgro and Castañeda, 2015; Mason et al., 2013; Van den Brink and Benschop, 2012; Ward and Wolf-Wendel, 2004). In this paper, we are able to disentangle the effect of both formal and informal types of support offered to women in academia, showing how each affects mothers' careers and perceptions in different ways. These findings, which we uncover thanks to our original, large-scale survey, represents, to the best of our knowledge, a novel contribution to the literature.

Finally, our work connects to the large body of literature that studies the impact of family arrangements on women's labour market outcomes. In a seminal contribution, Becker (1985) highlights how child-rearing responsibilities impede investments in human capital and reduce the working hours of women, yielding large gender differences in labour market. Lundberg and Rose (2000) provide evidence consistent with Becker's theory. The division of labour within the family exerts significant spillovers on women's behaviour, thus exacerbating the disparities between men and women in the job market. As for the academic sector, Backer (2012:22) posits that "*gendered living arrangements and unequal workloads at home contribute to the perpetuation of the academic gender gap*"³ Similarly, Craig (2006) finds that gender inequality in childcare duties impairs the career progression of academic women, but that college-educated fathers tend to be more supportive. In our paper, we recover most of these patterns: both domestic support and the availability of longer childcare hours are positively and significantly correlated with the mother's current salary, even after controlling for the partner's employment at childbirth.

³See also Baker (2010).

3 Our Data

We devote this section to describing our novel data. We first present our survey in detail, and then move to describe the information we have collected on current and previous occupational maternity packages offered by UK Higher Education Institutions (HEIs).

3.1 The Survey

We exploit an online survey of virtually the whole population of academic women in the UK, conducted between January 2016 and June 2017. The survey consists of more than 115 questions ⁴ sent to 59,161 valid email addresses. Approximately 17% of academic women filled the questionnaire, yielding a total of 9,671 observations.

The survey covers respondents from 138 UK Higher Education Institutions (HEIs)⁵ out of a total of 163 (HESA, 2016).⁶ All of the 24 universities belonging to the Russell group are represented. The University College London is the most represented (525 obs.), whereas Arts University Bournemouth, Canterbury Christ Church University and Liverpool John Moores University have only one respondent each. Women in our sample work across 37 different disciplines: Psychology, Psychiatry and Neuroscience are the fields with the highest number of respondents (750 obs.), followed by Biological Sciences (742 obs.). 287 respondents work in Politics and International Studies, while 142 women come from Economics and Econometrics. Compared to the population data from the Higher Education Statistical Agency (HESA) for the academic year 2015/16, our sample under-represents women aged 30 years old or below and over-represents those aged 36-45. This skewness in the age distribution has some advantages as it allows us to focus on women who were in their fertile years during the most recent wave of maternity reforms in the UK. As a result of the age distribution, our survey is also overcrowded with professors and academics on a permanent position or full-time contract, compared to the HESA

⁴The actual number of questions varies depending on the characteristics of the respondent

⁵The 26 universities not represented in the data, due to the lack of respondents, are: Arts University Bournemouth, Central School of Speech & Drama, Glasgow Caledonian University, London Business School, Royal Academy of Music (University of London), Royal Conservatoire of Scotland, Courtauld Institute of Art (University of London), Robert Gordon University, University College Birmingham, University for the Creative Arts, University of Cumbria, University of Wales, Ravensbourne University, Rose Bruford College, Conservatoire for Dance and Drama, Guildhall School of Music and Drama, Institute of Cancer Research, Leeds College of Art, Liverpool School of Tropical Medicine, National Film and Television School, Newman University, Plymouth College of Art, St Mary's University College, Stranmillis University College, University of St. Mark and St. John, Writtle University College.

⁶Our questionnaire included one option - "Institute of Education, University of London" - not present in the 2015/16 HESA sample, raising the total number of institutions covered in our survey to 138.

population.⁷

The survey is almost equally split between mothers and childless women (54% vs. 46%). Most mothers have one (38%) or two children (49%), with few having three children (about 5%) or more (1% between 4 and 6). Since large families are rare and potentially different from the rest of the sample, we exclude mothers with more than three children from our main empirical analysis.⁸ Table 1 displays summary statistics for mothers and non-mothers in our sample.⁹ Mothers are 47 years-old on average and earn a gross annual salary of £48,823. 23% of them are professors, 79% on permanent contracts, only 5% on fixed-terms positions (not displayed). The average number of children is 1.77. Compared to mothers, women without children are younger, earn less and are less likely to be on permanent/professorial contracts (all differences between mothers and non-mothers are statistically significant at 1%).

Table 1: Descriptive Statistics for Mothers and Non-Mothers.

	Mothers			Non-Mothers			p-value
	Mean	St. Dev.	N.	Mean	St. Dev.	N.	
Age	46.91	8.88	3,033	41.60	9.78	2722	0.000
Gross Salary	48,824	16,255	3,358	44,827	14,344	3,128	0.000
Professor	0.23	0.42	3,722	0.15	0.35	3,603	0.000
Permanent	0.80	0.40	3,688	0.63	0.48	3,577	0.000
N. Children	1.77	0.75	3,722	0	0	3,604	-

Salary is measured by £5,000 increments from £17,500 up to £105,000. Professor is an indicator variable taking value one if the respondent reports her current title to be Professor. Permanent and Fixed-Term are indicator variables taking the value of one if the respondent reports her current contract is permanent or fixed-term, respectively. All variables are measured at the time of the survey.

3.2 Occupational Maternity Provisions in UK Academia

Maternity provisions are generally characterized by two dimensions: their *length* - the time one can take off without losing her job - and *generosity* - the financial support granted while on leave - which can be either *statutory*, hence mandated by the Government, or *occupational*, enhanced and managed by the employer.

⁷For detailed information on our survey, its features and its representativeness with respect to the HESA academic population, see Troeger et al. (2020)).

⁸We focus on women who answered at least 90% of the questionnaire, hold a PhD at the time of the survey and are not *emeriti* or research assistants. We also remove the small number of respondents (47) who indicated they adopted at least one of their children, as parental provisions differ slightly for those who adopt.

⁹Descriptive statistics for the controls and outcomes studied are presented in detail in Appendix A.

Statutory Maternity Pay (SMP) is set at the national level and provides those who satisfy the eligibility criterion with a minimum weekly payment. In the UK, since 2007, eligible mothers must have worked continuously for the same employer for at least 26 weeks up to the 15th week before the expected week of childbirth, earning more than £120 a week on average. If a woman qualifies for SMP, she receives 90% of her average weekly earnings (before tax) for the first 6 weeks, and then a flat payment (or 90% of the average weekly earnings, whichever is lower) for the next 33 weeks.¹⁰ The final 13 weeks of leave are unpaid (the maximum length of leave in the UK is 52 weeks).

Given the meagre legal minimum set forth by the UK law, many employers - including universities - offer what is known as Occupational Maternity Pay (OMP). UK HEIs are an interesting case-study in this sense, as they exhibit important variations in the provisions they offer, which stem, in particular, from the strategic goals each university pursues.¹¹ For this project, we gathered data on the occupational packages offered over time by 160 universities in the UK. Among the different indexes generally used to capture leave generosity¹², we opted for the so-called “Full Weeks Equivalent” (FWE), which looks at the full monetary value of the benefit.¹³ Our data confirms the existence of a significant heterogeneity across UK HEIs (Table 2). The FWE index for occupational packages currently being offered ranges between 5.40 and 26: at one extreme we have 1 university not topping-up the SMP at all, at the other 9 grant six months of full monetary compensation. Almost two-thirds of the institutions offer between 5.40 to 17 weeks of full pay, with a cluster of thirty-one providing 18.

¹⁰The exact amount of the weekly payment is adjusted yearly by the Government to account for inflation. At the time of writing, it corresponds to £151.20.

¹¹See Epifanio and Troeger (2019) for a more detailed discussion.

¹²Other widely adopted measures of generosity are the “full salary replacement weeks” and the number of weeks in which any salary is paid, either fully or partially. Our results remain robust to using the former, while we tend to discard the latter measure, which does not account for the share of salary being replaced.

¹³The index is computed as follows. For a package consisting of 6 weeks paid at 100% and 9 at 90%, the measure equals to the sum of the number of each “type” of week, weighted by the salary replacement received (in this case, 1 and 0.90, respectively, leading to a FWE of $6*1+0.90*9=14.10$).

Table 2: Full Weeks Equivalent by University (2019).

Full Weeks Equivalent	N. of Universities	%
0.00	1	0.63
5.40	5	3.13
11.40	4	2.50
11.80	33	20.63
12.00	17	10.63
13.00	1	0.63
14.00	1	0.63
15.00	2	1.25
15.80	5	3.13
16.00	28	17.50
17.00	7	4.38
18.00	31	19.38
19.00	3	1.88
19.50	5	3.13
20.00	3	1.88
21.90	1	0.63
22.00	4	2.50
22.50	1	0.63
26.00	8	5.00
Total	160	100.00

By digging into the provisions offered in previous decades by UK HEIs, we were able to retrieve the occupational benefits available to our respondents at the time of each childbirth.¹⁴ In Table 3 we show that, at the time of their most recent childbirth, approximately 15% of mothers were granted between 5 and 15.8 weeks at full salary, two thirds benefited from between 16 to 18 FWE, with the remaining 19% being entitled to 19 to 26 weeks. The descriptive statistics discussed in this section therefore point to the fact that academic mothers enjoyed substantially different maternity benefits following their latest pregnancy, and that the generosity of the maternity provisions varies greatly across UK

¹⁴Whenever the childbirth date precedes the approval date of the oldest document in our possession for the relevant institution, we impute that policy as the one applying to this respondent. It is partly to reduce the impact of such assumption on our estimates that, in the empirical analysis, we focus on the most recent childbirth.

Higher Education Institutions, even in current times.

Table 3: Full Weeks Equivalent (FWE) at most recent childbirth.

Full Weeks Equivalent	Number of Mothers	%
5.40	11	0.59
5.80	2	0.11
11.40	5	0.27
11.80	118	6.32
12.00	118	6.32
13.00	4	0.21
13.80	5	0.27
15.00	6	0.32
15.80	5	0.27
16.00	518	27.76
17.00	75	4.02
18.00	646	34.62
19.00	16	0.86
19.50	39	2.09
20.00	17	0.91
21.90	2	0.11
22.00	85	4.56
23.40	11	0.59
26.00	183	9.81
Total	1,866	100.00

4 Empirical Strategy

Our empirical analysis proceeds in three distinct steps. First, we conduct a simple comparison between women with and without children, to uncover the relationship between motherhood and current outcomes. Second, we compare the career progression of mothers and non-mothers. Finally, we explore factors that can alleviate (or aggravate) the motherhood penalty in academia. We describe each analysis in turn here, before showing our results in the following section.

4.1 Estimating the Motherhood Penalties

We first compare mothers and non-mothers on a number of dimensions, by means of a simple linear regression. We characterize their professional achievements in terms of current gross salary, tenure and professorial status. We also explore differences in terms of job satisfaction and perceptions regarding the fairness of salary and task allocation, compared to male colleagues. Finally, we analyse a factor often linked to satisfaction: the current commuting time to the workplace. This is operationalized through the following regression:

$$Y_{idu} = \alpha + \beta_1 \text{Mother}_{idu} + \beta_2 X_i + \beta_3 W_u + \delta_d + \epsilon_{idu} \quad (1)$$

The six different outcomes (Y_{idu} , where i is an academic currently working in discipline d , at university u), are all captured at the time of the survey.¹⁵ First, we employ a rank variable capturing the gross income, measured by £5,000 increments, from £17,500 to £105,000. Then, we look at a range of dichotomous variables measured at the time of the interview and taking value one if, respectively: (1) having full professorial status; (2) holding a permanent contract; (3) Being neutral/somewhat/very satisfied at the workplace; (4) Judging the salary allocation as fair or probably fair; (5) Judging the distribution of teaching and administrative responsibilities as fair or probably fair; (6) Reporting a commuting time to work of 45 minutes or more.¹⁶

The main explanatory variable of interest is Mother_{idu} , equal to one if the academic has children (any number), else zero.¹⁷ We also include a set of individual controls (X_i), measured at the time of the survey, a set of characteristics of the university respondents currently works for (W_u) that we retrieve from HESA administrative data, and fixed effects for the current department (δ_d).¹⁸ We include the following individual controls: dichotomous variables equal to one if the respondent is a full professor and on a permanent

¹⁵The specific wording of the survey items used to construct our variables is reported in Appendix B and, more extensively, in Troeger et al. (2020).

¹⁶Even though most of the outcomes are binary choice variables, we estimate linear probability models due to the inclusion of departmental fixed effects. For this reason, random effects probit models are not appropriate - and conditional logit models prove to be very inefficient. Since we are only interpreting the direction and significance of effects, this choice does not appear to be problematic, especially since findings are consistent in sign and magnitude when we run the regressions with binary outcomes using a logit model, as shown in Appendix C.1.

¹⁷In Appendix C.1, we show how findings are robust to different operationalizations of the variable, as well as when we look at the marginal effect of having more than one child.

¹⁸With department fixed effects, we compare mothers and non-mothers within a given discipline (economics, geology, etc.). We, therefore, cannot uncover heterogeneous effects of motherhood on salary and other outcomes across disciplines. We plan to devote further attention to this aspect in the future, using finer-grained data on individual publications.

contract, respectively,¹⁹, fixed effects for her reported responsibilities (teaching, research, administration) and birth decade, a rank variable for the number of employments over time reported in the survey. These variables help us capturing the level of experience and the responsibilities of the respondent: factors that are likely correlated with her current perceptions regarding the job and her salary. We also control for the year in which the respondent began her latest job, as this might affect both chances of being promoted and current satisfaction. Finally, we employ a rank variable capturing current commuting time,²⁰ given that commuting might be positively (negatively) correlated with salary (satisfaction) but higher salary might compensate the longer distance from home.

In terms of HEI characteristics, we include in our regression indicators for whether the university belongs to the Russell Group²¹ and to the so-called “Golden Triangle”²², and control for the score it obtained in the 2008 Research Assessment Exercise (RAE). These variables serve as useful proxies for the academic “prestige” of the respondent’s institution at the time of the survey, which is likely highly correlated with her research output over time. We also control for the share of female academics being employed and for the average salary earned by female employees for the current HEI, as indicators of the gender diversity and female condition at the institution.²³

4.2 The Impact of Childbirth Timing on Careers

The empirical strategy described in the previous section allows us to recover in a more robust way the patterns discussed in Table 1 and beyond. However, it is not without flaws. Mothers and non-mothers might in fact differ on a number of unobservable characteristics, such as their field or partner choice, their willingness to change employer, their productivity and ambition to climb the academic ladder: all factors likely correlated with their career progression and current salary, and beyond our control. Further, women may decide to become mothers after having reached a certain stage of their career, suggesting that our estimates suffer from reverse causality. To alleviate these concerns, in additional tests we now present, we focus on a subset of individuals who exhibit similar character-

¹⁹Except when professorship and contractual status are the outcome variables.

²⁰Except when commuting time is the outcome variable.

²¹See <https://russellgroup.ac.uk/about/our-universities/> for more details.

²²We include as members of the Golden Triangle the following HEIs: University of Cambridge, University of Oxford, Imperial College London, University College London, King’s College London, London School of Economics and London School of Hygiene and Tropical Medicine.

²³All these variables measured in 2013 by HESA, unless noted otherwise. Such date is chosen to ensure that, from a time-series perspective, the causes (i.e. the right-hand-side variables) precede the effects (the dependent variables).

istics at a specific point in time, but then differ in their decision to have a child (or not) afterwards.²⁴

We set an arbitrary time threshold, 1st of January 2012 (i.e. 5 years before the survey took place), and focus exclusively on those respondents who, by that time, were: (1) employed in UK academia and; (2) not full professors. The reason behind our date choice is twofold: firstly, it allows for a sufficient lag for someone to obtain a promotion by the time of the survey; secondly, it prevents us from losing too much statistical power, as the information contained in our survey becomes more and more sparse going back in time, due to the distribution of childbirths. We show how results are robust to the choice of different thresholds in Appendix C.2.

Among this subset of respondents, we then define as “treated” those individuals who had their most recent child between 2012 and the time of the survey (conditional on having a non-professorial status by January 1, 2012).²⁵ We compare these respondents to two different “control” groups: the first, constituted by respondents who never had children; the second, consisting of mothers who had their last baby before December 31, 2009 (two years before the threshold). The adoption of two separate control groups allows us to explore a further nuance of the motherhood penalty, distinguishing between the “extensive” margin - choosing to have at least one child, or not - and the “intensive” margin - the impact of recently having a baby, compared to an earlier pregnancy. This second comparison removes a significant part of the endogeneity issue discussed above since both treated and control now have had children. It should be noted, however, that we are then measuring whether the effect of motherhood decreases over time (rather than the effect of becoming a mother) as mothers with children born before 2010 had more time to restart their career after their latest pregnancy.

We run the following linear regression²⁶:

$$Y_{idu} = \alpha + \beta_1 \text{Motherhood}_{idu} + \beta_2 X_i + \beta_3 W_u + \delta_d + \epsilon_{idu} \quad (2)$$

Where the two outcomes of interest (y_{idu}) - all measured at the time of the survey - are: the dummy for professorship discussed in the previous section, a further dummy taking value one if the current gross salary is larger or equal than £62,500 (else 0). The choice

²⁴In future research, we plan reduce selection into motherhood and dig deeper in the causal impact of motherhood by matching mothers and non-mothers on their individual publication record.

²⁵Results are robust to a different definition of the treatment group, focusing on the first, rather than the latest, childbirth, as shown in Appendix C.2.

²⁶Results are also robust to the adoption of a logit model (Appendix C.2).

of the £62,500 threshold is due to the fact that, according to HESA²⁷, the overwhelming majority of senior academics earned more than £60,140 in A.Y. 2017/18.²⁸ The variable $Motherhood_{idu}$ is a dummy taking value one if the respondent has had her most recent pregnancy between January 1, 2012 and the survey date. As discussed above, we consider two different control groups. In the first case, the control group is the sample of women at the same stage of their career in 2012, but ended up not having children (i.e., the indicator variable takes value zero for non-mothers). In the second, the control group is the sample of mothers at the same stage of their career, but who had their last child prior to December 31, 2009.

Variables X_i and W_u in Equation 2 contains the same set of individual and university characteristics as in Equation 1 (with the exception, obviously, of current contractual status). We, however, add two further individual controls: mother's age and for her number of children at the threshold date (i.e. 2012). This is meant to address an imbalance between our control and treated groups as treated individuals, who had their most recent child after 2012, are on average younger than members of the control group, especially mothers who had their latest child before 2010. Absent such controls, we risk attributing delay in reaching professorship to motherhood when it is simply an age effect. We, further, include the same set of fixed effects as in Equation 1 (e.g., birth decade, department fixed effects, etc.).

4.3 Correlates of the Motherhood Penalties

We seek to explore whether maternity leave provisions (i.e. *de jure* support) help alleviating the motherhood penalties, as well as three further factors widely discussed in the literature: formal/informal aid provided on the workplace (i.e. *de facto* support).

We study six out of the seven outcomes of interest: salary, professorship, permanent contract, satisfaction, perception of fair salary, and perception of fair task relative to male academics (the only excluded outcome being commuting time).

For this investigation, we restrict our sample to those who reported the date of birth of their latest child (rather than just their number, as for the previous steps), and who were employed in UK academia at the time of their most recent pregnancy.²⁹ We impose

²⁷See <https://www.hesa.ac.uk/data-and-analysis/staff/salaries> for more information.

²⁸Results are robust to the use of the rank variable previously discussed (Appendix C.2).

²⁹As discussed in Troeger et al. (2020), respondents were asked to list their current and six more recent occupations, alongside their job title and starting date of employment for each. In order to recover power for our analysis, whenever the information on employment is not directly present in the data, but reasonably deductible (i.e. there are "holes" between the jobs listed) we impute occupations as follows. Firstly,

such restrictions for a number of reasons. First, we only focus on respondents whose academic occupation at childbirth is known in order to exactly identify the maternity leave provisions (statutory and occupational) available at the time. Second, the most recent childbirth is likely the most informative when looking at outcomes measured at the time of the survey. Finally, our choice is motivated by data concerns. We seek to minimize the risk of “imperfect recalling”, which is arguably higher once we go back in time. Further, we aim to reduce the odds of imputing the occupational packages made available.³⁰ We run the following regression:

$$Y_{itdu} = \alpha + \beta_1 Support_{it} + \beta_2 X_i + \beta_3 V_{it} + \beta_4 W_u + \beta_5 Z_{ut} + \delta_d + \theta_t + \epsilon_{itdu} \quad (3)$$

The independent variable of interest is $Support_{it}$, that is the amount of support received by mother i at the time of her latest pregnancy, occurring in year t . In a first set of regressions, we define support as the generosity of maternity leave benefits, measured as the occupational Full Weeks Equivalent (FWE). In a second set of regressions, we use other forms of support: childcare availability, perception of Head of Department (HoD) support, feeling of exclusion, workload relief, and partner support. Childcare availability is measured with a dummy equal to one if the mother reported having access to more than 30 hours per week of childcare. HoD support builds on a survey item asking respondents how supportive their HoD was immediately after returning from maternity leave.³¹ We construct a dummy taking value one if the perception was slightly or very favourable. For exclusion, we use another survey item asking mothers whether they felt excluded “*from important departmental or work-related activities that could be considered vital to career enhancement*” after returning from leave. We build an indicator variable, equal to one if a respondent answered at least “occasionally excluded” (0 otherwise). For relief, we generate a dummy variable that equals one if the respondent was offered any form of workload reduction upon returning to work: teaching and administrative loads, amended expectations on research outputs, opportunities to take research leave, or exten-

when we know the previous and following employer, as well as their starting dates, but nothing about the occupation in between, we assume the job to be the same as the “earlier” one. Secondly, we have cases in which we know one employer, but we have no information about previous occupations, except for their start date(s). In these cases, we impute these jobs (only if the start date is present) from the oldest one for which we have such information. These assumptions are relevant as we use job start dates to determine the employer at childbirth. Still, as we focus on the most recent delivery, when the quality of the data is generally high, we do not expect these assumptions to drive our results.

³⁰In Appendix C.3, we replicate the same analysis looking at the first pregnancy, as well as computing averages across different ones, finding consistent results.

³¹We look at HoD support in the first 2 years following childbirth in Appendix C.3 and find comparable coefficients.

sions of the probationary period. Finally, we asked mothers how many childcare duties their partner undertook after childbirth, from 0 to 100 %. We define a partner as unsupportive (dummy equal to one) if (s)he was handling 25% or less of the duties. In turn, we define a partner as supportive (dummy equal to one) if (s)he was handling above 75% of duties. Our reference category, implicitly, is composed of partners with involvement between 26 and 74%.

The individual controls and fixed effects, as well as the university characteristics, all measured at the time of survey (X_i, W_u, δ_d) are similar to those employed in the previous models (Equation 1 and Equation 2).³² We also add a further set of control variables measured at the time of the latest childbirth (V_{it} and Z_{ut}). At the individual level (V_{it}), we control for mother's age at the time, partner's occupation (academic/non-academic, high/low rank, or no information on partner's employment, with fixed effects for each combination), contract status (permanent contract or not). We expect the respondent's and her partner's contractual status to be a good proxy for the financial security of the household at childbirth. At the institutional level (Z_{ut}), we control for the institution in which the mother was employed when having her most recent baby. Finally, we include a further fixed effect (θ_t) for the childbirth year, and control for the mother's reported number of children as the effect of support may vary as a function of the number of children a mother already has.³³

We also investigate how maternity policies affect the activities performed while on leave. In this case, our dependent variable is a dummy for performing an activity on leave: research, teaching, administrative tasks, attendance of conferences, journal editing or peer reviewing, and mentoring. Our independent variable of interest is the monetary compensation while on leave measured by the occupational Full Weeks Equivalent. Our regressions also include controls for individual and institutional features at the time of childbirth.³⁴

Before presenting our findings, a few remarks are in order. There are various reasons why our results have to be interpreted with some caution. First, even though we are controlling for a wide array of individual and institutional characteristics, we still face several

³²We drop the professorship dummy - highly correlated with the control for tenure (included) - not to over-burden the model.

³³To construct the variable we used the number of children for which we know the date of birth, rather than the survey item asking about it. This induces some slight discrepancies with the previous section (e.g. a mother that reports having three children but only lists the birth date for two of them would be considered as having two here).

³⁴We exclude controls measured at the time of the survey, in order to avoid broadly defined "post-treatment" variables on the right-hand-side of the model.

self-selection issues. Women who value family more may be more likely to choose unsupportive partners and/or sacrifice their careers following pregnancy. Hence, unobserved preferences may explain part of the correlation between family support and career accomplishments. Second, our analysis may be plagued by reversed causality issues. Women who are more productive may receive more support from their HoDs, and mothers who are currently happier with their job may retrospectively re-evaluate their line manager at childbirth under a more favourable light. Finally, successful academics may also feel more confident to take longer leaves, in case there is an unobservable stigma attached to the policy. In either case, professional accomplishments may be the cause, rather than the effect, of the formal and informal support received.³⁵

Nonetheless, we believe our analysis is important for three main reasons. First, little conclusive evidence has been advanced on factors explaining and/or mitigating the motherhood penalty. Second, the biases we document make small and even null effects still informative. In fact, if self-selection and/or reverse causality would bias our estimates away from zero, such results would be even more striking. Third, since we could hardly randomize motherhood or HoD/family support, our findings are among the best feasible evidence on the effect of institutional and family factors on mothers' professional life. With these caveats in mind, we now turn to presenting our results.

5 Motherhood Penalties: Estimation Results

We begin by showing the results of our comparison between mothers and non-mothers in the UK academic sector. One mechanism advanced by the literature for explaining the motherhood penalty on wages is that women tend to leave their jobs or take long breaks from employment once they have children. In our setting, all women have managed to remain active in academia following childbirth³⁶, hence we would expect little (or no) effect of motherhood on women's career, according to the literature. Having said that, the

³⁵Several other issues require cautious interpretation of the results. When it comes to maternity leave, we are only measuring an "Intention to Treat" here, as the focus of our paper is on the generosity of institutional support, rather than on actual uptake. Future research will be devoted to investigating the relationship between leave generosity and uptake, as well as to the impact of both on publication quality and quantity. A further confounding factor comes from the fact that maternity leave entitlements are not random. Indeed, as shown in Epifanio and Troeger (2019), more research-oriented universities offer better arrangements. This could be a concern if an interaction effect exists between quality of research activity and OMP generosity: our estimates would then be capturing the effect of leave generosity *and* the indirect benefit of say generosity on the careers of more research-oriented women.

³⁶While we cannot rule out the possibility for mothers temporarily leaving academia and then returning by the time of the survey, informal evidence seems to suggest this is a rare scenario, possibly irrelevant for our results.

fact that our survey necessarily suffers from sample selection issues, as we are unable to account for the (possibly large) number of women dropping out of academia following pregnancy, would lead us to interpret our estimates as lower bounds. For the sake of conciseness, we only display here our preferred specification³⁷, which includes the whole array of individual and institutional controls discussed in the previous sections³⁸. All standard errors are clustered at the (current) university level.

The findings presented in Table 4 reproduce the patterns documented in the literature. Mothers' current salary does not differ significantly from that of non-mothers, and the same holds true for their likelihood of being professors. Still, it is worth pointing out that our linear regression only provides us with a "static" picture of the profession, and is not informative of the dynamic impact motherhood exerts on careers. The null effects we record might therefore be due to the fact that mothers are on average older, hence had more time to reach professorship and earn a higher salary, to begin with. Results in Column 3 suggest that mothers are more likely to be in permanent contracts, but the same concerns hold true, as women who plan to have children may be more likely to wait until reaching a secure occupational position.³⁹ Further interesting patterns emerge from our analysis (not shown in the table, but available upon request). Firstly, respondents who are currently employed by Russell Group and Golden Triangle HEIs exhibit significantly higher salaries and likelihood to be professors but, at the same time, a lower chance of being on a permanent contract, consistently with the findings put forward in Epifanio and Troeger (2019) using aggregate data. Secondly, we show how female academics from medical professions and engineering tend to earn significantly more than in other fields.

³⁷Full tables available upon request.

³⁸The number of observations varies across columns due to the different response rate for the survey items employ. We chose not to restrict our sample and have an homogeneous number across columns in order to maximize the power of our analysis. Furthermore, given the relatively high response rate for the survey items we use, it is reasonable to assume the distribution of missing answers to be independent from the characteristics of the respondent.

³⁹Support for this latter interpretation is provided by another of our works (Troeger et al., 2020).

Table 4: Current Salary and Contract: Comparing Mothers and Non-mothers.

	(1)	(2)	(3)
	Salary	Professor	Permanent
Mother (1/0)	-613.5 (410.779)	0.00954 (0.009)	0.0556*** (0.009)
Observations	6281	6907	6858
Adjusted R^2	0.535	0.235	0.424
Individual controls	✓	✓	✓
University controls	✓	✓	✓
Department FE	✓	✓	✓

Clustered standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

When contrasting mothers and non-mothers on a number of dimensions related to current job satisfaction and fairness perceptions (Table 5), we notice that mothers are more likely than women without children to report contentment with their job (Column 1) and, at the same time, to judge negatively their salary compared to male colleagues (Column 2). This finding seems consistent with the “leaking pipe” narrative. Mothers are also women who are more likely to have reached a stable position by the time of the survey (Table 4), therefore, they may be also content with the status and security of their job. However, once reaching permanency, women seek to progress further and become professors. In this process, they may feel at disadvantage compared to male colleagues given the under-representation of female at top position and/or the gendered gap in salary. This idea seems to be supported by the observation that academics on a permanent contract are significantly more likely than women without children to perceive their salary as unfair compared to men than (not shown in the table). As for the allocation of teaching and administrative duties (Column 3), we find no differences between mothers and non-mothers. We finally look at one aspect often regarded as an important component of life satisfaction, that is commuting time. Results in Column 4 show that, compared to women without children, mothers are more likely to reside further away from their workplace. One plausible explanation for this could be that women with children tend to live in areas with affordable housing and/or childcare facilities, especially if the university is located in a big city. Alternatively, one could think that, in order to remain in academia, mothers

are more likely to accept less “attractive” (i.e. further away from home) job opportunities compared to their colleagues without children.

Table 5: Current Satisfaction and Perceptions: Comparing Mothers and Non-mothers.

	(1)	(2)	(3)	(4)
	Satisfaction	Fair Salary	Fair Tasks	Commuting
Mother (1/0)	0.0390*** (0.010)	-0.0519*** (0.015)	-0.0161 (0.014)	0.0698*** (0.016)
Observations	6842	5951	6245	6857
Adjusted R^2	0.032	0.051	0.033	0.034
Individual controls	✓	✓	✓	✓
University controls	✓	✓	✓	✓
Department FE	✓	✓	✓	✓

Clustered standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

In order to explore more in depth the dynamic impact of childbirths on careers, we now show the results of our second model (Equation 2), focusing on academics who were not full professors at the beginning of 2012, and chose to have a baby in the meantime (or not). This specification also allows us to disentangle between the “extensive” and the “intensive” margin of motherhood. We look at the differential likelihood of becoming professors by the time of our survey (2017) and earning more than a gross salary of £62,500. We find (Table 6) that the effect of having a child on becoming a professor is negative and statistically significant for both the intensive and the extensive margins. Mothers are less likely than non-mothers to become professor (Column 1). Mothers who gave birth after 2012 are less likely to be professor at the time of our survey than mothers who had their last child before 2010 (Column 2). We also find a negative effect on salary for both margins, though this effect is statistically significant only at the extensive margins (Column 4). Our findings seem to suggest that the motherhood penalty is particularly strong in the short-run. While becoming a mother hurts a woman career (Column 1), the effect seems to dissipate over time (though not comparable per se since the two control groups are different, it is interesting to note that the coefficients in column 2 and 4 are more than 3 times higher than those in column 1 and 3, respectively). This suggests that interventions shortly after giving birth may be particularly appropriate to mitigate

the motherhood penalty. We turn to this question in the next section.

Table 6: Motherhood Impact on Full Professorship and Earning £62,500 or More.

	(1) Professor	(2) Professor	(3) Salary	(4) Salary
Becoming mother (vs not)	-0.0211** (0.010)		-0.0147 (0.012)	
Youngest Child Post-2012 (Pre-2010)		-0.0946*** (0.025)		-0.0452* (0.026)
Observations	2646	1896	2442	1833
Adjusted R^2	0.085	0.091	0.101	0.114
Individual controls	✓	✓	✓	✓
University controls	✓	✓	✓	✓
Age at 2012	✓	✓	✓	✓
N. Children at 2012	✓	✓	✓	✓
Department FE	✓	✓	✓	✓

Clustered standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

6 Correlates of Motherhood Penalties: Empirical results

We present in this section the effect of maternity leave provisions (i.e. *de jure* support) and formal and informal practice at the workplace and within the household (i.e. *de facto* support) on the various dimensions of the motherhood penalty.

Table 7: Correlates of the Motherhood Penalties: Current Salary and Contract.

	Salary		Professor		Permanent	
	(1)	(2)	(3)	(4)	(5)	(6)
FWE	247.3** (102.173)		0.00179 (0.003)		-0.00521* (0.003)	
Childcare h.		5728.1*** (680.800)		0.0537*** (0.019)		0.0266 (0.018)
HoD Support		-505.0 (648.190)		-0.0378** (0.019)		-0.0298* (0.015)
Excluded		-2453.1*** (694.349)		-0.0663*** (0.023)		-0.0187 (0.017)
Relief Availability		1535.7* (829.335)		0.0136 (0.027)		0.0490** (0.021)
Unsupp. Partner		-2191.7*** (744.109)		-0.0330 (0.023)		-0.0217 (0.023)
Supp. Partner		2188.3* (1178.465)		-0.000702 (0.031)		0.0102 (0.029)
Observations	1596	1311	1701	1378	1692	1370
Adjusted R^2	0.342	0.396	0.180	0.208	0.384	0.421
Current controls	✓	✓	✓	✓	✓	✓
Controls at birth	✓	✓	✓	✓	✓	✓
HEI controls	✓	✓	✓	✓	✓	✓
Department FE	✓	✓	✓	✓	✓	✓
Birthyear FE	✓	✓	✓	✓	✓	✓

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7 shows our results for a first group of career outcomes, controlling for the full set of individual and university level characteristics discussed in Section 4.3.⁴⁰ Columns

⁴⁰Full tables available upon request.

1, 3 and 5 show the results associated to maternity leave generosity (FWE), Columns 2, 4, 6 show the results for the other forms of support: childcare, support from the HoD, exclusion from important departmental decision, workload relief, and support from the partner.

We discover that a marginal increase in the FWE index - corresponding to about three extra weeks at full salary - is positively and significantly associated to an increase in current wage by around £250 (Column 1). We also notice how women whose partners have a very limited involvement in childcare responsibilities currently earn less, and vice-versa (Column 2). These effects are quite large, corresponding to 12% of a standard deviation (17% for the variable encompassing “positive” support). As already noted, the magnitude of these coefficients might be driven by mothers’ unobserved preferences for work-life balance. Similarly, mothers having access to 30 or more hours of childcare per week earn significantly more than their colleagues who did not receive as much support⁴¹, as do those who did not feel excluded from important departmental activities that they considered vital to career enhancement. We recover the same signs and significance for these two variables when we look at the likelihood of currently being a professor (Column 3), whereas neither this outcome, nor the chances of having a permanent contract (Column 4), appear to be correlated with the generosity of leave provisions (Columns 3 and 5).⁴²

In Table 8 we examine perceptions of satisfaction and fairness, measured at the time of the survey. While *de jure* leave generosity does not seem to exert any impact on these variables (Columns 1,3,5), we find that *de facto* departmental support and inclusiveness significantly correlates with each of them (Columns 2,4,6). One possible explanation is that a positive personal experience at childbirths matters more in shaping perceptions about academia being an inclusive environment, as well as overall satisfaction, compared to formal entitlements. Also in this case, the arrow of causality might also go in the opposite direction, with those who are currently more satisfied being more prone to re-evaluate their past in a more favourable light.

⁴¹Once again, we run the risk of capturing the inverse relationship, especially if income is time-dependent, with better-off households being able to afford more hours of childcare.

⁴²We believe that part of the effect of FWE on career outcomes might be absorbed by the controls we use, in particular the ranking of the mother’s institution at childbirth (Russell Group and/or Golden Triangle). Previous research (Epifanio and Troeger, 2019) has in fact shown how more research intensive HEIs tend to offer better paid and longer occupational maternity packages as a way to attract and retain high-quality female academics.

Table 8: Correlates of the Motherhood Penalty: Current Satisfaction and Fairness.

	Satisfied		Fair Salary		Fair Tasks	
	(1)	(2)	(3)	(4)	(5)	(6)
FWE	0.00272 (0.003)		-0.00161 (0.005)		0.000194 (0.003)	
Childcare Hours		0.00971 (0.019)		-0.00240 (0.032)		0.00257 (0.028)
HoD Support		0.119*** (0.028)		0.117*** (0.032)		0.128*** (0.034)
Excluded		-0.162*** (0.024)		-0.135*** (0.027)		-0.142*** (0.031)
Relief Availability		0.0141 (0.028)		0.0200 (0.034)		0.0591* (0.033)
Unsupp. Partner		-0.0271 (0.025)		0.0132 (0.034)		-0.0288 (0.034)
Supp. Partner		-0.0288 (0.040)		-0.0646 (0.045)		-0.136*** (0.048)
Observations	1654	1367	1446	1207	1528	1277
Adjusted R^2	0.029	0.091	0.044	0.077	0.041	0.094
Current controls	✓	✓	✓	✓	✓	✓
Controls at birth	✓	✓	✓	✓	✓	✓
HEI controls	✓	✓	✓	✓	✓	✓
Department FE	✓	✓	✓	✓	✓	✓
Birthyear FE	✓	✓	✓	✓	✓	✓

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Finally, we look at the activities mothers performed while on leave to understand whether the generosity of occupational maternity pay possibly exacerbates the depreciation of human capital due to absence from work widely discussed in the literature. Re-

sults presented in Table 9 do not support the idea of more generous leave “crowding-out” research efforts by academic mothers.⁴³ We do find, however, a negative and significant association between higher FWE and chances of undertaking ad-hoc teaching while on leave. This is not surprising: if mothers do not bear a substantial salary hit staying home, they face lower pressure to work occasionally shortly after childbirth.

Table 9: Maternity Pay Generosity and Activities After Latest Childbirth.

	(1)	(2)	(3)	(4)	(5)	(6)
	Research	Teach	Admin	Conferences	Mentor	Journal
FWE	0.00183 (0.003)	-0.00441** (0.002)	0.00178 (0.002)	-0.00141 (0.003)	0.00136 (0.003)	-0.00330 (0.004)
Observations	1678	1678	1678	1678	1678	1678
Adjusted R^2	0.059	0.007	0.013	0.051	0.118	0.029
Controls at birth	✓	✓	✓	✓	✓	✓
HEI controls	✓	✓	✓	✓	✓	✓
Department FE	✓	✓	✓	✓	✓	✓
Birthyear FE	✓	✓	✓	✓	✓	✓

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

7 Robustness Checks

We conducted several sanity checks to ensure our findings remain robust to the inclusion of alternative proxies and to the use of alternative specifications.

We replicate the analysis discussed in Section 4.1 in Appendix C.1, finding similar results when using separate indicators for the number of children as well as a count variable (C.1.1), when comparing mothers with one child to those choosing to have more (C.1.2), and when running those regressions with binary outcomes using a logistic model (C.1.3). In order to test for the robustness of the model presented in Section 4.2, we perform a number of tests, whose results are presented in C.2. We show how the coefficients remain

⁴³Results vary by disciplines, however. Mothers in fields that require where laboratory activities and field work are crucial tend to be less active in their research endeavours while on maternity leave (results available upon request). This suggests that generous maternity leave allows for optimal allocation of tasks only if mothers are not subject to external constraints such as access to necessary equipment for research.

stable to the adoption of a rank variable for salary (C.2.1), when employing a logit model (C.2.2), when changing the treatment group by focusing on the first childbirth (C.2.3), and, finally when we choosing different thresholds (C.2.4). We find comparable results in sign and magnitude, with coefficients losing significance, especially for salaries, once we set our threshold closer to the survey date, which is not surprising given that this significantly reduces the likelihood of the respondent becoming professor or moving onto a higher salary band in the meantime.

We also perform a number of robustness checks for our analysis of the correlates of motherhood penalty 4.3) in Appendix C.3. First, we run all the regressions using an alternative measure of maternity leave generosity - *full-salary replacement weeks* - finding coefficients that are broadly consistent (C.3.1). Second, we employ a logistic regression, whenever relevant, with results being virtually unchanged (C.3.2). Third, we consider the mother's oldest, rather than youngest, childbirth (C.3.3), finding consistent but, as anticipated, weaker coefficients, possibly due to the longer lag between the survey date and the event under scrutiny. Fourth, we replicate our analysis computing, whenever possible, the average of both dependent and independent variables across childbirths (C.3.4). This latter robustness test allows us, at the cost of sacrificing some precision in our estimates, to alleviate the risk of outliers (e.g. problematic pregnancies, long lags between childbirths...) driving the results. In this specification, we recover all the results obtained in the main body of the paper, when looking at the most recent delivery. Finally, we employ a different proxy for the support from the Head of Department in Appendix C.3.5, exploiting a similar survey item asking the support received by HoDs in the two years following childbirth (rather than about the return from leave) and find a comparable effect.

8 Concluding Remarks

In this paper, we exploit an original survey giving voice to academic women to explore the costs of motherhood and the factors that impact their professional lives. While we do not find conclusive evidence in support of a motherhood penalty in terms of salaries, our novel data allows us to explore subtler disparities. Even in an environment such as the UK academia, where workers are highly educated and can often benefit from flexible working arrangement, having a child appears to reduce mothers' chances of climbing the academic ladder and becoming professors. This is particularly the case when we look at the impact of having a child later, rather than sooner, on the chances of reaching a professorial contract and the highest salary band by the time of the survey. Though

mothers seem to be more satisfied with their current jobs than women with no children, their contentment in this dimension is counterbalanced by a stronger perception of being underpaid compared to male colleagues in similar hierarchical positions. We argue that this ambivalent effect, taken together with the finding of academic women tending to postpone pregnancy until tenured, are consistent with the so-called “leaking pipe” phenomenon. Mothers are also likely to have reached a secure position, due to their higher experience, and are generally happier with their status, but they become increasingly dissatisfied with the under-representation of women in top positions of the academic ladder.

We then show how formal, informal and domestic forms of support all play a significant, though different, role in explaining the disadvantages mothers bear in the working environment. Mothers having access to more generous maternity provisions exhibit significantly higher current salaries. Most importantly, a well paid leave does not appear to crowd out research activity, but actually alleviates mothers’ financial pressure to return to work early and carry out ad-hoc teaching at a delicate time of their lives. The importance of remaining active research-wise, and the crucial role played by other forms of support in the weeks following childbirth, are supported by the fact that primary child-carers exhibit lower current salaries compared to mothers whose partners evenly share child-rearing duties in the first years of the baby’s life. Similarly, mothers with access to longer childcare hours earn currently more than those who did not benefit from this form of assistance.

Finally, the perception of a supportive and inclusive working environment at childbirth is positively correlated with higher levels of job satisfaction and perceived fairness reported for the current job. Taken together, these results highlight the need to expand our horizons when it comes to analysing the effects of motherhood on female careers. Having children does not simply affect career outcomes, but dramatically reshapes women’s psychological attitudes in the workplace and beyond, in a way that could hardly be tackled by a one-size-fits-all policy interventions. While maternity provisions and childcare support significantly benefit mothers’ careers, a smooth and sympathetic approach to the motherhood experience by the employer positively and persistently correlates with feelings of satisfaction and fairness in academia, even many years following delivery. Moreover, we find that subjective feelings of “exclusion” from the departmental decision-making actually reflect into a substantially lower likelihood for these mothers to climb the academic ladder, making a favourable and inclusive work environment even more important.

Our results, we repeatedly cautioned, may not uncover causal relationships (e.g., our

estimates may suffer from reverse causality). Yet, our paper is unique in documented the multifaced motherhood penalties and surveying an entire sector. In this last paragraph, we take a leap of faith and discuss the potential policy implications of our work. Our analysis unveils the sometimes subtle effects of different policy interventions on different occupational and personal dimensions, highlighting that there is, unfortunately, no cure-all remedy for the motherhood penalties. A more inclusive firm culture is best suited to improve mothers' satisfaction at work, broadly conceived. This could be achieved by designing and arranging adequate training opportunities for line managers, so to help them understanding and coping with mothers' necessities. Adequate childcare provision and generous maternity leave policies appear to be key to foster mothers' career. While costly, these measures would help mothers retaining their professional networks and would ensure they do not step back from their research agenda (in other words, these forms of support limit the depreciation of mothers' human capital while on leave).

Our recommendations above would alleviate the motherhood penalties, but not eliminate them. This paper also highlights the consequences of gender disparity within the household. An equal sharing of the childcare duties with the partner is a key predictor of mothers' current earning power, even in the academic sector. A dramatic transformation of cultural and social stereotypes on who "should be" the primary caretaker appears to be much needed. We believe that the launch of Shared Parental Leave in 2015 represents an interesting novelty for the UK.⁴⁴ The timing of our survey makes it impossible to study the impact of such reform. Nonetheless, we hope that our results motivate scholars to study the consequences of encouraging fathers to take on a more active role during the first years of their children's lives.

⁴⁴The low uptake of such leave (less than 2% in 2018, according to the Department of Business, Energy and Industrial Strategy) is slightly depressing in light of our findings. See <https://www.bbc.com/news/business-43026312>.

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Appendix

A Descriptive Statistics

Below descriptive statistics for the main outcomes and controls employed in our empirical analysis.

Table A.1: Descriptive Statistics: Dependent Variables (at Time of the Survey).

	Mothers			Non-Mothers			p-value
	Mean	St. Dev.	N.	Mean	St. Dev.	N.	
Gross Salary	48824	16255	3358	44827	14344	3128	0.000
Gross Salary $\geq 62.5k$	0.21	0.40	3358	0.13	0.33	3128	0.000
Professor	0.23	0.42	3722	0.15	0.35	3603	0.000
Permanent	0.80	0.40	3688	0.63	0.48	3577	0.000
Satisfaction	0.78	0.41	3684	0.77	0.42	3421	0.000
Salary Fair	0.47	0.50	3238	0.57	0.50	2942	0.000
Responsibilities Fair	0.60	0.49	3322	0.65	0.48	3169	0.000
Commute $\geq 45mins$	0.40	0.49	3677	0.33	0.47	3402	0.000
Leave Research	0.35	0.48	3722	0	0	0	-
Leave Teach	0.07	0.25	3722	0	0	0	-
Leave Admin Tasks	0.09	0.29	3722	0	0	0	-
Leave Conferences	0.20	0.40	3722	0	0	0	-
Leave Mentoring	0.27	0.44	3722	0	0	0	-
Leave Journal	0.23	0.42	3722	0	0	0	-

Table A.2: Descriptive Statistics: Independent Variables (at Time of the Survey).

	Mothers			Non-Mothers			p-value
	Mean	St. Dev.	N.	Mean	St. Dev.	N.	
Age	46.91	8.88	3033	41.60	9.78	2722	0.000
N. Children	1.77	0.75	3722	0	0	3604	-
Appointment Year	2010	17.84	3639	2012	5.19	3555	0.000
N. Occupations	1.40	0.98	3722	1.42	0.93	3604	0.321
Russell Group	0.47	0.50	3711	0.52	0.50	3595	0.000
Golden Triangle	0.18	0.38	3711	0.21	0.40	3595	0.004
RAE Score 2008	123	23	3698	123	23	3581	0.182
Sh. Fem. Academics	0.44	0.06	3698	0.43	0.06	3581	0.002
Avg. Fem. Salary	41100	2482	3698	41082	2401	3581	0.758

Table A.3: Descriptive Statistics: Independent Variables (at Youngest Childbirth).

	Mothers		
	Mean	St. Dev.	N.
Childbirth Year	2005	9.60	3286
Mother's Age at Childbirth	35.40	4.54	2976
Permanent	0.61	0.49	2950
Partner Rank: High Academic	0.16	0.36	3286
Partner Rank: Low Academic	0.18	0.38	3286
Partner Rank: High Non-Academic	0.31	0.46	3286
Partner Rank: No Info	0.09	0.29	3286
Partner Help: $\leq 25\%$	0.32	0.47	3286
Partner Help: $> 75\%$	0.10	0.30	3286
Partner Help: No Info	0.20	0.40	3286
Childcare Hours ≥ 30	0.55	0.50	2771
FWE	17.55	3.78	1866
Supportive HoD	0.55	0.50	2592
Excluded	0.40	0.49	2600
Relief	0.18	0.39	3286
Age (2012)	41.65	8.89	3033
N. Children (2012)	1.31	0.94	3286
Russell Group	0.52	0.50	1871
Golden Triangle	0.21	0.41	1871
RAE Score 2008	124	22	1866
Sh. Fem. Academics	0.43	0.06	1866
Avg. Fem. Salary	41091	2369	1866

B Survey Items

In this section, we present the wording of the survey items used to construct our main dependent and independent variables. The full questionnaire can be retrieved in Troeger et al. (2020).

B.1 Dependent Variables

1. **Salary:** *What is your current gross annual salary?*

Possible answers:

- from “under £20,000”
- to “above £100,001” (by increments of £5,000)

We took the midpoint for each category (e.g. £27,500 if between “£25,001 and £30,000”). We attribute a value of £17,000 to those below £20,000 (34 observations). We exclude respondents with salary above £100,001 (16 observations), since we cannot easily attribute a value to their earnings.

2. **Professor:** *What is your current title or role?*

Possible answers:

- Professor
- Associate Professor
- Reader
- Senior Lecturer
- Lecturer
- Early Career Researcher
- Research Assistant
- Other

We generated a dummy with value 1 if the respondent reported to be a professor, 0 for all other ranks.

3. **Permanent:** *Which best describes your current employment contract?*

Possible answers:

- Permanent
- Probationary (with a defined route to permanency)

- Fixed-Term

We constructed a dummy variable taking the value 1 if the respondent reported to be on permanent contract, 0 in the remaining cases.

4. **Satisfaction:** *Please evaluate the level of satisfaction you have with your current job*

Possible answers:

- Very Satisfied
- Satisfied
- Somewhat Satisfied
- Neutral
- Somewhat Dissatisfied
- Dissatisfied
- Very Dissatisfied

We dichotomized responses into a dummy with value 1 if the respondent reported to be very satisfied, satisfied, somewhat satisfied (0 otherwise).

5. **Salary Fairness:** *Do you believe that, in comparison to your male colleagues, your salary is fair?*

Possible answers:

- Definitely Yes
- Probably Yes
- Probably Not
- Definitely Not
- Don't Know

We built a dummy equal to 1 if the answer was definitely or probably yes (0 otherwise). "Don't Know"s are dropped from the analysis.

6. **Responsibility Fairness:** *Do you think the teaching and administrative responsibilities you are asked to undertake are fair in comparison to the tasks assigned to your male colleagues of equal rank?*

Possible answers:

- Definitely Yes
- Probably Yes

- Probably Not
- Definitely Not
- Don't Know

We built a dummy equal to 1 if the answer was definitely or probably yes (0 otherwise). "Don't Know"s are dropped from the analysis.

7. **Commuting:** *Approximately how long does it take you to commute from your home to the University?*

Possible answers:

- Less than 15 minutes
- Between 15 and 30 minutes
- Between 31 and 45 minutes
- Between 46 and 60 minutes
- Between 1 and 2 hours
- More than 2 hours

We generated a dummy equal to 1 if commuting time is above 45 minutes, 0 otherwise.

8. **Activities:** *(If the respondent indicated they took any form of maternity leave after the birth of their first/second/third youngest child): During your maternity leave for your first/second/third youngest child, which, if any, of the following academic activities did you undertake? (Tick All that Apply)*

Possible answers:

- Keeping in touch with academic colleagues for work related purposes
- Mentoring and working with post-doctoral and/or doctoral students
- Attending academic conferences
- Conducting research
- Teaching classes on an ad hoc basis
- Undertaking administrative duties at the University
- Undertaking administrative duties associated with your field or discipline (e.g. edited a journal, submitting a peer review)
- Other

- Not Applicable–I was not in Academia
- Don't Know/Don't Remember

We coded each answer as a separate dummy, equal to one if the respondent undertook that activity, else 0.

B.2 Independent Variables

1. **Childcare Duration:** *In a typical week, during term time, how many hours of childcare was (is or will be) available to you for your youngest child for the two years after you returned to work from maternity leave?*

Possible answers:

- Less than 5
- Between 6 and 10
- Between 11 and 20
- Between 21 and 30
- Between 31 and 40
- More than 40
- Don't Know or Don't Remember

We constructed a dummy taking value 1 if the respondent reported more than 30 hours of childcare were available upon return from leave (0 otherwise).

2. **HoD support:** *Referring to the period around the birth of your first child, how supportive was your Head of Department?*

Possible answers:

- Very supportive
- Slightly Supportive
- Neither Supportive nor unsupportive
- Slightly unsupportive
- Very unsupportive

We constructed a dummy taking value 1 if the respondent reported the HoD was very or slightly supportive (0 otherwise). As a robustness test, we employed a survey item asking about perceived HoD support in the first 2 years following each

childbirth. The options provided are the same and a comparable dummy is generated accordingly.

3. **Excluded:** *After returning to work from childbirth and/or maternity leave following the birth of your second youngest child, did you feel excluded from important Departmental or Work Related activities that could be considered vital to career enhancement?*

Possible answers:

- Yes, definitely
- Yes, somewhat
- Only occasionally
- Not at all
- No applicable or Don't Know

We built a dummy equal to 1 if the answer was only occasionally, yes somewhat/ definitely, 0 otherwise). "Don't Know"s are dropped from the analysis.

4. **Relief:** *When you returned to work following the birth of your first child, were you offered any of the following:*

Possible answers:

- Teaching relief
- Admin relief
- Teaching relief
- Research outputs relief
- Sabbatical
- Other

We generated a dummy equal to 1 if at least one of these forms of relief was offered (0 otherwise).

5. **Partner Support:** *Approximately what percentage of childcare responsibilities were (are or will be) handled by your partner or spouse in the two years following your youngest child's birth?*

Possible answers:

- Less than 10%
- Between 11 and 25%

- Between 26% and 50%
- Between 51% and 75%
- Between 76% and 100%
- Don't Know or Don't remember

We generate four sets of dummies taking value one if reported support was, respectively: (1) below 25%; (2) between 26 and 75%; (3) above 75%; (4) Don't Know or Don't remember.

C Robustness Tests

C.1 Estimating the Motherhood Penalties: Robustness

C.1.1 Dichotomous and Rank Variables for Children

In Table C.1 and C.2, we replace the indicator variable for motherhood with a series of dichotomous controls taking value 1 if the mother had, respectively, one, two, three, four or more children (0 if none). Findings are consistent with those presented in the main body of the paper. The same holds true when we substitute the indicator with a count variable for the number of children, ranging from 0 to 6 (C.3 and C.4).

Table C.1: Current Salary and Contract: Comparing Mothers and Non-mothers.

	(1) Salary	(2) Professor	(3) Permanent
One Child	-648.2 (468.133)	0.0126 (0.011)	0.0455*** (0.011)
Two Children	-557.3 (467.208)	0.00910 (0.011)	0.0687*** (0.012)
Three Children	-750.2 (809.068)	0.0119 (0.028)	0.0500*** (0.019)
Four+ Children	-553.1 (1549.007)	-0.0571 (0.043)	-0.0116 (0.040)
Observations	6281	6907	6858
Adjusted R^2	0.534	0.236	0.424
Individual controls	✓	✓	✓
University controls	✓	✓	✓
Department FE	✓	✓	✓

Clustered standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table C.2: Current Satisfaction and Perceptions: Comparing Mothers and Non-mothers.

	(1)	(2)	(3)	(4)
	Satisfaction	Fair Salary	Fair Tasks	Commuting
One Child	0.0300** (0.013)	-0.0468*** (0.015)	-0.0145 (0.017)	0.0765*** (0.019)
Two Children	0.0497*** (0.011)	-0.0500*** (0.018)	-0.0213 (0.018)	0.0605*** (0.019)
Three Children	0.0275 (0.022)	-0.0857*** (0.029)	0.0178 (0.024)	0.0858*** (0.028)
Four+ Children	0.0320 (0.046)	-0.0424 (0.054)	-0.0911 (0.061)	0.0710 (0.055)
Observations	6842	5951	6245	6857
Adjusted R^2	0.032	0.050	0.034	0.033
Individual controls	✓	✓	✓	✓
University controls	✓	✓	✓	✓
Department FE	✓	✓	✓	✓

Clustered standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table C.3: Current Salary and Contract: Comparing Mothers and Non-mothers.

	(1)	(2)	(3)
	Salary	Professor	Permanent
N. Children	-247.0 (203.548)	0.00147 (0.005)	0.0223*** (0.005)
Observations	6281	6907	6858
Adjusted R^2	0.534	0.235	0.423
Individual controls	✓	✓	✓
University controls	✓	✓	✓
Department FE	✓	✓	✓

Clustered standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table C.4: Current Satisfaction and Perceptions: Comparing Mothers and Non-mothers.

	(1)	(2)	(3)	(4)
	Satisfaction	Fair Salary	Fair Tasks	Commuting
N. Children	0.0169*** (0.004)	-0.0231*** (0.007)	-0.00731 (0.006)	0.0285*** (0.007)
Observations	6842	5951	6245	6857
Adjusted R^2	0.032	0.050	0.033	0.032
Individual controls	✓	✓	✓	✓
University controls	✓	✓	✓	✓
Department FE	✓	✓	✓	✓

Clustered standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

C.1.2 Comparing Mothers with One or More Children

In Table C.5 and C.6 we focus on the “intensive” margin, restricting our analysis on the subset of mothers and on the effect of having a further baby. We therefore adopt an indicator equal to one if the mother had more than one child (0 if just one), finding results in line with those obtained when comparing mothers and non-mothers.

Table C.5: Current Salary and Contract: Comparing Mothers with One or More Children.

	(1) Salary	(2) Professor	(3) Permanent
More than 1 child	158.4 (464.214)	-0.00577 (0.014)	0.0285** (0.012)
Observations	3241	3572	3544
Adjusted R^2	0.510	0.203	0.335
Individual controls	✓	✓	✓
University controls	✓	✓	✓
Department FE	✓	✓	✓

Clustered standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table C.6: Current Satisfaction and Perceptions: Comparing Mothers with One or More Children.

	(1) Satisfaction	(2) Fair Salary	(3) Fair Tasks	(4) Commuting
More than 1 child	0.0146 (0.014)	-0.0196 (0.017)	0.00132 (0.016)	-0.00371 (0.018)
Observations	3533	3110	3189	3544
Adjusted R^2	0.031	0.022	0.030	0.036
Individual controls	✓	✓	✓	✓
University controls	✓	✓	✓	✓
Department FE	✓	✓	✓	✓

Clustered standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

C.1.3 Estimation with Logit Model

Replicating the analysis employing a logit regression for the binary outcomes yields consistent results, as shown in Tables C.7 and C.8

Table C.7: Current Salary and Contract: Comparing Mothers and Non-mothers.

	(1) Professor	(2) Permanent
Mother (1/0)	0.0914 (0.071)	0.398*** (0.077)
Observations	6907	6858
Individual controls	✓	✓
University controls	✓	✓
Department FE	✓	✓

Clustered standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table C.8: Current Satisfaction and Perceptions: Comparing Mothers and Non-mothers.

	(1) Satisfaction	(2) Fair Salary	(3) Fair Tasks	(4) Commuting
Mother (1/0)	0.231*** (0.058)	-0.219*** (0.061)	-0.0724 (0.062)	0.318*** (0.070)
Observations	6842	5951	6245	6857
Individual controls	✓	✓	✓	✓
University controls	✓	✓	✓	✓
Department FE	✓	✓	✓	✓

Clustered standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

C.2 The Impact of Childbirth Timing on Careers: Robustness

In this section, we test for the robustness of the analysis presented in Section 4.2.

C.2.1 Alternative Salary Measure

We employ at a different salary outcome, substituting the indicator used in the main body with the rank variable it was originally derived from, and finding identical results (Table C.9), with a £3811.10 penalty for mothers who had their most recent childbirth in the five years preceding the survey (compared to those who did so up to the seventh year before it).

Table C.9: Motherhood Impact on Current Salary (Rank).

	(1) Salary	(2) Salary
Becoming mother (vs not)	-684.7 (583.323)	
Youngest Child Post-2012 (Pre-2010)		-1941.0** (940.251)
Observations	2442	1833
Adjusted R^2	0.239	0.223
Individual controls	✓	✓
University controls	✓	✓
Age at 2012	✓	✓
N. Children at 2012	✓	✓
Department FE	✓	✓

Clustered standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

C.2.2 Estimation with Logit Model

Our findings are consistent when using a logit regression C.10.

Table C.10: Motherhood Impact on Full Professorship and Earning £62,500 or More.

	(1) Professor	(2) Professor	(3) Salary	(4) Salary
Becoming mother (vs not)	-0.551** (0.267)		-0.347 (0.246)	
Youngest Child Post-2012 (Pre-2010)		-1.087*** (0.266)		-0.489* (0.263)
Observations	2527	1849	2423	1794
Individual controls	✓	✓	✓	✓
University controls	✓	✓	✓	✓
Age at 2012	✓	✓	✓	✓
N. Children at 2012	✓	✓	✓	✓
Department FE	✓	✓	✓	✓

Clustered standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

C.2.3 Different Definition of Treated Mothers

We find comparable results when we re-define our treated individuals as those having their *oldest* child (rather than their latest, as we do in the main text), as we do in Table C.11.

Table C.11: Motherhood Impact on Full Professorship and Earning £62,500 or More.

	(1) Professor	(2) Professor	(3) Salary	(4) Salary
Becoming mother (vs not)	-0.0211** (0.010)		-0.0147 (0.012)	
First Child Post-2012 (Last Pre-2010)		-0.118*** (0.037)		-0.0646* (0.038)
Observations	2646	1621	2442	1570
Adjusted R^2	0.085	0.099	0.101	0.123
Individual controls	✓	✓	✓	✓
University controls	✓	✓	✓	✓
Age at 2012	✓	✓	✓	✓
N. Children at 2012	✓	✓	✓	✓
Department FE	✓	✓	✓	✓

Clustered standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

C.2.4 Different Choice of the Threshold

Finally, we check for the robustness of our results to the choice of different thresholds: the 1st of January 2011, 2013, 2014 and 2015, respectively (Tables C.12, C.13, C.14, C.15). Coefficients are consistent in sign and generally significant, even though they reasonably tend to lose magnitude and significance as we set our threshold closer to the time of the survey.

Table C.12: Motherhood Impact on Full Professorship and Earning £62,500 or More.

	(1) Professor	(2) Professor	(3) Salary	(4) Salary
Becoming mother (vs not)	-0.0263** (0.011)		-0.0302** (0.012)	
Becoming mother (vs before)		-0.0859*** (0.024)		-0.0555** (0.026)
Observations	2466	2028	2272	1956
Adjusted R^2	0.083	0.102	0.098	0.115
Individual controls	✓	✓	✓	✓
University controls	✓	✓	✓	✓
Age at 2011	✓	✓	✓	✓
N. Children at 2011	✓	✓	✓	✓
Department FE	✓	✓	✓	✓

Clustered standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table C.13: Motherhood Impact on Full Professorship and Earning £62,500 or More.

	(1)	(2)	(3)	(4)
	Professor	Professor	Salary	Salary
Becoming mother (vs not)	-0.0131 (0.010)		-0.00891 (0.014)	
Becoming mother (vs before)		-0.0510** (0.020)		-0.0203 (0.023)
Observations	2791	2147	2569	2077
Adjusted R^2	0.086	0.081	0.098	0.092
Individual controls	✓	✓	✓	✓
University controls	✓	✓	✓	✓
Age at 2013	✓	✓	✓	✓
N. Children at 2013	✓	✓	✓	✓
Department FE	✓	✓	✓	✓

Clustered standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table C.14: Motherhood Impact on Full Professorship and Earning £62,500 or More.

	(1)	(2)	(3)	(4)
	Professor	Professor	Salary	Salary
Becoming mother (vs not)	-0.0210** (0.009)		-0.00620 (0.016)	
Becoming mother (vs before)		-0.0494*** (0.017)		-0.0301 (0.020)
Observations	2990	2235	2752	2163
Adjusted R^2	0.107	0.072	0.103	0.090
Individual controls	✓	✓	✓	✓
University controls	✓	✓	✓	✓
Age at 2014	✓	✓	✓	✓
N. Children at 2014	✓	✓	✓	✓
Department FE	✓	✓	✓	✓

Clustered standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table C.15: Motherhood Impact on Full Professorship and Earning £62,500 or More.

	(1) Professor	(2) Professor	(3) Salary	(4) Salary
Becoming mother (vs not)	-0.00569 (0.009)		0.00283 (0.016)	
Becoming mother (vs before)		-0.0253* (0.013)		-0.0120 (0.016)
Observations	3140	2295	2892	2225
Adjusted R^2	0.092	0.072	0.094	0.085
Individual controls	✓	✓	✓	✓
University controls	✓	✓	✓	✓
Age at 2015	✓	✓	✓	✓
N. Children at 2015	✓	✓	✓	✓
Department FE	✓	✓	✓	✓

Clustered standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

C.3 Correlates of the Motherhood Penalties: Robustness

In this final section, we check the robustness the analysis presented in Section 4.3.

C.3.1 Full Salary Replacement Weeks

We begin by adopting an alternative index to the Full Weeks Equivalent (FWE), employing the number of weeks at full salary offered by the university occupational policy at the time of the most recent childbirth. Results shown in Tables C.16, C.17 and C.18 are broadly consistent with those in the main body. We recover in particular the positive relationship between a more generous leave and current salary.

Table C.16: Correlates of the Motherhood Penalty: Current Salary and Contract.

	Salary		Professor		Permanent	
	(1)	(2)	(3)	(4)	(5)	(6)
Full Salary	139.7*** (47.114)		0.0000261 (0.001)		-0.00141 (0.002)	
Childcare h.		5728.1*** (680.800)		0.0537*** (0.019)		0.0266 (0.018)
HoD Support		-505.0 (648.190)		-0.0378** (0.019)		-0.0298* (0.015)
Excluded		-2453.1*** (694.349)		-0.0663*** (0.023)		-0.0187 (0.017)
Relief Availability		1535.7* (829.335)		0.0136 (0.027)		0.0490** (0.021)
Unsupp. Partner		-2191.7*** (744.109)		-0.0330 (0.023)		-0.0217 (0.023)
Supp. Partner		2188.3* (1178.465)		-0.000702 (0.031)		0.0102 (0.029)
Observations	1596	1311	1701	1378	1692	1370
Adjusted R^2	0.342	0.396	0.180	0.208	0.383	0.421
Current controls	✓	✓	✓	✓	✓	✓
Controls at birth	✓	✓	✓	✓	✓	✓
Department FE	✓	✓	✓	✓	✓	✓
Birthyear FE	✓	✓	✓	✓	✓	✓

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table C.17: Correlates of the Motherhood Penalty: Current Satisfaction and Fairness.

	Satisfied		Fair Salary		Fair Tasks	
	(1)	(2)	(3)	(4)	(5)	(6)
Full Salary	0.00127 (0.002)		-0.000788 (0.003)		0.00121 (0.002)	
Childcare h.		0.00971 (0.019)		-0.00240 (0.032)		0.00257 (0.028)
HoD Support		0.119*** (0.028)		0.117*** (0.032)		0.128*** (0.034)
Excluded		-0.162*** (0.024)		-0.135*** (0.027)		-0.142*** (0.031)
Relief Availability		0.0141 (0.028)		0.0200 (0.034)		0.0591* (0.033)
Unsupp. Partner		-0.0271 (0.025)		0.0132 (0.034)		-0.0288 (0.034)
Supp. Partner		-0.0288 (0.040)		-0.0646 (0.045)		-0.136*** (0.048)
Observations	1654	1367	1446	1207	1528	1277
Adjusted R^2	0.029	0.091	0.044	0.077	0.041	0.094
Current controls	✓	✓	✓	✓	✓	✓
Controls at birth	✓	✓	✓	✓	✓	✓
HEI controls	✓	✓	✓	✓	✓	✓
Department FE	✓	✓	✓	✓	✓	✓
Birthyear FE	✓	✓	✓	✓	✓	✓

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table C.18: Correlates of the Motherhood Penalty: Activities After Oldest Childbirth.

	(1) Research	(2) Teaching	(3) Admin.	(4) Conferences	(5) Mentor	(6) Journal
Full Salary	0.00191 (0.002)	-0.00169 (0.001)	0.000264 (0.001)	0.0000405 (0.001)	0.000825 (0.002)	-0.00117 (0.002)
Observations	1678	1678	1678	1678	1678	1678
Adjusted R^2	0.060	0.006	0.013	0.051	0.118	0.028
Controls at birth	✓	✓	✓	✓	✓	✓
HEI controls	✓	✓	✓	✓	✓	✓
Department FE	✓	✓	✓	✓	✓	✓
Birthyear FE	✓	✓	✓	✓	✓	✓

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

C.3.2 Logit Specification

We then replicate our analysis for the binary outcomes using a logit specification in Table C.19, C.20, C.21, and coefficients again appear quite stable in sign and significance.

Table C.19: Correlates of the Motherhood Penalty: Current Salary and Contract.

	Professor		Permanent	
	(1)	(2)	(3)	(4)
FWE	0.0187 (0.031)		-0.0779** (0.034)	
Childcare h.		0.552** (0.232)		0.259 (0.245)
HoD Support		-0.394** (0.197)		-0.559** (0.221)
Excluded		-0.715*** (0.248)		-0.459** (0.188)
Relief Availability		0.220 (0.288)		0.548** (0.261)
Unsupp. Partner		-0.406* (0.236)		-0.309 (0.269)
Supp. Partner		-0.0140 (0.343)		-0.188 (0.400)
Observations	1651	1261	1564	1201
Current controls	✓	✓	✓	✓
Controls at birth	✓	✓	✓	✓
HEI controls	✓	✓	✓	✓
Department FE	✓	✓	✓	✓
Birthyear FE	✓	✓	✓	✓

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table C.20: Correlates of the Motherhood Penalty: Current Satisfaction and Fairness.

	Satisfied		Fair Salary		Fair Tasks	
	(1)	(2)	(3)	(4)	(5)	(6)
FWE	0.0167 (0.018)		-0.00676 (0.023)		0.00115 (0.015)	
Childcare h.		0.0564 (0.137)		-0.00543 (0.145)		0.0155 (0.135)
HoD Support		0.849*** (0.185)		0.547*** (0.145)		0.611*** (0.156)
Excluded		-1.141*** (0.169)		-0.622*** (0.124)		-0.675*** (0.140)
Relief Availability		0.160 (0.206)		0.0813 (0.151)		0.287* (0.159)
Unsupp. Partner		-0.178 (0.179)		0.0624 (0.152)		-0.133 (0.165)
Supp. Partner		-0.179 (0.310)		-0.292 (0.207)		-0.662*** (0.222)
Observations	1632	1332	1438	1198	1518	1268
Current controls	✓	✓	✓	✓	✓	✓
Controls at birth	✓	✓	✓	✓	✓	✓
HEI controls	✓	✓	✓	✓	✓	✓
Department FE	✓	✓	✓	✓	✓	✓
Birthyear FE	✓	✓	✓	✓	✓	✓

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table C.21: Correlates of the Motherhood Penalty: Activities After Oldest Childbirth.

	(1)	(2)	(3)	(4)	(5)	(6)
	Research	Teaching	Admin.	Conferences	Mentor	Journal
FWE	0.00821 (0.012)	-0.0639** (0.026)	0.0189 (0.020)	-0.00628 (0.014)	0.00924 (0.016)	-0.0148 (0.017)
Observations	1667	1567	1569	1628	1664	1659
Controls at birth	✓	✓	✓	✓	✓	✓
HEI controls	✓	✓	✓	✓	✓	✓
Department FE	✓	✓	✓	✓	✓	✓
Birthyear FE	✓	✓	✓	✓	✓	✓

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

C.3.3 Looking at the First Pregnancy

We then move into looking at the first childbirth, rather than at the latest one. The set of covariates we control for is the same, with child-related variables being adjusted accordingly. The coefficients match those obtained in the main body of the paper (Table C.22, C.23 and C.24) but, as anticipated, the magnitude of the effects on current outcomes decreases, possibly due to the longer lag between the survey date and the event.

Table C.22: Correlates of the Motherhood Penalty: Current Salary and Contract.

	Salary		Professor		Permanent	
	(1)	(2)	(3)	(4)	(5)	(6)
FWE	193.8*		0.00275		-0.00682**	
	(102.811)		(0.003)		(0.003)	
Childcare h.		4392.1***		0.0301		0.0591***
		(652.238)		(0.020)		(0.020)
HoD Support		-1234.2*		-0.0199		-0.00436
		(685.896)		(0.021)		(0.021)
Excluded		-2107.3***		-0.0460**		-0.00282
		(693.202)		(0.021)		(0.018)
Relief		994.0		0.0157		0.0481*
		(972.882)		(0.027)		(0.025)
Unsupp. Partner		-2130.4***		-0.0185		-0.0205
		(743.101)		(0.026)		(0.019)
Supp. Partner		1995.9*		-0.00442		0.000276
		(1116.558)		(0.033)		(0.028)
Observations	1374	1141	1555	1275	1545	1267
Adjusted R^2	0.326	0.383	0.185	0.200	0.391	0.406
Individual controls	✓	✓	✓	✓	✓	✓
University controls	✓	✓	✓	✓	✓	✓
Department FE	✓	✓	✓	✓	✓	✓

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table C.23: Correlates of the Motherhood Penalty: Current Satisfaction and Fairness.

	Satisfied		Fair Salary		Fair Tasks	
	(1)	(2)	(3)	(4)	(5)	(6)
FWE	0.00317 (0.003)		-0.00165 (0.006)		0.00187 (0.003)	
Childcare h.		-0.0102 (0.023)		0.0419 (0.039)		0.0241 (0.034)
HoD Support		0.0712** (0.032)		0.0789** (0.035)		0.106*** (0.032)
Excluded		-0.163*** (0.030)		-0.162*** (0.032)		-0.158*** (0.030)
Relief		0.0239 (0.028)		0.0122 (0.039)		0.0753** (0.034)
Unsupp. Partner		-0.0377 (0.029)		0.0199 (0.038)		-0.0226 (0.039)
Supp. Partner		-0.0350 (0.046)		-0.0765 (0.055)		-0.0869* (0.049)
Observations	1420	1183	1239	1038	1306	1096
Adjusted R^2	0.018	0.063	0.030	0.061	0.046	0.101
Current controls	✓	✓	✓	✓	✓	✓
Controls at birth	✓	✓	✓	✓	✓	✓
HEI controls	✓	✓	✓	✓	✓	✓
Department FE	✓	✓	✓	✓	✓	✓
Birthyear FE	✓	✓	✓	✓	✓	✓

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table C.24: Correlates of the Motherhood Penalty: Activities After Youngest Childbirth.

	(1)	(2)	(3)	(4)	(5)	(6)
	Research	Teaching	Admin.	Conferences	Mentor	Journal
FWE	0.00362 (0.003)	-0.00357* (0.002)	0.00263 (0.003)	0.00232 (0.003)	0.00111 (0.004)	-0.00374 (0.004)
Observations	1447	1447	1447	1447	1447	1447
Adjusted R^2	0.084	0.004	0.008	0.033	0.074	0.024
Controls at birth	✓	✓	✓	✓	✓	✓
HEI controls	✓	✓	✓	✓	✓	✓
Department FE	✓	✓	✓	✓	✓	✓
Birthyear FE	✓	✓	✓	✓	✓	✓

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

C.3.4 Averaging Support Across Pregnancies

We replicate our analysis computing, whenever possible, the average of both dependent and independent variables across childbirths. Whenever it is not feasible or advisable to do so (e.g. Activities while on leave), we include controls and fixed effect measured at the time of the oldest childbirth (full tables available upon request). Results are broadly consistent with those presented in the main text, as shown in Table C.25 and C.26.

Table C.25: Correlates of the Motherhood Penalty: Current Salary and Contract.

	Salary		Professor		Permanent	
	(1)	(2)	(3)	(4)	(5)	(6)
FWE (Avg)	205.4** (102.917)		0.00224 (0.003)		-0.00689** (0.003)	
Childcare h. (Avg)		5162.1*** (670.712)		0.0291 (0.021)		0.0482** (0.020)
HoD Support (Avg)		-1192.7* (689.962)		-0.0276 (0.024)		-0.0193 (0.022)
Excluded (Avg)		-2096.7*** (693.509)		-0.0450* (0.023)		-0.0110 (0.019)
Relief (Avg)		1300.3 (1029.448)		0.0200 (0.031)		0.0591** (0.026)
Unsupp. Partner (Avg)		-4538.0*** (1369.689)		-0.0618 (0.046)		-0.0622* (0.033)
Supp. Partner (Avg)		4578.7** (1947.207)		0.0112 (0.072)		0.00927 (0.056)
Observations	1374	1171	1555	1310	1545	1301
Adjusted R^2	0.326	0.390	0.185	0.205	0.391	0.404
Current controls	✓	✓	✓	✓	✓	✓
Controls at birth	✓	✓	✓	✓	✓	✓
HEI controls	✓	✓	✓	✓	✓	✓
Department FE	✓	✓	✓	✓	✓	✓
Birthyear FE	✓	✓	✓	✓	✓	✓

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table C.26: Correlates of the Motherhood Penalty: Current Satisfaction and Fairness.

	Satisfied		Fair Salary		Fair Tasks	
	(1)	(2)	(3)	(4)	(5)	(6)
FWE (Avg)	0.00434 (0.003)		-0.00186 (0.006)		0.00100 (0.003)	
Childcare h. (Avg)		0.00205 (0.022)		0.0343 (0.040)		0.0151 (0.034)
HoD Support (Avg)		0.0945*** (0.034)		0.123*** (0.035)		0.142*** (0.035)
Excluded (Avg)		-0.183*** (0.030)		-0.169*** (0.033)		-0.164*** (0.031)
Relief (Avg)		0.0240 (0.032)		0.00509 (0.039)		0.0737** (0.036)
Unsupp. Partner (Avg)		-0.0584 (0.050)		0.0353 (0.065)		-0.0520 (0.059)
Supp. Partner (Avg)		-0.138 (0.095)		-0.0977 (0.098)		-0.191** (0.095)
Observations	1420	1215	1239	1069	1306	1126
Adjusted R^2	0.019	0.075	0.030	0.063	0.046	0.109
Current controls	✓	✓	✓	✓	✓	✓
Controls at birth	✓	✓	✓	✓	✓	✓
HEI controls	✓	✓	✓	✓	✓	✓
Department FE	✓	✓	✓	✓	✓	✓
Birthyear FE	✓	✓	✓	✓	✓	✓

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

C.3.5 Head of Department Support in First Two Years

Finally, we recover the same positive effect on current satisfaction and perceived fairness if we look at support from Hod in the first two years of life of the youngest baby, rather than right upon returning from leave, by using a different survey item (Table C.27).

Table C.27: Correlates of the Motherhood Penalty: Current Satisfaction and Fairness.

	Satisfied		Fair Salary		Fair Tasks	
	(1)	(2)	(3)	(4)	(5)	(6)
FWE	0.00272 (0.003)		-0.00161 (0.005)		0.000194 (0.003)	
Childcare Hours		0.0118 (0.020)		0.000551 (0.032)		-0.00944 (0.026)
HoD Support (2 years)		0.124*** (0.029)		0.150*** (0.032)		0.164*** (0.038)
Excluded		-0.147*** (0.025)		-0.118*** (0.030)		-0.145*** (0.034)
Relief Availability		0.0143 (0.031)		0.0193 (0.034)		0.0480 (0.033)
Unsupp. Partner		-0.0188 (0.026)		0.00436 (0.037)		-0.0272 (0.035)
Supp. Partner		-0.0328 (0.042)		-0.0704 (0.047)		-0.131*** (0.047)
Observations	1654	1296	1446	1145	1528	1216
Adjusted R^2	0.029	0.090	0.044	0.081	0.041	0.112
Current controls	✓	✓	✓	✓	✓	✓
Controls at birth	✓	✓	✓	✓	✓	✓
HEI controls	✓	✓	✓	✓	✓	✓
Department FE	✓	✓	✓	✓	✓	✓
Birthyear FE	✓	✓	✓	✓	✓	✓

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$