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Do mothers get lost at the postdoc stage? Event history analysis of psychologists at German universities (1980–2019)

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Abstract
Women in academia are typically outnumbered by men, a phenomenon metaphorically known as "the leaky pipeline." This study contributes by showing a motherhood penalty in the career pipeline at the postdoctoral stage in Germany—that is, during habilitation. Based on CV information and an email survey, the paper examines which factors are associated with being awarded a habilitation and whether these factors differ between women and men as well as mothers and fathers. Using Cox regressions of retrospective career trajectories of almost all psychologists at German universities in 2019 (2527 scientists with 37,423 publications), the study shows that SSCI/SCIE articles and having a PhD from abroad increase the habilitation risk more strongly for women and mothers than for men and fathers. Net of career factors observed by CVs, however, mothers have a 42% significantly lower habilitation risk.

Keywords Leaky pipeline · Motherhood penalty · Habilitation · Scientific careers · Postdoctoral qualification · Academia

Introduction

At the European level, the proportion of women completing their PhD is equal to that of men (and growing at a much faster rate), raising the total share of women in academia to one-third in 2018 (European Commission, 2021, p. 96). The lower overall share of women can be largely explained by the underrepresentation of women in higher academic positions. The "leaky pipeline" phenomenon in academia was first mentioned in the 1980s: the higher the career level (from doctoral and postdoctoral positions to professorships), the lower the proportion of women (Alper & Gibbons, 1993; Berryman, 1983). This phenomenon is especially visible within psychology in German academia. In the last 20 years, approximately 70 – 80% of psychology students were female, but in 2018, only approximately 40% of psychology professors were women (Statistisches Bundesamt, 2019a, p. 452, 2019b, p. 108).

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Ideally, scientists leave academia because only the most talented are promoted. Thus, a (forced) leaving of academia is only justified when it is not related to ascribed characteristics such as gender (Merton, 1973 [1942]). Nevertheless, the reasons for a leaking pipeline are not yet clear. Although the leaky pipeline occurs as a universal phenomenon across different academic fields, more pipeline leakage prevails in academic disciplines with a high proportion of women, such as the social sciences and psychology (Ceci et al., 2014; Schubert & Engelage, 2011). Other studies extend this observation by emphasizing that the finding is reversed after ten years in the social sciences in Sweden, when more men than women exit academia (Silander et al., 2013). When gender-specific exit rates cannot explain the lower share of women in higher positions, however, the phenomenon of the leaky pipeline again becomes puzzling.

Hypothesizing gender-specific career tracks in higher education, I observe entire careers from PhD students (predocs) and PhD holders (postdocs) to the last career stage for highly qualified researchers headed for professorships in Germany—that is, the German *habilitation*. For this purpose, I use a unique, large-scale dataset of virtually all academic psychologists in Germany collected in 2019. Because psychology exhibits compositional attributes of the social sciences and humanities (balanced gender ratios) but is characterized by internal merit systems related to the natural sciences (e.g., peer-review publishing culture), the results of this study may be transferable to other research fields.

German academia: habilitation as postdoctoral qualification

To analyze the academic career tracks of psychologists, I refer to three basic career stages in Germany: (a) the doctoral stage, (b) the postdoctoral stage, and (c) the established researcher stage, such as tenured professorships, which are usually the only permanent positions in German academia (accounting for approximately 18% of the academic staff at German universities).[1] To obtain the scarce professorships in Germany, scientists have to complete a mandatory PhD thesis within the first stage, followed by a second thesis (the so-called habilitation). What makes the career stages prior to professorships particularly precarious in Germany is that academic positions within the first two stages are usually temporary positions with a limit of 12 years due to the German fixed-term law in academia. As a result, scientists in Germany have to procure one of the scarce permanent positions after 12 years in academia, or they have to leave academia as they cannot be further temporarily employed. One exception is, for example, due to parental leave, with one child extending the period by two more years.

I focus on scientists' second academic stage in German psychology that traditionally leads to habilitation (*venia legendi*), which is still the most frequent path followed to qualify for tenured professorships (with approximately 50% of all psychology professorships at German universities in 2019). According to the prequalifications of psychology professors in 2019, alternatives to the habilitation are a high number of publications comparable to a habilitation thesis (15%), a PhD as sufficient qualification for professorships at a university of applied sciences (15%),[2] or the newly introduced (in 2002) junior professorships

[1] See https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Bildung-Forschung-Kultur/Hochschulen/Tabellen/personal-gruppen.html [retrieved February 09, 2022].

[2] Universities of applied sciences are German universities that focus on applied sciences in practice and teaching and have less of a focus on research.

in Germany (7%).[3] In other countries, scientists receive permanent positions also below tenured professorships (e.g., in France)[4] or positions that are supposed to eventually lead to tenured professorships (e.g., tenure-track positions in the USA: assistant professorships)[5] and thus signal career prospects at an earlier career stage. In contrast, scientists in Germany face longer periods of job insecurity, which interferes with life and family decisions. Due to the structural peculiarities of German higher education, I focus on habilitation as a postdoctoral qualification indicating a pivotal point at which scientists are forced to leave academia or alternatively find a permanent position in academia.

In light of gender and parenting differences, Germany provides regulations that coincide with family and career decisions. Different family regimes across countries may shape decisions concerning the division of paid and unpaid work between women and men. In contrast to the USA (ideal–typical for the liberal regime with less state assistance for unpaid work) and the Nordic countries (ideal–typical for social-democratic regimes that foster dual-earner models), Germany, as a conservative regime, enforces a historically strong male-breadwinner and female-caregiver model (for an overview, see Cooke & Baxter, 2010). Policies such as marital splitting and joint taxation financially incentivize low female labor market participation, resulting in a high share of homemaking as well as part-time working mothers (Cooke & Baxter, 2010). Compared to other countries, long periods of parental leave are possible in Germany, which results in career interruptions in favor of raising children within the family instead of childcare facilities (Aisenbrey et al., 2009). Although the regulations are tailored for unequal earners within a partnership, academic women, who often have equally educated partners, work less than men when they have children (Sieverding et al., 2018). This may be because women fear stigma when they continue their careers. As a result, the aforementioned study concludes that career interruptions and reduced working hours harm mothers' career commitment and long-term success at German universities. In this context, the following section introduces how parenting and career determinants in academia affect career advancement differently for female and male psychologists at German universities.

What affects career advancement in academia? Gender differences in

Parenting The fact that scientists leave academia is not surprising per se; however, it is surprising when significantly more women than men leave academia for reasons unrelated to a lack of skills. Contrary to career orientation, one commonly discussed reason refers to the balance of family and career, which particularly prevents women from succeeding in academia. According to Gary Becker's family economic approach (Becker, 1965, 1985), each partner in a relationship specializes in either work or family. Since family responsibilities are increasingly attributed to women, their careers are more often characterized by career breaks or part-time jobs, usually caused by having children (Kleven et al., 2019; Ledin et al., 2007). These circumstances discourage women from staying in academia until

[3] Percentages in parentheses refer to the share of prequalifications of all tenured psychology professorships in 2019 in Germany; see Statistisches Bundesamt (2020, p. 330).

[4] In addition to approximately 20% tenured professorships, approximately 60% of academic staff at French universities are permanently employed (Kreckel and Zimmermann 2014, p. 115).

[5] The newly introduced junior professorships in Germany in 2002 are comparable to the US assistant professorships but thus far tend not to be tenure track.

reaching the rare chairs at the end of the academic career pipeline and can drive the perception of academia as an "either–or" decision between career and family (e.g., Ginther & Kahn, 2009; Lind, 2008).

In academic psychology and beyond, men are more likely to have children than women (for an overview, see Caprile et al., 2012; for psychology, see Helmreich et al., 1980). The hurdles to reconciling family and career seem to be particularly high in Germany, where fewer female professors have children compared to those in other EU countries (Lind, 2008). Surveys in German academia support these structural hurdles for mothers (Beaufaÿs & Krais, 2005). This notion is reflected in childbearing as one of the main reasons women leave academia (Preston, 2004; Van Anders, 2004).

Publications Publications—an outcome of scientific productivity and achievement—lead to higher promotion chances in hiring decisions in academia (for the USA, e.g., see Long et al., 1993; for Germany, e.g., see Lutter et al., 2022). However, the amount of publishing varies by gender. Women publish less over their entire careers, a fact that is visible across different disciplines (e.g., Cole & Zuckerman, 1984; Fox, 2005; Yu Xie & Shauman, 1998). Although the amount of publishing in psychology is higher than that in other fields within the social sciences, the female productivity gap still remains, especially in terms of journal articles (D'Amico et al., 2011; König et al., 2015; Mayer & Rathmann, 2018). Some authors argue that one reason why women publish less is due to their earlier career dropouts (Huang et al., 2020), while others also point to productivity gaps between women and men at advanced career stages (for psychology professors, see D'Amico et al., 2011; Lutter et al., 2022; Mayer & Rathmann, 2018). Differences in publication patterns could therefore also be reflected in gender differences at earlier stages when obtaining a postdoctoral qualification such as habilitation.

Mobility Mobility is important for the accumulation of social capital through access to beneficial networks, which is different for women and men. While previous research has shown that women have less access to supportive networks, the presence of these networks is important for career advancement in academia (for Germany, see Barthauer et al., 2016; Lutter et al., 2022; for different scientific fields and countries, see Heffernan, 2021). Moreover, international experience is particularly useful in creating new knowledge, the "foreign premium" of which improves labor market benefits in the home country (Musselin, 2004; Scellato et al., 2012). Thus, it is likely that being mobile helps to accumulate social capital that, in turn, is an important avenue toward the postdoctorate qualification. Women, however, are more likely to be site-bound than men when they have children (for Europe, see Ackers, 2004; for the USA, see Rosenfeld & Jones, 1987; Yue Xie & Shauman, 2003).

Educational background Monetary and personal resources are distributed differently at universities, which may impact the career development of scientists. Gender inequality results when cutting-edge universities recruit particularly male scientists, despite considering individual performances. Studies in the USA have shown that following prestigious university tracks at elite universities only favors men in becoming tenured (Long et al., 1993). In Germany, however, so-called universities of excellence were introduced only in 2005 to make Germany more internationally competitive as a research location. Comparable research is missing that considers the impact on careers of male and female scientists at the postdoctoral stage when they have former degrees from German universities of excellence.

Postdoc experience The longer scientists remain in academia, the more they disqualify themselves from other labor markets. This issue comes increasingly into focus within the postdoc stage. Authors have commonly shown that women take longer to advance along the career pipeline (Long et al., 1993; Silander et al., 2013; Valian, 1999). In Germany, a more recent study of female postdocs further found a relationship between overcommitment and strain, which drives women to leave academia (Dorenkamp & Weiß, 2018). Scholars have therefore called the postdoctoral stage in Germany "the rush hour of life" (Baader et al., 2017, p. 279), in which they have to make important life decisions that affect their careers.

Awards and grants Gendered outcome evaluations coincide with the Matilda effect in scholarly awards or grants (Rossiter, 1993; see also the "Matthew effect" in Merton, 1968). First, women receive fewer awards because of their underrecognition compared to men. Second, award winners are more likely to gain further awards in the future—even if other scientists are equally proficient. Across different fields, women win fewer prizes overall (Lincoln et al., 2012). Whereas authors in Sweden in 1997 mentioned nepotism and sexism in peer review of fellowship applications (Wold & Wennerås, 1997), a meta-analysis ten years later still showed men's significantly higher chances of receiving grants (Bornmann et al., 2007). More recent research shows that women in German sociology receive more awards than men, and when they do, they have higher chances of obtaining tenured professorships (Lutter & Schröder, 2016). For this reason, it is likely that awards and grants are also beneficial for the postdoctoral qualification stage, but in a different manner for women and men.

While I clearly stated what factors affect career development and how these differ between genders, little agreement exists in what causes those differences. While authors claim that different *preferences* surface with (family and) career decisions (Ferriman et al., 2009; Niederle & Vesterlund, 2007; Sieverding et al., 2018), others follow *discrimination* strands that disadvantage women and mothers in academia (Acker, 1990; Benschop & Brouns, 2003; Correll et al., 2007; Rossiter, 1993; Wold & Wennerås, 1997). Both scenarios can lead to fewer women remaining in academia, whether because they decide to do so due to their preferences or they refrain from applying for higher positions due to experienced discrimination (or both). This paper does not seek to distinguish the underlying mechanisms but shows whether parenthood and career factors are associated with habilitation in German psychology.

Data and methods

For this study, I used hand-coded CV and publication records of psychology departments at 72 German universities and two research institutes. A qualified team of six trained student assistants collected these data using university websites in 2019. I applied several consistency checks to ensure that the data were (intercoder) reliable and valid (double-blind coding). The dataset includes a total of 2527 scientists with 37,423 publications, where each publication represents an observation. Because I used retrospective data, this study covers scientific careers from 1980 to 2019. The dataset was complemented by an email survey sent to all psychologists in the dataset (response rate of 61%) asking whether they have children and when the children were born.

Based on the longitudinal data of scientific careers, I applied semiparametric Cox regression modeling with Efron's approximation for ties clustered by scientists (Cox, 1972; Efron, 1977). Scientists in the dataset were part of the "risk set" as soon as they started publishing to be considered potential candidates for a postdoctoral qualification (i.e., the habilitation). The risk set thus included the observation years for all scientists throughout their careers, but only until either a certain event occurred (habilitation) or the observation period expired for those who had not yet obtained a habilitation (or never will), so-called right-censored data (Blossfeld et al., 2019). For some cases, I additionally right-censored data when scientists should no longer be considered part of the risk-set because they no longer intend to habilitate—that is, after initial tenured professorships and three years after a junior professorship as one of the few alternatives to habilitation.[6] I thus used event information on 468 *habilitations* of psychologists (295 males and 173 females) as the outcome variable.

Variables

As explanatory variables, I first used a dummy variable for *gender.* Because I assumed that children affect scientific careers differently (motherhood penalty), I included *parenthood* separately by gender as a categorical variable (ref. childless men). I could thus compare the habilitation risk due to gender, parenthood, or both. The variable is time dependent, so that mothers and fathers receive the value 1 as soon as their first child was born. To ensure that the results are not biased by nonresponse, I added two more categories of women and men who did not participate in the survey.[7]

After holding parenthood constant, I added the number of *publications* as an observable outcome of scholarly productivity that increases throughout a career. I used a coding scheme that distinguishes among [1] articles ranked in the (Social) Science Citation Index (SSCI/SCIE); [2] other articles; [3] monographs; [4] edited volumes; [5] book chapters; and [6] gray literature. To account for coauthored work, I weighted each publication by the number of authors n using the Formula $2/(n+1)$. Single-author articles received a weight of 1, while two-author publications received a weight of 0.67, and so forth.[8]

For *mobility*, I measured the number of university changes within Germany throughout a scientist's career. I also added the number of *months* a researcher *spent abroad* and a time-constant dummy variable for being awarded a *PhD from abroad*. I only recorded months spent abroad when the country was neither where the scientists graduated nor Germany, irrespective of their origin country.

[6] In the main analyses, I right-censor the years since the first appointment and three years since the junior professorship if the scientists have *not yet habilitated*. I did so in the first case because once a scientist held the first tenured professorship, s/he skipped the habilitation by qualifying via an alternative. One alternative is the junior professorship with a special peculiarity because some scientists do both a habilitation thesis and a junior professorship. To consider this second case, I right-censored cases after three years of holding a junior professorship. I chose three years because the candidate is evaluated after this time, so the junior professorship can be extended to six years, and the intention to simultaneously habilitate might decrease. For robustness checks, I censored the years as soon as someone started a junior professorship, assuming they skipped the habilitation (A5.1). I also censored data after six years of holding a junior professorship (A5.2); both of the procedures yielded the same results.

[7] Nonresponses were equally distributed across gender. I additionally conducted three different robustness checks to account for potential survey nonresponse bias; an additional dummy variable that accounts for missing information, a complete record analysis, and multiple imputation (see Online Appendix Table A8).

[8] I used log transformation $\log_e(x+1)$ for continuous explanatory variables to normalize their distribution. I thus assumed that, e.g., the first publication is more important for an academic career than the tenth.

The next model added the share of degrees from *universities of excellence* in Germany calculated by the number of degrees in total. If someone completed his or her highest study degree at a university of excellence, he or she received the value 1; if they were then awarded a PhD at a non-excellence university, they received the value 0.5. Additionally, I considered job experience through the *years since the PhD* (with a minimum of 0 for scientists who did not yet have a PhD). Because I assumed increasing years would be advantageous only up to a certain threshold, I additionally measured the years since the PhD by a squared term. I refer to these variables in the analysis as "human capital," attributable to education and work experience (Becker, 1993 [1964]).

I also added the number of *awards* as well as the number of research grants through *research funding* of the German Research Foundation (DFG) as the main research funding institution in Germany.

Finally, I added two control variables: I used a dummy variable to control for *selected publication* lists when senior scientists only published their recent or best publications.[9] I additionally added four categories of entry *cohorts* when scientists started their careers (1980–1989, 1990–1999, 2000–2009 (ref.), and 2010–2019).

Results

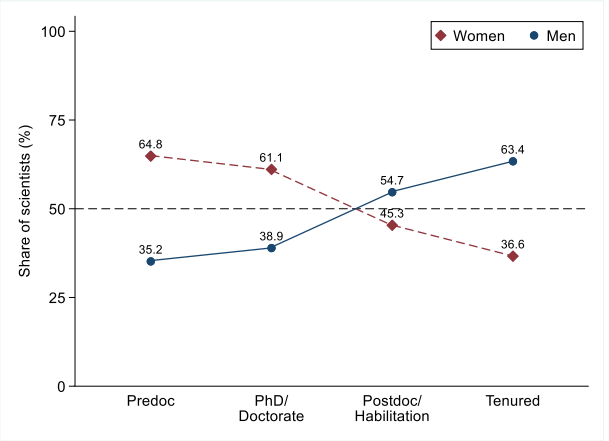
Descriptive results: who gets lost in the career pipeline?

Figure 1 shows the proportion of scientists at different career stages along the career pipeline in 2019. According to the leaky pipeline hypothesis, more women tend to leave academia, whereas the proportion of male scientists increases, which yields a "scissors diagram." The proportion of female graduates is almost 65%, while the gender ratio is reversed at higher career stages. According to Fig. 1, the period between PhD and habilitation seems to be especially challenging because of the starkest decrease in women. As Fig. 1 is only a snapshot of the year 2019, we cannot disentangle whether this is due to compositional shifts in the past or a growing leaky pipeline throughout scientists' careers, but considering only the cohorts after 2000 still shows the strongest decline of female scientists between PhD and habilitation (see Online Appendix B1).

Table 1 provides descriptive statistics for all variables used in this study. Values are based on psychologists in the habilitation year. Variables are in descending order of their relative differences between women and men.

The greatest (positive) difference in women compared to men is in the years since their PhD. Women need approximately 15% more time to obtain a habilitation—that is, 7.6 years from PhD to habilitation—one year slower than men. Nevertheless, women only need approximately half a year longer to habilitate over their entire career (on average, approximately 11 years), which suggests that women either earn their PhD faster or publish later as the observation time starts with publishing. In turn, the greatest (negative) difference from men lies in the publication behavior of women. Men serve as editors twice as often as women, while women have overall fewer publications than their male colleagues: approximately 15% fewer SSCI/SCIE articles and 30% fewer non-SSCI/SCIE articles. The number of monographs and book chapters, however, and other mean values only slightly

[9] Of the incomplete publications listed (approximately 7% of all scientists), approximately 44% were attributed to female scientists, so the distribution is not skewed by gender.



N_{predoc}=748; N_{PhD}=1015; $N_{habilitation}$=86; $N_{tenured}$=554

Fig. 1 "Scissors-diagram:" Different career levels of psychologists at German universities in 2019, separately for gender

and statistically nonsignificantly differ between male and female scientists. Nevertheless, men have one child on average, which is slightly more but comparable to the number of women (1.04 and 0.93) when they obtain a habilitation.

Table 2 shows the summary statistics separately for mothers and fathers at the time they obtain their habilitation. The years since obtaining a PhD are again striking in the comparison of mothers and fathers. After obtaining a PhD, mothers take two years longer to habilitate, which is approximately 30% longer than fathers take. While we find in Table 1 that women need half a year longer to habilitate, the gap increases after having children such that mothers need approximately one year longer to habilitate than fathers. Although not statistically significant, nearly twice as many mothers have earned a PhD abroad, while

Table 1 Summary statistics at the year of obtaining habilitation, separately for males and females

	obs (Ma)	obs (Fe)	mean (Ma)	mean (Fe)	rel dif (Fe/Ma in %)	abs dif (Fe-Ma)	se	*p*
Years since PhD	246	149	6.61	7.61	115.13	1	0.29	< .01
PhD from abroad	246	149	0.07	0.08	114.29	0.01	0.03	0.79
Months abroad	246	149	12.91	13.87	107.44	0.95	2.29	0.68
Excellence university	246	149	0.35	0.37	105.71	0.02	0.04	0.63
Years to habilitation	246	149	10.49	10.95	104.39	0.46	0.39	0.23
Monographs	246	149	0.63	0.64	101.59	0.01	0.09	0.93
Mobility	246	149	1.77	1.77	100.00	0	0.15	0.98
Number of children	134	98	1.04	0.93	89.42	−0.11	0.13	0.41
Book chapters	246	149	3.91	3.46	88.49	−0.45	0.45	0.31
Awards	246	149	0.53	0.46	86.79	−0.07	0.11	0.53
SSCI/SCIE articles	246	149	6.67	5.69	85.31	−0.98	0.47	0.04
Research funding	246	149	0.72	0.6	83.33	−0.12	0.11	0.28
Non-SSCI/SCIE articles	246	149	2.77	1.93	69.68	−0.84	0.32	0.01
Gray literature	246	149	2.17	1.19	54.84	−0.97	0.36	0.01
Edited volumes	246	149	0.24	0.11	45.83	−0.12	0.05	0.02

Ma = male; *Fe* = female; only complete cases

Table 2 Summary statistics at the year of obtaining habilitation, separately for fathers and mothers

	obs (Fa)	obs (Mo)	mean (Fa)	mean (Mo)	rel. dif (Mo/Fa in %)	abs. dif (Fa-Mo)	se	*p*
PhD from abroad	80	56	0.06	0.11	183.33	−0.04	0.05	0.35
Monographs	80	56	0.59	0.85	144.07	−0.26	0.17	0.13
Months abroad	80	56	12.99	16.75	128.95	−3.76	3.89	0.34
Years since PhD	80	56	6.84	8.8	128.65	−1.97	0.48	<.01
Mobility	80	56	1.46	1.79	122.60	−0.32	0.22	0.15
Book chapters	80	56	4.16	4.98	119.71	−0.82	0.83	0.33
Excellence university	80	56	0.33	0.36	109.09	−0.03	0.07	0.61
Years to habilitation	80	56	11.42	12.42	108.76	−1	0.6	0.10
SSCI/SCIE articles	80	56	6.71	7.1	105.81	−0.4	0.85	0.64
Research funding	80	56	0.61	0.63	103.28	−0.01	0.16	0.94
Awards	80	56	0.61	0.61	100.00	0.01	0.2	0.98
Number of children	80	56	1.74	1.63	93.68	0.11	0.12	0.34
Non-SSCI/SCIE articles	80	56	2.73	1.87	68.50	0.86	0.55	0.12
Edited volumes	80	56	0.26	0.11	42.31	0.15	0.09	0.10
Gray literature	80	56	3.16	1.32	41.77	1.84	0.79	0.02

Fa = father; *Mo* = mother; only complete cases

they had approximately 30% more experience abroad and approximately 20% more university changes within Germany.

Regression models

To present the Cox regression results of what is associated with habilitation, Table 3 successively adds gender, children, publications, mobility, human capital, and research awards and grants (models 1–6). The coefficients show hazard ratios (the multiplicative effects of the covariates on the hazard of a habilitation).

In model 1, I used a covariate baseline model including gender and two controls: selected publication lists and entry cohorts of scientists. Because hazards are ensured to be positive and the reference value is 1, a coefficient of 0.74 is negatively associated with habilitation. Simply put, the risk of a habilitation decreases by 26% for women.

Model 2 differs not only between female and male scientists but also by parenthood. Compared to childless men, the habilitation risk *decreases* for mothers by 18% (nonsignificant), while the habilitation risk *increases* for fathers by 53%. As this result does not consider any productivity factors, I now add career information to the remaining models.

I added scholarly productivity through different types of publications in model 3. With additional (log) SSCI/SCIE articles, the habilitation risk increases by 159%, followed by monographs and book chapters (52% and 40%). We can also say that having 50% more SSCI/SCIE publications is associated with a 47% increased habilitation risk, and

Table 3 Cox regression models on obtaining habilitation

	(1) Gender	(2) Children	(3) Publications	(4) Mobility	(5) Human capital	(6) Awards/grants
Female	0.74** (−3.10)					
Childless man		*Reference*				
Father		1.53* (2.47)	1.38+ (1.82)	1.39+ (1.85)	0.99 (−0.04)	0.95 (−0.29)
Man w/o info		1.18 (1.02)	1.11 (0.65)	1.18 (0.97)	1.00 (−0.02)	0.95 (−0.29)
Childless woman		0.97 (−0.16)	1.21 (1.04)	1.19 (0.91)	0.96 (−0.18)	0.94 (−0.27)
Mother		0.82 (−1.04)	1.01 (0.07)	0.99 (−0.08)	0.62* (−2.28)	0.58** (−2.59)
Woman w/o info		0.94 (−0.36)	1.31 (1.61)	1.38+ (1.90)	0.92 (−0.45)	0.94 (−0.32)
SSCI/SCIE articles (ln)			2.59*** (10.67)	2.36*** (9.39)	1.95*** (6.78)	1.77*** (5.89)
Non-SSCI/SCIE articles (ln)			1.07 (0.71)	1.10 (0.94)	1.21+ (1.88)	1.33** (2.83)
Monographs (ln)			1.52** (2.88)	1.47** (2.63)	1.31+ (1.77)	1.26 (1.50)
Edited volumes (ln)			1.16 (0.63)	1.37 (1.48)	1.28 (1.13)	1.33 (1.33)
Book chapters (ln)			1.40*** (3.72)	1.33** (3.17)	1.14 (1.47)	1.14 (1.46)
Gray literature (ln)			0.95 (−0.66)	0.92 (−0.97)	1.09 (1.01)	1.07 (0.73)
Mobility (ln)				1.89*** (6.03)	1.46*** (3.77)	1.40** (3.28)
Months abroad (ln)				1.10** (2.60)	1.08* (2.22)	1.06+ (1.71)
PhD from abroad				0.68+ (−1.94)	0.59* (−2.46)	0.65* (−1.96)
Excellence university					1.96*** (5.13)	1.97*** (5.19)
Years since PhD					1.76*** (7.48)	1.73*** (7.32)
Years since PhD (sq.)					0.98*** (−3.81)	0.98*** (−3.68)
Awards (ln)						1.14 (0.94)
Research funding (ln)						1.72*** (4.32)
Only selected publications	2.65*** (5.77)	2.61*** (5.67)	3.02*** (5.58)	2.81*** (4.96)	2.15*** (4.60)	1.94*** (3.83)
Cohorts *(ref. 2000–2009)*						
1980–1989	1.53** (3.22)	1.55*** (3.35)	1.67** (3.17)	1.73*** (3.71)	1.96*** (4.37)	2.29*** (5.20)
1990–1999	1.71*** (4.75)	1.75*** (4.88)	1.76*** (4.42)	1.56*** (3.36)	1.67*** (3.94)	1.66*** (3.79)

Table 3 (continued)

	(1) Gender	(2) Children	(3) Publications	(4) Mobility	(5) Human capital	(6) Awards/grants
2010–2019	0.34*** (−4.40)	0.34***(−4.44)	0.32*** (−4.69)	0.30*** (−4.92)	0.42*** (−3.75)	0.43*** (−3.59)
Pseudo r^2	0.02	0.02	0.06	0.08	0.13	0.14
Log-likelihood	−2966.37	−2962.31	−2842.32	−2807.85	−2629.46	−2615.03
Degrees of freedom	5	9	15	18	21	23
Chi^2	122.14	124.99	277.13	327.19	859.40	909.34
AIC	5942.74	5942.62	5714.63	5651.71	5300.92	5276.07
BIC	5985.39	6019.39	5842.58	5805.25	5480.06	5472.26
Number of events (habilitation)	468	468	468	468	468	468
N (persons)	2527	2527	2527	2527	2527	2527
N (persons-publications)	37,423	37,423	37,423	37,423	37,423	37,423

Exponentiated coefficients (hazard ratios); t statistics in parentheses; *ln*, logged values; *sq*, squared

+ $p<0.1$, * $p<0.05$, ** $p<0.01$, *** $p<0.001$

having 100% more SSCI/SCIE publications (a doubling of the publication amount) is associated with an almost doubled habilitation risk (increased by 93%).[10]

By adding variables that measure mobility in model 4, the mobility's (log) hazard ratio of 1.89 indicates that—among women and men holding children and publications constant—institutional changes in Germany increase the habilitation risk by 89%. Mobility is therefore positively associated with habilitation, which cannot be explained by the variation in the number of children or publications. The number of months spent abroad increases the habilitation risk by 10%. In turn, having a PhD from abroad decreases the risk by 32%.

Model 5 adds human capital variables. The share of degrees from universities of excellence almost doubles the habilitation risk (by 96%), indicating the important role of German universities of excellence for academic career prospects. In similar magnitude, the years since obtaining a PhD increases the habilitation risk by 76%. As expected, the risk is subsequently reduced when a squared term that counts for the years since the PhD was added. Early years after the PhD are therefore particularly important to obtain a habilitation, but only up to a certain point.

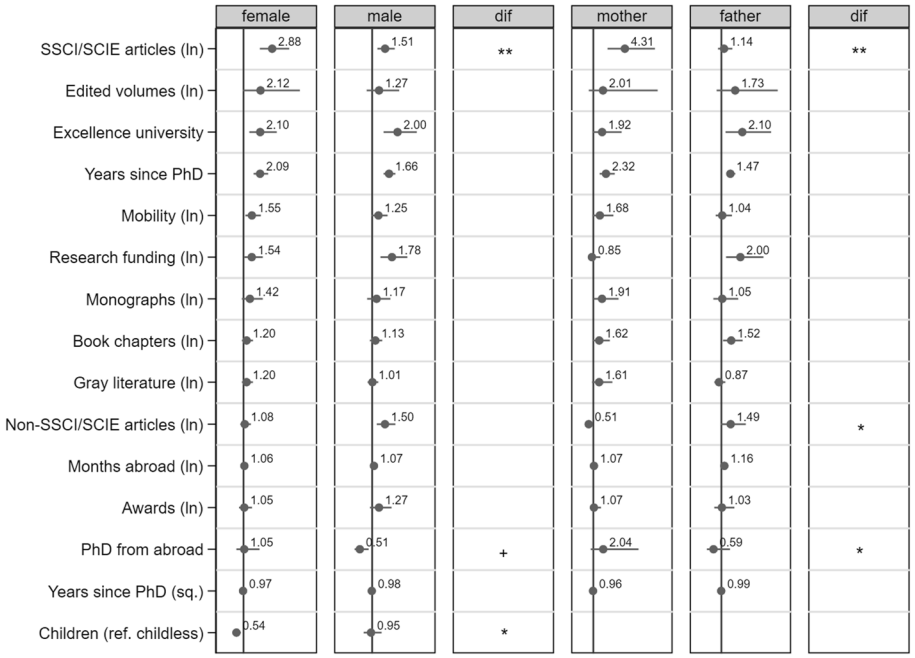
Model 6 adds (log) research funding and (log) scholarly awards and, as such, covers the full model, including gender, having children, and all CV components. The habilitation risk increases by 72% with additional (log) research funding, while (log) scholarly awards are only slightly and nonsignificantly associated with a higher habilitation risk. Among all career variables, the strongest predictors that correlate with a habilitation risk in academia are SSCI/SCIE articles, universities of excellence, and the years since the PhD. This confirms Table A12 in the Online Appendix, where I standardized the coefficients that enable them to be compared.

Net of the career determinants, what should be further mentioned is that only the group of mothers has a 42% lower habilitation risk compared to that of childless men in the full model. Mothers' lower habilitation risk becomes visible as soon as human capital variables are added (reduced by 38% in model 5) and is otherwise spurious. To take a closer look into these *gender and parenthood differences*, I plotted the full model (model 6 in Table 3) separately for each group in Fig. 2. Based on these models, I calculated interaction terms conditioned on gender and parenthood and present their significance in Fig. 2 (for regression models with interaction terms, see Online Appendix A6).

As can be seen in Fig. 2, the positive association of (log) SSCI/SCIE articles and habilitation risk is due to the subsample of women (188% for women and 51% for men). This difference between women and men is statistically significant at $p < 0.01$ (see also the interaction term of model 2 in Table A6.1), which implies that publishing is a main driver for the increased habilitation risk for women. Similar results can be found for having a PhD from abroad, which increases the habilitation risk for women stronger as compared to men. Among the subsample of women, mothers still have a 46% lower habilitation risk.

The differences in the habilitation risk of mothers and fathers resemble the magnitude and significance levels of women and men. However, the impact of SSCI/SCIE articles diverges for mothers and fathers. With additional (log) SSCI/SCIE publications, the habilitation risk increases for mothers by 331%, while increasing (log) SSCI/SCIE articles are

[10] 50% increase in publications $= 1.5^{\ln(2.59)}$; 100% increase in publications $= 2^{\ln(2.59)}$. Online Appendix A3 shows how the hazard ratio changes when continuous variables, such as the numbers of university changes, increases by 50% or 100%. Table A3 also provides examples of nonlogged variables, e.g., the habilitation risk increases by 3% with each additional SSCI/SCIE article that is published (Model 1), all else being equal.



Exponentiated coefficients (hazard ratios); ln, logged values; sq = squared. Control variables (incomplete publications list and entry cohorts) are included but not shown here. + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. $N_{female/male}$=2527; $N_{mother/father}$=691. Wald test indicates that adding interaction effects (SSCI/SCIE articles, non-SSCI/SCIEarticles, PhD from abroad, and children) improves the model fit.

Fig. 2 Plotted Cox regression models on obtaining habilitation, separately for gender and parents (incl. significances of interaction terms)

not associated with the habilitation risk for fathers (specifically, nonsignificant by 14%). In turn, non-SSCI/SCIE articles increase the habilitation risk of fathers (but not for mothers), which is a significant difference that I did not observe between women and men. However, the impact of having a PhD from abroad becomes more substantial among mothers than fathers (2.04 vs. 0.59).

To illustrate the group differences, I also plotted the survival curves of model 6 in Table 3 separately for childless women, childless men, mothers, and fathers (see Fig. 3). This simplifies the understanding of the habilitation risk of each group—that is, the risk to habilitation depending on the years in academia (observation years). The survival curves show the inverse relationship to hazard ratios: an increased hazard ratio means a positive association, which translates into decreasing survival curves. Based on all psychologists in the dataset, the survival curves show the habilitation risk at each point during a career, accounting for right-censored observations or outflowing data. Consistent with the result of the Cox regressions, it appears that childless men and fathers habilitate "faster" (or at a higher risk) overall, followed by childless women and mothers (controlling for all covariates). The fact that mothers are associated with a reduced habilitation risk is also reflected in the survival curve with the weakest fall.

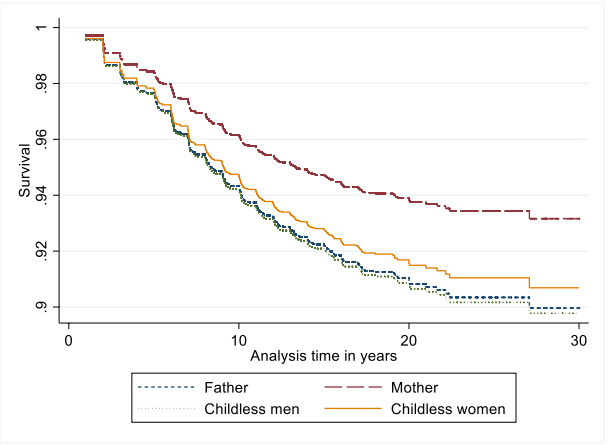


Fig. 3 Survival curves of psychologists who obtained habilitation, separately for gender and parenthood (all covariates held constant)

Discussion and conclusions

Based on the results of my analysis, I found a so-called motherhood penalty within the postdoctoral phase in the field of psychology in Germany. This penalty cannot be explained by lower productivity or hurdles due to mobility, university affiliation, job experience, awards, or grants as confounding variables. While it is not surprising that publications are positively associated with habilitation, I found that mothers do *not* publish less than fathers at the time they obtained a habilitation (for similar results, see Cole & Zuckerman, 1987; Krapf et al., 2017). Interaction effects also showed that the impact between SSCI/SCIE articles and habilitation is stronger and more positive for women (than men) and mothers (compared to fathers). This leads to different conclusions. Writing SSCI/SCIE articles is more important for women than men in that these publications strongly predict women's career progress, i.e., the habilitation risk. This might be due to women publishing less than men over their careers (D'Amico et al., 2011; König et al., 2015; Mayer & Rathmann, 2018), which is why each publication "counts more" for them. From a methodological view, women (or mothers) with more publications might also be different than men (and fathers) in other characteristics, such as being more career oriented or spending more time teaching instead of doing research. As a result, the interaction effect reflects this variation (of hitherto unobserved characteristics within each group). This heterogeneity can probably be seen in the descriptive tables, where mothers publish more SSCI/SCIE articles than fathers at the time they obtain habilitation, while women publish fewer than men at the same time. Family aspiration further anticipates career decisions for women, as suggested by Ceci et al. (2014). When only highly productive women may decide a priori to have children while other female scientists cannot overcome the hurdles to combine family and a scientific career, this leads to the self-selection of highly productive mothers (in line with Fox, 2005; Joecks et al., 2014). As SSCI/SCIE articles are weighted by the number of authors, the accumulation of coauthors might also differ between women and men. This difference, however, cannot be seen significantly among psychologists in Germany (Lutter et al., 2022). A similar conclusion can be drawn by the interaction of having a PhD from abroad, a relationship that is more positively associated with habilitation for women (than men) and for mothers (than fathers). While Musselin (2004) argued that it is rather difficult for foreign postdocs to settle in Germany so that they instead use that experience

as a career boost in their home countries, this conclusion holds only for male psychologists, whose habilitation risk is negatively associated with having a PhD from abroad in this study. What if more men re-emigrate to their home countries so they do not stay long enough to reach the German habilitation, causing this result? Since we only collected data from psychologists currently working at German universities, this scenario can only be observed by follow-up data collection points.

Net of career determinants, the main reason for a leaky pipeline can be associated with gender differences in family responsibilities, as I actually found lower habilitation risk for *mothers* but not for fathers. I can rule out that the lower habilitation risk is solely due to gender; rather, having children affects the relationship between gender and habilitation differently and has a negative impact solely on mothers. This result is reflected in the descriptive statistics, as men are more likely to have children on par with others (for an overview, see Caprile et al., 2012). However, I also considered the number of children as a robustness check, but the results hardly change (see Online Appendix A1–A2). This finding is further mirrored by Williams (2004), who argued that women hit the "maternal wall" before they can reach the peak of an academic career, a finding that also reflects the well-documented hurdles for mothers in German academia (e.g., Beaufaÿs & Krais, 2005; Lind, 2008).

Why do female postdocs face disadvantages when they have children? Taking a closer look at academic spouses suggests a few answers: Female professors tend to have scientist partners (Rusconi & Solga, 2010), which is detrimental for "academic mothers" when women in predominantly female disciplines spend more time on child care. As noted in the introduction, this can lead to longer periods of career interruptions or reduced working hours with detrimental effects on women's careers. This can be seen by the study of Sieverding et al. (2018) and is supported by long periods of parental leave encouraged by German policies. Although having children suspends the German fixed-term law for two more years, this simultaneously increases the period of job insecurity. Because more female scientists tend to have so-called dual academic career relationships—that is, their partner also participates in the academic field—this may further contribute to the findings of a detrimental effect of motherhood (Ceci et al., 2014; Solga & Rusconi, 2007). This trend is increasingly visible across Europe because more women earn higher educational degrees and prefer an academic partner (Tzanakou, 2017) and is therefore of particular interest in psychology, which has a high proportion of women. Likewise, the burden is especially onerous for postdocs with young children (Mason et al., 2013). It should also be mentioned here that women are more likely to withdraw from doctoral education in Germany, assuming they do not reach the first qualification stage at all (Jaksztat et al., 2021). This mirrors the findings of the present study, as the years after the PhD are strongly and positively associated with habilitation for women (and mothers). A lower habilitation risk for mothers in the full sample becomes visible as soon as the years since the PhD are added, which is likely the point at which more women (or mothers) dropped out of the academic pipeline. This finding becomes even stronger with standardized coefficients in Appendix A12.

Assuming systematic gender differences in academic dropouts leads to a limitation of this study related to the so-called survivorship bias. This could be a possible scenario within this study, as we retrospectively collected data in 2019 so that psychologists who left academia before that point could not be sampled. As a result, the remaining women within this study could be more selective than men. This point is related to the aforementioned limitation concerning unobserved heterogeneity within the data, when, e.g., only career-committed women remain in academia. When the career factors I observed within CVs and having children are also caused by some hitherto unobserved characteristics (such

as preferences or experienced discrimination, as mentioned in the introduction), the "motherhood penalty" I found at the postdoc stage of psychologists in Germany is then a result net of "prebiased" career determinants.

More recent research strands consider women and the increasing opportunities for nonacademic careers in industrial and technical fields in Europe (Etzkowitz et al., 2011; Meulders et al., 2003), but comparable research on academic psychologists and their opportunities in the nonacademic labor market in Germany is missing. For (PhD) psychologists, there are certainly still attractive job opportunities outside academia in health care and therapeutic professions, but whether these pathways are gender- or parent-specific and, in turn, the explanation for unequal opportunities for mothers to habilitate remain unclear. Nevertheless, this study suggests that fewer women tend to obtain a habilitation, although it is still the traditional path to qualify for professorships in psychology.

What if they take alternative routes within academia? In Germany, scientists can skip habilitation but still be considered for a professoriate at a university of applied sciences. In contrast to universities, gender parity almost prevails (48%) among psychology professorships at universities of applied sciences in Germany (Statistisches Bundesamt, 2020, p. 118). One reason for gendered preferences may be because universities of applied sciences tend to focus on teaching rather than research, thus representing institutionalized faculty roles that are (stereo)typical for women (see, e.g., Miller & Chamberlin, 2000). This is of interest especially for women with family plans if, instead of a "tenure-track pipeline," they prefer teaching-intensive faculties "in favor of careers they believed were more compatible with their plans" (Ceci et al., 2014, p. 121). This is what Kleven et al. (2019) have called a "postchild effect of realized fertility," when women respond to motherhood such that they change their employment conditions to improve balancing work and family, which again leads to a self-selection of women at universities remaining childless. Beyond that, it still remains open whether family decisions are individual choices per se or whether "these choices are constrained by biology and/or society" (Ceci & Williams, 2011, p. 3161); a closer examination of this issue is, however, beyond the scope of this study.

While focusing on children, this study lacks information about family relationships and the cohabitation of spouses. Although I do not expect this to bias the results as, for example, being married does not hurt women's likelihood of academic success (Ginther & Kahn, 2009), future research could investigate whether this provides a more detailed explanation on the division of labor in the household, career interruptions, and actual working hours, especially among dual-career families. Furthermore, I did not consider other supportive factors, such as the role of mentors in academia, which can be crucial, especially for early career scientists to access information and improve tacit knowledge (in grant proposals, e.g., Van der Weijden et al., 2015).

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Data availability The datasets generated and analyzed during the current study are not publicly available due to them containing information that could compromise research participant privacy.

Code availability The code to replicate the study analyses is available at https://osf.io/ev8mx/

Declarations

Conflict of interest The author declares no competing interests.

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