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Same degrees, different outcomes? Fields of study choices and gender wage inequality in Finland and Germany

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ABSTRACT

Men and women's diverging fields of study choices contribute to the gender wage gap among highly educated workers in several countries, yet systematic cross-national comparisons are rare. Using data from the German Socio-Economic Panel Study, the German Microcensus, and Statistics Finland this study explores whether fields of study shape the gender wage gap differently in Germany than in Finland; two countries that display strong linkages between education and employment, but differ in the generosity of family policies. The results show that fields of study are an important source of gender wage disparities in both countries. In Germany, associations between characteristics of fields and wages do not seem to differ between the genders. In Finland, the findings suggest that women profit more than men from fields with strong linkages to occupations. Our findings highlight that research analyzing the association between fields of study and gender inequality needs to consider institutional features and gender-specific patterns.

1. Introduction

The persistent and pronounced gender wage inequalities among highly educated workers continue to puzzle scholars (Boye and Grönlund, 2018; Mandel and Rotman, 2021). The gender wage gap among tertiary-educated workers is in several countries already visible in the first years after graduation (Francesconi and Parey, 2018; Galos and Kulic, 2023). However, it also varies considerably across countries (Lažetić, 2020; Passaretta et al., 2023). For instance, among those graduating in 2000, the unadjusted gender wage gap in monthly earnings five years after graduation peaks at 39% in Germany. It is lower in the Nordic countries; for example, approximately 27% in Finland (Triventi, 2013).

Fields of study are an important predictor of wages (Kim et al., 2015), and women disproportionally enroll into lower-paying fields (Ochsenfeld, 2014). Thus, women and men's diverging fields of study choices contribute substantially to the gender wage gap among tertiary educated workers in several country contexts, such as the US (Quadlin et al., 2023; Shauman, 2006), Germany (Francesconi and Parey, 2018; Goldan, 2021), and Finland (Napari, 2008). So far, however, systematic cross-national comparisons are rare. This is surprising, as graduates' career patterns – and gender differences therein – differ considerably across countries (Bol et al., 2019; Passaretta et al., 2023). In this study, we explore whether women's fields of study choices are equally detrimental to their wage trajectories in different socio-political contexts. This offers a more nuanced view on debates deeming women's fields of study choices to be a source of inequality (Bayer and Wilcox, 2019).

There are several reasons to assume that fields of study choices shape the gender wage gap differently across countries. First, research has long shown that educational systems differ in how fields of study are linked to occupations and career paths (Di Stasio &

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Van De Werfhorst, 2016; Giesecke and Schindler, 2008). Yet only a limited number of cross-nationally comparative studies have explored whether such education-employment linkages also predict gender inequality (Reimer and Steinmetz, 2009). Second, the contested 'welfare state paradox' argument suggests, amongest others, that employers potentially prefer men over women for prestigious, high-wage positions in countries with generous family policies (Mandel & Semyonov, 2006). Extensive family policies are assumed to institutionalize women's family responsibilities and heighten gender discrimination at the top. However, certain skill types and fields of study might be more protected against employers' preferential treatment than others (Estévez-Abe, 2006). The 'welfare state paradox' has given rise to numerous cross-nationally comparative studies that offer mixed conclusions (see e.g., Brady et al., 2020; Cooke et al., 2022; Mandel, 2012). We add to this research stream by asking whether highly educated women profit more from fields with strong links to occupations. We argue that women's higher returns to strongly linked fields are more pronounced in contexts, where family policies are generous.

Against this backdrop, we raise the question whether fields of study choices shape the gender wage gap differently across countries. We adopt a case-based design and compare Germany and Finland. This county selection allows us to contrast two institutional dimensions: education-employment linkages and family policies. Finland and Germany both represent countries with high levels of horizontal gender segregation (Breda et al., 2020) and strong education-employment linkages (Hannan et al., 1999, p. 24; Lindberg, 2009). Yet family policy constellations differ: Finnish family policies are generally described as more generous than German (Cooke et al., 2022; Mandel, 2012).

We explore two patterns. First, we ask if women's lower wages primarily reflect a gender-neutral match between education and employment: Women earn less than men if they graduate disproportionally from fields that are linked to lower remunerated positions (Quadlin et al., 2023; Reimer and Steinmetz, 2009). If education-employment linkages are the primary institutional feature, we expect similar patterns across the countries. Conversely, women might experience difficulties in recouping their skill investments (Quadlin et al., 2023). Following the welfare state paradox, we explore whether gender-specific returns to fields vary by the generosity of family policies (Estévez-Abe, 2006; Mandel & Semyonov, 2006). Specifically, if family policies intervene in how fields of study link to wages – and the gender wage gap – we expect different patterns across the countries. By exploring if the coupling between education and employment is linked to gender inequality and family, our findings have important socio-political implications.

Empirically, the analyses draw on 2000–2018/20 data from the German Socio-Economic Panel Study (GSOEP), the German Microcensus, and Statistics Finland to assess how the gender gap in hourly wages unfolds over the first ten years after graduation. We acknowledge that education-employment linkages differ both across and within countries (Bol et al., 2019). To capture this variation, we use a recently developed measure of field-specific pathways (Diprete et al., 2017), which – to our knowledge – has not been utilized to understand gender wage inequality among tertiary educated men and women.

2. Fields of study choices and gender inequality

While scholars generally agree that fields of study account for a sizable portion of the gender wage gap among higher education graduates, the underlying mechanisms remain debated (Murphy and Oesch, 2016; Ochsenfeld, 2014). According to the evaluative discrimination of skills, fields preferred by women are connected to unpaid, reproductive tasks and therefore subject to lower cultural appreciation and wages (England et al., 1994). Detecting devaluation empirically is challenging, as studies typically control for a restricted number of confounders (Ochsenfeld, 2014; Shauman, 2006). For instance, Bol and Heisig (2021) find that a higher share of women is associated with lower wages when accounting for different skill-related measures. The findings of Ochsenfeld (2014), in contrast, do not detect a net association between the gender composition of fields and wages.

Sorting-based mechanisms tend to view the lower remuneration of female-dominated fields as consequences of gender-specific preferences (Ochsenfeld, 2014). For instance, the specialized human capital framework maintains that men and women acquire different mixtures of general, occupation- and firm-specific human capital, which differ by investment costs, portability, and wage returns (Polachek, 1981). A crucial tenet of the argument is that women prefer fields requiring more general skills, in which family-related employment interruptions are associated with smaller earnings losses. General skills, however, yield lower earnings (Polachek, 1981, p. 64).

Several studies show that specialized fields of study, occupations, and job are associated with higher earnings and that women are underrepresented in these (Bol and Heisig, 2021; Boye and Grönlund, 2018; Perales, 2013; Shauman, 2006). The importance of specificity for gender wage inequality, however, remains contested, not least because target populations and measurements vary substantially across studies (Murphy and Oesch, 2016; Ochsenfeld, 2014; Tam, 1997). For instance, among the group of tertiary-educated workers, the findings of Ochsenfeld (2014) show that 'on-the-job training', measured at the level of fields, barely shapes the gender wage gap in Germany. Boye and Grönlund (2018), in turn, highlight that gender differences in job complexity, measured at the individual level, indeed account for tertiary educated women's lower earnings in Sweden. Finally, Grönlund et al. (2017) show that 'on-the-job' training contributes more to women's lower wages in Finland than in Sweden, Norway, and Denmark.

Apart from the transferability of skills, fields predominantly preferred by women could be connected to jobs supporting women's responsibilities for family life (Hakim, 2002; Ochsenfeld, 2014). Women might prefer female-dominated occupations because they offer family-friendly working arrangements, such as less overwork, more flexibility, or greater part-time opportunities (Bächmann

et al., 2022; Leuze and Strauβ, 2016), although these arrangements are associated with lower wages (Cha and Weeden, 2014; Leuze and Strauβ, 2016).

So far, only a few studies have compared the association between fields of study choices and gender inequality across countries. These point to some variation across countries but are mainly based on older and/or cross-sectional data, or focus on other labor market outcomes than wages (Machin and Puhani, 2003; Reimer and Steinmetz, 2009; Triventi, 2013).

3. Theoretical framework

3.1. General considerations

Fields of study are an important predictor of wages, as they connect graduates' skills to occupations and jobs in the labor market (Kim et al., 2015). This matching process can be gender-neutral: If women disproportionally opt for fields that link to lower remunerated positions, fields of study choices will account for their lower wages relative to men. Research has, however, shown that the consequences of fields vary by gender: Men and women graduating from the same field partly work in different occupations (Zheng and Weeden, 2023) and, ultimately, in differently remunerated jobs (Galos and Kulic, 2023; Quadlin et al., 2023).

In this study, we compare Germany and Finland. The countries display high gender equality in terms of opportunities and rights, but strong horizontal gender segregation in higher education (Breda et al., 2020) and the labor market (Barth et al., 2023; Hausmann and Kleinert, 2014); in Finland this segregation is somewhat stronger than in Germany (see also section A2 in the appendix). We focus on two institutional features, namely education-employment linkages and family policies.[1] We argue that education-employment linkages – on an institutional level – should foster a gender-neutral match between graduates and wages, predicting fairly similar patterns across the countries. Conversely, we assume that the matching process will be gender-specific and differ between the countries if family policies shape how fields of study choices link to wages.

3.2. Education-employment linkages and the gender wage gap

Female-dominated fields of study yield lower wages in part because they are attached to occupations with lower wages (Leuze and Strauβ, 2014). Occupational gender segregation accounts for the gender wage gap among highly-educated workers in several country contexts (Leuze and Strauβ, 2016; Triventi, 2013). Crucial for the role of fields of study, however, is whether graduates from female-dominated fields also enter and continue working in lower-remunerated female-dominated occupations and jobs (Reimer and Steinmetz, 2009). As previous research has shown, the link between educational credentials and career trajectories is stronger in some countries than in others (Giesecke and Schindler, 2008; Reimer and Steinmetz, 2009).

3.2.1. Ideal types and country cases

Scholars have traditionally differentiated between occupationalized systems and their maximum contrast, organization-based systems (Müller and Shavit, 1998). In the former, the educational system provides students with occupation-specific knowledge and skills. Employers, in turn, typically view credentials as signals of skills and rely on them. This feature supports graduates in finding jobs that match their qualifications (Di Stasio & Van De Werfhorst, 2016). The strong link between the education and employment persists beyond the initial transition, as labor market regulations, occupational boundaries, and unions foster it (Estévez-Abe, 2006; Manzoni et al., 2014). In organization-based systems, in turn, training in the educational system is more general and employers tend to rely more on on-the-job training than educational degrees (Leuze, 2007). Graduates typically enter lower positions and experience more career mobility (Leuze, 2007). Although these classifications have mainly been utilized for the VET system, they also capture country differences among higher education graduates (see e.g., Giesecke and Schindler, 2008; Leuze, 2007; Lindberg, 2009).

Earlier research has unambiguously characterized Germany as an occupationalized system with a strong coupling between education and employment (Giesecke and Schindler, 2008; Leuze, 2007), whereas school-to-work transitions in Finland have received less attention. Existing studies argue that higher education in Finland entails a higher degree of occupational specificity than traditional organization-based systems (Lindberg, 2009; Prix, 2013). Specifically, Finland is a decoupled system where signals of educational degrees remain strong (Hannan et al., 1999). This suggests that Finland displays weaker education-employment linkages than Germany, but this can be depicted as a difference of degree rather than of regime type.

3.2.2. How women's fields of study choices contribute to the gender wage gap

Since the match between the field of study and job is tight in occupationalized systems, German graduates from female-dominated fields of study should be more likely to enter matching female-dominated occupations and jobs than their counterparts in Finland. Over the course of employment, German graduates should also be less likely to change career and pursue more lucrative options in other fields, as strong boundaries restrict mobility (see also, Sacchi et al., 2016). We *hypothesize that the gender composition of fields of study*

[1] This study does not hypothesize about the size of the gender wage gap. While horizontal gender segregation contributes to the gender wage gap, its absolut size reflects several further dimensions, such as family formation and discrimination between men and women (Cooke et al., 2022).

contributes to the gender wage gap in both countries, but to a slightly greater degree in Germany than in Finland (H1a).[2,3]

3.2.3. How field-specific education-employment linkages contribute to the gender wage gap

Education-employment linkages also vary substantially across fields of study within countries (Bol et al., 2019). Previous research has distinguished between more general, academic fields (e.g., humanities, mathematics, and social sciences), occupation-specific fields (e.g., law or teaching), and applied fields, which can be located between these two types (e.g., engineering, computer science, and business) (Noelke et al., 2012). As discussed in the previous section, women are often assumed to enroll into fields with more general skill profiles (Tam, 1997).

Several theories posit that fields with specific skills or strong education-employment linkages yield higher wages. In addition to specialized human capital hypothesis (Polachek, 1981), wage advantages of strong education-employment linkages could emerge from institutionalized closure mechanisms in the labor market (Diprete et al., 2017). For instance, occupational groups can use credentials as a means to restrict access and establish a favorable supply-demand relationship between graduates and labor market positions (Weeden, 2002). Taken together, specificity should be positively associated with wages. If men are overrepresented in fields requiring specific skills, this male advantage explains both why female-dominated fields yield lower and why female graduates earn less than their male counterparts (Polachek, 1981; Shauman, 2006).

The wage advantages associated with strongly linked fields have been shown to differ across institutional contexts: Strong education-employment linkages generate greater returns in occupationalized systems, such as Germany (Di Stasio & Van De Werfhorst, 2016; Diprete et al., 2017). If graduates profit more from strong occupational pathways in Germany than in Finland, *women's lower earnings should be more strongly attributed to field-specific linkages in Germany than in Finland (H1b)*. Again, we expect the country difference to be moderate.

3.3. Family policies, fields of study, and the gender wage gap

While women, on average, graduate from fields attached to lower earnings, scholars also show that fields of study affect men's and women's wages differently (Galos and Kulic, 2023; Leuze and Strauβ, 2014; Quadlin et al., 2021, 2023). Employer discrimination is one potential mechanism, explaining why gender wage inequality is more pronounced in some fields than in others. In the following, we will argue that gender-specific returns are larger in contexts, where family policies are generous and work-facilitating.

3.3.1. Do field-specific education-employment linkages affect wages of men and women differently?

Women's role as primary caregivers is often argued to induce employer discrimination (Cooke et al., 2022). Employers might anticipate work interruptions and higher responsibility for family among women and be more reluctant to provide them with on-the-job training or offer them promotions (Estévez-Abe, 2006). This type of differential treatment should affect highly educated women particularly. For employers, family-related absenteeism is more detrimental in lucrative, high-status jobs, as training costs are higher and employees more difficult to replace (Cooke et al., 2022; Estévez-Abe, 2006; Mandel, 2012; Mandel & Semyonov, 2006). Women without children are affected, too, since employers view them as potential mothers (Estévez-Abe 2006).

Employers' possibilities to influence career trajectories – and thereby discriminate – could, however, differ by the *type* of acquired skills (Estévez-Abe, 2006, pp. 153–154). Fields of study that are connected to strong occupational pathways should protect women from discrimination, as entry and career progression are structured by educational degrees. In contrast, career advancement is likely to rely more on employer involvement in weakly linked fields. This suggests that employers' possibilities to offer women lower wages or restrict their access to internal career ladders is greater in weakly linked fields (Estévez-Abe, 2006, pp. 153–154). Thus, the positive gradient between education-employment linkages and wages is likely to be greater for women than for men.

3.3.2. Do gender-specific returns vary by the generosity of family policies?

According to the controversial 'welfare state paradox' argument (Mandel, 2012; Mandel & Semyonov, 2006), employer discrimination of women is more pronounced in family-friendly policy contexts. Policies such as long and generously compensated parental leave, the right to reduce working hours, or the right to provide for sick children allow women to reconcile family and work (Hook and Paek, 2020). These policies enhance maternal employment, amongst others, by supporting lower educated women (Korpi et al., 2013). At the same time, generous family policies institutionalize women's career interruptions and responsibility for the family (Mandel 2012). For instance, if parental leave entitlements replace forgone wages for extended periods, mothers care for young children longer

[2] Empirical studies conclude that fields of study choices contribute to women's lower earnings through occupational sorting (Leuze and Strauβ, 2014; Ransmayr and Weichselbaumer, 2023). Yet some establish an association between the gender composition of fields and wages also net of occupations. This 'net' effect has, amongst others, been interpreted as devaluation of skills (see e.g., Leuze and Strauβ, 2014).

[3] It is important to note that the association between occupational gender segregation and wages can differ between countries. The strength of this association is crucial when analysing if – and how – fields of study contribute to the gender wage gap. So far, only a restricted number of studies have analyzed cross-national variation in wage effects of horizontal gender segregation (see e.g., Bol and Heisig, 2021; Grönlund and Magnusson, 2016; Murphy and Oesch, 2016). Findings both confirm (Murphy and Oesch, 2016) or find no (Bol and Heisig, 2021; Grönlund and Magnusson, 2016) country differences in the associations between the gender composition and wages (and the gender wage gap). While more cross-nationally comparative research is warranted, a negative association between occupational segregation and wages has been established in both Germany and Finland (Grönlund et al., 2017; Leuze and Strauβ, 2016; Triventi, 2013).

at home (Nieuwenhuis et al., 2017). Research shows that high-earning and highly educated mothers respond to policy incentives prolonging work interruptions (Frodermann et al., 2023; Hook and Paek, 2020), although they have the most to lose (Cooke et al., 2022).

The 'welfare state paradox' argument holds that generous family policies penalizes highly educated women the most: As absence due to child rearing is costly, employers should be reluctant to hire women for demanding, well-paid positions in contexts with extensive family policies. Empirically, Mandel (2012) shows that policies minimizing the work-family conflict also increase gender wage gaps among high-earners and highly educated workers (Mandel, 2012).

The 'welfare state paradox' argument has encountered broad criticism (see also, Brady et al., 2020). For example, Cooke et al. (2022, p. 962) suggest that recent policy efforts to increase fathers' uptake of parental leave countervail negative effects of extensive family policies on high-wage mothers' earnings. Research also shows that gender wage gaps among highly skilled workers (Grönlund and Magnusson, 2016) and top earners (Cooke et al., 2022; Korpi et al., 2013) are not consistently larger in countries with extensive family policies.

3.3.3. Family policies in Germany and Finland

Germany and Finland differ in the generosity of their family policies. (West) Germany has historically been one of Europe's most established male breadwinner regimes. Policies such as joint taxation, generous child benefits, low availability of early childcare and education (ECEC), and long child-rearing leaves with low compensation rates have encouraged one- or one-and-a-half-earner arrangements (Evertsson et al., 2016). Since the mid-2000s, Germany has introduced several policies aimed at increasing maternal employment. The substantial parental leave reform in 2007 replaced the flat-rate, partly means-tested benefit with an earnings-related scheme of 12 months. It also added two bonus months if the other parent uses at least two months (Frodermann et al., 2023). Public provision of childcare has expanded, although availability is still insufficient and regional variation is pronounced (Zoch, 2020). One-and-a-half-earner arrangements are still visible in high part-time employment rates among women and mothers (Cooke et al., 2022; OECD, 2020).

Finland, together with the other Nordic countries, instituted strong support for dual-earning/dual-caring arrangements early on via a set of policies such as individual taxation, universal, earnings-related parental leave entitlements, and a right to publicly subsidized, full-time childcare for young children (Grönlund et al., 2017; Grönlund and Magnusson, 2016). Since the 1990s, earnings-related parental leave has been available for approximately 10 months, after which families can obtain a flat-rate, cash-for-care benefit provided until the child's third birthday (Grönlund et al., 2017; Närvi et al., 2022). 'Fathers-only leave' was introduced in 2003 and extended in 2010 and 2013 (Saarikallio-Torp and Miettinen, 2021), but mothers continue to use approximately 90% of all leave (Kela, 2020). It is worth noting that a new leave scheme has been implemented in August 2022, increasing the non-transferable leave quota to fathers to 3.9 months (Närvi et al., 2022). To date, Finland has invested a larger share of its GDP in ECEC than Germany (OECD, 2020) and displays a higher maternal employment rate than Germany, particularly in full-time employment (OECD, 2020).

Following the 'welfare state paradox' argument, we assume that employers' incentive to discriminate against women is stronger in Finland than in Germany. For instance, the Finnish earnings-related parental leave entitlements coupled with a cash-for-care benefit encourage also tertiary educated women to interrupt longer than corresponding leave regulations in Germany (Frodermann et al., 2023; Miettinen and Saarikallio-Torp, 2023). These differences are also visible in child bearing patterns (Nisén et al., 2021). The lower compatibility of work and family life has furthered postponed childbirths in Germany among highly educated women (Braakmann, 2013; Raab and Struffolino, 2020), and childlessness is high in this group (Bujard, 2015). In Finland, in turn, highly educated women display lower rates of childlessness than low educated in recent cohorts (Jalovaara et al., 2021).

Turning to education-employment linkages, this suggests that *women should profit more from occupation-specific fields relative to men in Finland than in Germany (H2a)*. If, however, family-friendly policies do not induce stronger employer discrimination, as argued by the critics of the 'welfare state paradox', we expect *no country difference in the gender-specific effects of education-employment linkages (H2b)*.

4. Data sources and statistical modeling

4.1. Data and sample selection

This study traces wage trajectories of tertiary degree holders in Finland and Germany from the year of graduation until the tenth year after obtaining a degree (i.e., for a maximum of eleven years) in the time frame 2000–2018/2020. To create comparable groups, the definition of tertiary degree holder differs between the countries. While higher education in both countries encompasses university and non-university institutions (*universities of applied sciences*), they differ with regard to stratification. In Germany, the main difference is not in recognition, but rather in the knowledge transmitted, as universities of applied sciences (*Fachhochschulen*) focus more on practical and universities on academic knowledge. Labor market outcomes of graduates do not vary substantially by type of tertiary degree (Leuze, 2007). By contrast, the Finnish higher education system entailed only universities until the mid-1990s. Universities of applied sciences (*ammattikorkeakoulu*) emerged as a result of a reform in which 2–3 year long intermediate, vocational training programs (*opisto*) were standardized and gradually upgraded to the tertiary level as Bachelor's degree programs (Prix, 2013). Studies consistently report lower labor market returns among non-university graduates (Prix, 2013; Sirniö et al., 2016). Therefore, this study excludes BA graduates from non-university institutions in Finland.

Individual-level wage trajectories are based on two longitudinal data sets: the German Socio-Economic Panel Study (GSOEP, v37) and register-based data provided by Statistics Finland. For Germany, the analyses are conducted on 2450 individuals (9999 person-

years) who obtained a BA or higher degree from a German tertiary education institution in 2000–2016, following their employment patterns for the first ten years or until 2020. This period is required to guarantee a sufficient sample size.[4] For Finland, we use full-population data (FOLK module), which includes individuals who lived in Finland for at least one year between 1987 and 2020. Information on wages is obtained from the harmonized Structure of Earnings data, a subsample based on the FOLK data that provides detailed accounts on wages, working time, and occupations.[5] The analyses are conducted on 161,714 individuals (984,616 person-years) who received a lower (*Bachelor's*) or higher (*Master's, PhD*) degree in 2000–2014, covering their wage trajectories in the time frame 2000–2018. For both countries, the sample is restricted to individuals aged 22–35 when graduating and excludes graduates whose degree was obtained abroad, self-employed people, students, and observations with missing values on covariates. Individuals that obtain a further degree in another field of study are censored.

The analyses focus on two characteristics of fields of study, namely their gender composition and the extent to which they are linked to specific occupations in the labor market. These characteristics are for Germany generated in Mikrocensus (waves 2000, 2003–2016) – a representative sample of 1% of the German population – to ensure that single fields entail enough individuals. Field characteristics are matched to the individual-level trajectories in GSOEP. Estimations in Mikrocensus are weighted. For Finland, these predictors are calculated by means of the full population (FOLK) and the harmonized Structure of Earnings data. Education-employment linkages are based on weighed data.

4.2. Variables

The analysis utilizes the natural logarithm of the hourly wage as a dependent variable.[6] It focuses on fields of study as a key explanation for the gender wage gap over the first ten years after graduation. Field characteristics are based on the detailed ISCED 2013 classification and aggregated for each graduation year separately. We then use the *average* value of the time period.[7] We identify 39 different fields for Germany and 43 for Finland (see Table A1 and discussion in A1, appendix). The *gender composition* of fields of study expresses the percentage of women in each field among tertiary degree holders aged 23–35. Fields with fewer than 30 graduates are combined with larger fields. While the multivariate analyses include gender composition linearly (in 10% steps), the descriptive analyses separate between female-dominated (at least 70% women), male-dominated (less than 31% women), and integrated fields (the middle of this continuum) to aid interpretation.

To measure the link between fields of study and labor market positions, we follow Diprete et al. (2017) and use an entropy-based measure. This approach differs from several previous studies on graduate employment, which have classified fields as either general or occupation-specific (see e.g., Noelke et al., 2012). A further approach involves measures of employer-provided on-the-job training and further education (Ochsenfeld, 2014), the degree of specialization required for the job (Boye and Grönlund, 2018), or specific tasks performed at work (Bol and Heisig, 2021). While valuable, these measures conflate firm- and occupation-specific human capital and do not determine if specificity is a characteristic of the degree or the job.

Instead, the "local linkage score" (Diprete et al., 2017) captures for each field of study whether its degree holders work in a broader or narrower range of occupations. Put simply, if those with a degree in human medicine mainly work in a few occupations, such as physicians, this indicates a narrower range of occupations, i.e., a stronger linkage between fields of study and occupations. Conversely, if graduates spread across a wide range of occupations – a pattern more typical in humanities or business – the local linkage score will assume a lower value (see also, Bol et al., 2019). The field-specific linkage score is denoted as

$$M(ed)_g = \sum_j p_{j|g} \times \log\left(\frac{p_{j|g}}{p_j}\right), \tag{1}$$

where $p_{j|g}$ represents the probability of working in occupation j conditional on graduating from field g, and p_j the unconditional probability of working in occupation j (irrespective of degree) (Diprete et al., 2017, pp. 1920–1921). The local linkage score estimates how the distribution of tertiary degree holders with a field-specific degree across occupations differs from the overall distribution of workers across occupations. The score assumes a high value if the linkage between fields of study and occupations is strong. Conversely, a value of 0 indicates that graduates from a specific field do not cluster in occupations more than the overall occupational distribution (Elbers et al., 2021, p. 1121). The estimator is based on all workers aged 15–64 and requires each field to entail at least 75 tertiary degree holders (Bol et al., 2019; DiPrete et al., 2017). Occupations are captured by 3-digit ISCO-88 codes. In the multivariate analyses, we standardize the index. Table A1 (appendix) displays the average gender composition, local linkage score, and the relative size of each field of study.

[4] Information on the time of graduation from higher education originates from two sources. For ca 68% of the sample graduation was surveyed in the annual questionnaires, whereas 32% reported the year of graduation in the retrospective biography questionnaire.

[5] As the Structure of Earnings Data is collected from various sources, coverage varies by year and sector. It is important to note that small co-operates (less than five individuals) are excluded. For more information, see Statistics Finland (2024).

[6] For Germany, the hourly wage is estimated as (gross monthly earnings + overtime compensation/weekly working hours including paid overtime/4.345). In both countries the wages are deflated using the consumer price index. Wages are trimmed at the 99th percentile.

[7] For instance, in Germany the share of women in human medicine increased from 53% in 2000 to 62% in 2016; the corresponding rise in Finland is 64% (2000) to 66% (2014). Graduates from human medicine obtain the average value over the time period (57% in Germany and 65% in Finland).

The analyses control for *individual- and macro-level covariates* shown to predict both wages and the gender wage gap. These covariates could also affect the association between fields of study characteristics and wages. First, we control for the type of higher education degree, as degrees vary systematically across fields of study (Goldan, 2021; Lörz et al., 2015) and affect wages (Leuze and Strauβ, 2014). Second, we adjust for all years spent in full- and part-time employment and its quadratic term. Part-time experience is weighed with 0.5. Although child-related employment interruptions are one important source of women's lower labor market experience (Evertsson et al., 2016), part-time work is also more common in female-dominated than in male-dominated occupations (Bächmann et al., 2022). We also account for the age of the youngest child and having a partner in the household, as the choice of a field could be related to anticipation of family life (Polachek, 1981; but see also Mann and DiPrete, 2013). Finally, we control for ethnic background and whether respondents were older than 32 years when graduating.

Previous studies differ in how they consider employment characteristics. Employment characteristics partly alter the association between fields of study characteristics and wages, as graduates work in differently remunerated occupations and jobs *as a result* of their fields of study choices (Leuze and Strauβ, 2014). Following Ochsenfeld (2014, p. 542), we argue that controls for such mediating processes would bias the estimates (see also, Bol et al., 2019; Bol and Heisig, 2021). This decision has implications for the interpretation of estimates. The selected field characteristics – the gender composition and education-employment linkages – measure *occupational sorting* that is related to fields of study. The female slope, in turn, captures occupational gender segregation that occurs irrespective of field of study choices (see also, Ochsenfeld, 2014, p. 542). This also applies to other characteristics of the job: If female-dominated fields yield lower wages due to their proximity to the public sector or smaller firms (Mandel, 2012), this will be reflected in the estimates for fields of study. Again, gender differences in employment unconditional on fields of study are measured in the female slope.

Finally, to control for macro-structural trends, we include the annual unemployment rate and percentage changes in GDP, the time period in which graduation occurred (*hereafter graduate cohort*), and for Germany, whether respondents live in the East or West. For Germany, we also consider whether the school-to-work transition was observed in the panel or recorded retrospectively (see footnote 4). All continuous predictors are centered around the grand mean. Table A2 (appendix) shows the distribution of the main covariates for both countries by gender.

4.3. Methodological approach

We use a three-level design with wage observations (t) nested in individuals (i) (*level 2*), who, in turn, are nested in fields of study (g) (*level 3*). We utilize a random-intercept model (Rabe-Hesketh and Skrondal, 2022)

$$y_{tig} = \beta_1 + \beta_2 w_{1g} + \beta_3 w_{2g} + \beta_4 female_{ig} + \beta_5 X_{tig} + \zeta_{ig}^{(2)} + \zeta_g^{(3)} + \epsilon_{tig} \quad (2)$$

where y_{tig} is the logarithm of the hourly wage for individual i at time point t, $\beta_2 w_{1g}$ the gender composition of fields of study and $\beta_3 w_{2g}$ their local linkage score, $\beta_4 female_{ig}$ the gender of graduates, $\beta_5 X_{tig}$ the observed controls, and ϵ_{tig} the first-level error term. The model includes an individual $\beta_1 + \zeta_{ig}^{(2)}$ and a field-specific $\zeta_g^{(3)}$ random intercept.[8]

The models are estimated using a restricted maximum likelihood estimator; confidence intervals in Figs. 3 and 4 are calculated using the *t*-distribution with 40 (Finland) and 36 (Germany) degrees of freedom (see Elff et al., 2021). To assess whether the association between education-employment linkages and hourly wages is gender-specific, we estimate the full model separately for men and women. This approach simultaneously considers that the association between the gender composition of fields and wages can differ between men and women (see e.g., Leuze and Strauß, 2014). We also interact the female slope with both fields of study characteristics, specifying the female slope as a random coefficient (Heisig and Schaeffer, 2019). As this design cannot test for causal differences, we report on trends in Germany and Finland and focus on the direction of effects.[9]

4.4. Supplementary analyses

The analyses draw on wage trajectories of higher education graduates entering the labor market at different time points. This means that the composition of the sample, the distribution of covariates, and effects can change over time. We address such changes over time both descriptively and analytically. First, Table A3 shows how the sample composition has shifted over time, while Figs. A2 and A3 depict changes in fields of study characteristics. Second, we consider that the association between fields of study and wages can vary over time by estimating models for different graduate cohorts (Prix, 2013). For Finland, the large sample size allows us to estimate models for each graduate cohort separately, whereas the German sample is divided into two time periods: before and after the substantial parental leave reform in 2007 (Mari and Cutuli, 2021). This strategy also adds to our substantive understanding: Changes in family policies over time *within* the countries should predict similar patterns as *between* the countries. Specifically, extensions of father-only leave should *reduce* the female-advantage in the strength of education-employment linkages in Finland, while the 2007 reform in Germany should increase gender differences in the associations.

[8] The data structure could also include a further random intercept for the combination of "field of study X graduation cohort". We opt for three levels and control for graduation cohort (results on four-level specifications available upon request).

[9] To compare coefficient estimates between the countries, we estimate t-tests, assuming no covariance.

We also explore whether our main conclusions are sensitive to specifications. For instance, robust standard errors should be applied if the covariance structure is incorrect, but these require (in Stata) a maximum likelihood estimator (Rabe-Hesketh and Skrondal, 2022). When the number of higher-level clusters is limited, however, a restricted maximum likelihood estimator is advisable (Elff et al., 2021; Rabe-Hesketh and Skrondal, 2022). We discuss these and other issues in section C2 (appendix).

5. Results

5.1. Descriptive results

Fig. 1 gives a first impression of how the hourly gross wage differs between men and women on average during the first ten years after graduating from higher education in Germany and Finland. Although women already earn less than men in the first years after graduation, men experience steeper wage growth than women in both countries. On average, highly educated men earn approximately 15% more than women during the first 10 years in Germany and 13% in Finland (Table 1), although the wage gap grows substantially over the course of employment. The difference between the countries is less marked than in previous studies assessing monthly earnings (Triventi, 2013).

Table 1 depicts the main predictors for men and women separately. In both countries, men and women opt for different fields of study. Segregation by gender appears somewhat stronger in Finland, but supplementary analyses reveal that this country difference reflects the marginal distribution (see Fig. A1 and discussion A2 in the appendix).

As shown in Table A1 (appendix), the gender composition of single fields follows similar patterns in both countries, with some notable differences in life sciences and humanities, where medicine, biology, and languages entail a higher share of women in Finland than in Germany. In the majority of fields, the share of women increases moderately over time, although the shift has been more pronounced in some fields, such as law (see Fig. A2).

Regarding field-specific education-employment linkages, variation seems to be more marked across fields than countries (Fig. 2). In fact, single fields, such as teaching, physics, and electrical engineering, display almost identical values in both countries. Medicine, law, but also theology represent fields with strong linkages to specific occupations and the linkage-strength assumes values around 3 and 4. History, language acquisition, and business, in turn, are weakly linked with values close to 1. It is worth noting that several fields in both countries have experienced a decrease in the strength of education-employment linkages over time, but overall patterns across fields and countries remain stable (see Fig. A3).

However, most importantly, the results reveal that women in both countries graduate on average from fields displaying stronger education-employment linkages than men (see Table 1). The positive correlation between the local linkage score and the share of women in a field underpins this pattern (see Table A1). The descriptive findings contrast the assumption of stronger occupation-specific pathways among men and in male-dominated fields of study. Instead, these findings highlight that a focus on occupation-specific rather than firm-specific specialization yields different conclusions about men and women's fields of study choices.

5.2. Multivariate results

Figs. 3 and 4 present the findings of the step-wise models for both countries (see Tables A4 and A5 for full models and Figs. A4 and A5 for cohort-specific models). The baseline model (M0) displays the female coefficient from a linear random-intercept regression, with wage observations nested in individuals, to demonstrate the gender wage gap without fields of studies. The following models are based on the three-level random-intercept specification.

The first two models (Fig. 3) confirm well-established findings. In both countries, tertiary-educated women earn approximately 9–10% less than men net of individual-level controls (M0). However, more importantly, fields of study choices contribute substantially to highly educated women's lower wages. In both Finland and Germany, the female coefficient decreases by (almost) a half when the models take the variance structure of fields of study into account (M1)[10]. Overall, this pattern highlights that fields of study are an important layer for understanding gender wage disparities in countries where horizontal segregation in higher education is strong and educational credentials structure labor market trajectories.

Do the gender composition of fields and the linkage between fields and occupations contribute to gender wage disparities more in Germany than in Finland? First, we consider the gender composition of fields (Fig. 3, M2). For Germany, the estimate obtained by the longitudinal analysis largely complies with previous cross-sectional findings (see e.g., Ochsenfeld, 2014): A 10% increase in the share of women in a given field is associated with an approximate 3% decrease in wages. The gender wage gap is also reduced, although the shift is small (see Leuze and Strauβ, 2014 for a similar decrease). In Finland, the association between the gender composition and hourly wages is negative, but appears weaker. At first glance, the results suggest that graduates from female-dominated fields are

[10] It is worth noting that the female coefficient in M1 reflects both within- and between variation across fields of study. Centering 'being female' around the share of women in a field (CWC) yields a larger reduction in effect size in Germany. This coefficient expresses within-variation and is consistent with the subsequent model M2 (see also, Enders and Tofighi, 2007)

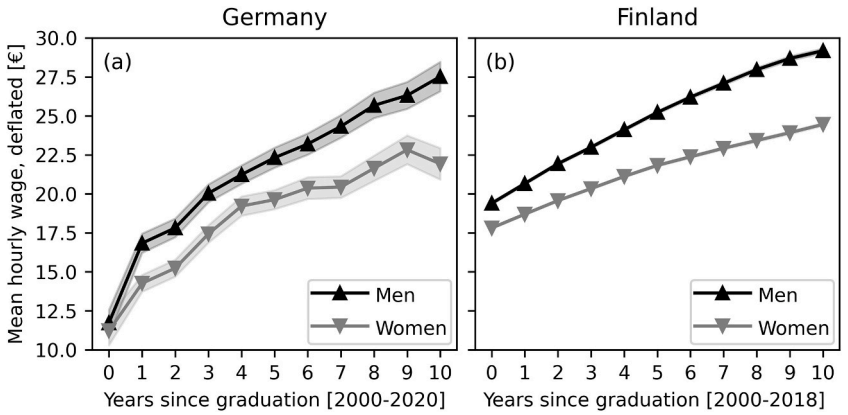

Fig. 1. Mean hourly gross wage (in Euro) during the first ten years after graduation in Germany and Finland (95% confidence intervals).
Source: GSOEP (v37); Finnish full-population data (FOLK) merged with the harmonized Structure of Earnings.

Table 1
Descriptive statistics for main predictors of samples by gender (person-years).

	Germany				Finland			
	Women		Men		Women		Men	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Hourly wages (€)	18.32	(7.97)	21.56	(8.75)	21.21	(6.72)	24.44	(7.51)
Share of women in fields of study (%)	59.92	(17.65)	42.31	(21.51)	68.38	(19.28)	43.74	(23.78)
Gender composition of fields of study								
Male-dominated field	7.8		35.8		6.5		40.3	
Integrated field	48.9		49.0		39.3		42.7	
Female-dominated field	43.4		15.2		54.3		17.0	
Local linkage strength	1.97	(0.82)	1.80	(0.74)	2.17	(0.84)	1.86	(0.71)

Source: For Germany, individual-level trajectories are based on the GSOEP (v37), while fields of study characteristics are generated in Microcensus (2000, 2003–2016). The Finnish models merge full-population data (FOLK) with Structure of Earnings; estimates are weighed.

allocated to lower-remunerated positions particularly in the occupationalized German labor market.

The subsequent models add the field-specific education-employment linkage (M3). The strength of education-employment linkages is positively associated with wages in both countries, although the effect is not statistically significant ($p < 0.05$) in Germany (see also, Bol et al., 2019). For Finland, a standard deviation increase in linkage strength – a difference between e.g., law and physics – is associated with a 7% increase in hourly wages. Thus, graduating from a field connected to specific occupational pathways is an advantage in Finland, at least in the first ten years after graduation (see also section C, appendix). Supplementary analyses indicate that effect sizes are larger for more recent Finnish graduate cohorts (see Fig. A4). But most importantly, findings seem to contradict the specialized human capital hypothesis, as occupation-specific skill profiles neither account for the gender wage gap nor for the gender composition of fields of study. Instead, the multivariate results underpin the descriptive findings: In both countries education-employment linkages slightly strengthen the influence of the gender composition on wages. For instance, in Finland, the coefficient estimate for gender composition shifts from −1.4% (M2) to −2.3% (M3) once linkage strength is included.[11] Turning to the hypothesized country difference, our findings, overall, point to similar patterns in Germany and Finland.

Finally, we raise the question of whether fields of study influence wages of male and female graduates differently. We assumed that women would experience larger gains from strongly linked fields in Finland, where generous family policies should heighten employer discrimination (*H2a*). However, we also noted that several studies detect little differences in gender wage gaps at the top by family policy models (*H2b*). Our results indicate that the association between field-specific education-employment linkages and wages differs between men and women, but only in Finland. In Finland, the benefits from strongly linked fields are more pronounced among women

[11] It is important to note that this suppressor effect also holds true for the field-specific local linkage: The association between education-employment linkages and wages is weaker once when models exclude the gender composition (results available upon request).

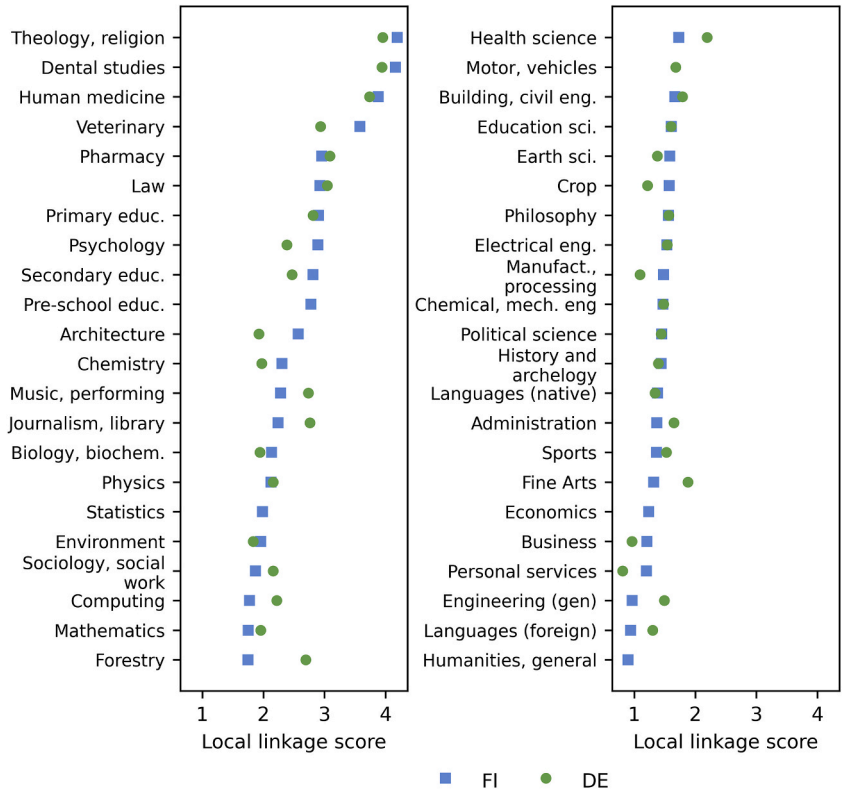

Fig. 2. Field-specific linkage strength in Germany and Finland.
Source: Microcensus (2000, 2003–2016); FOLK merged with the harmonized Structure of Earnings (2000–2014).

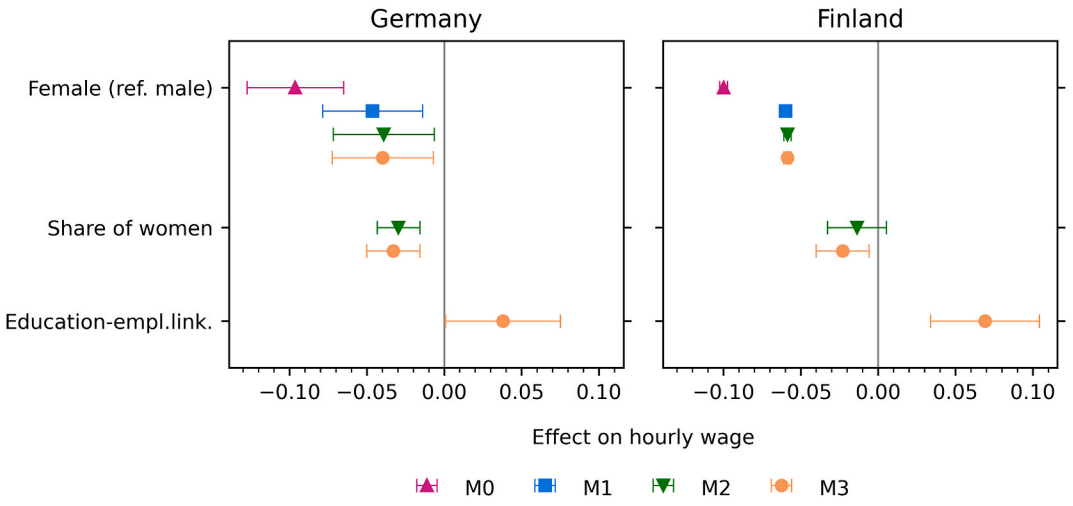

Fig. 3. Effect of gender and fields of study characteristics on logarithm of gross hourly wages
Notes: Estimates of a random-intercept model with 95% confidence intervals. The share of women in a given field is estimated in 10% increases. The models include controls for the type of degree, labor market biographies, family formation, graduate cohort, ethnic background, age at graduation, macro-structural trends, and for Germany, a sample characteristic and region.
Source: For Germany, individual-level trajectories are based on the GSOEP (v37 2000–2020), while fields of study characteristics are generated in Microcensus (2000, 2003–2016). The Finnish models merge full-population data (FOLK) with Structure of Earnings (2000–2014).

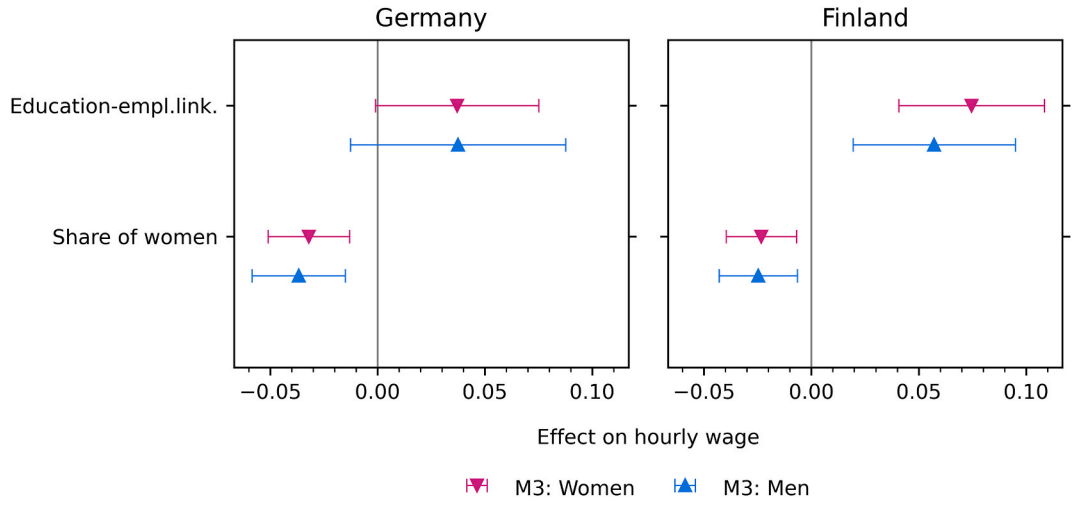

Fig. 4. Gender-specific effects of study characteristics on gross hourly wages
Notes: Estimates of a random-intercept model with 95% confidence intervals. The share of women in a given field is estimated in 10% increases. The models include controls for the type of degree, labor market biographies, family formation, graduate cohort, ethnic background, age at graduation, macro-structural trends, and for Germany, a sample characteristic and region.
Source: For Germany, individual-level trajectories are based on the GSOEP (v37 2000–2020), while fields of study characteristics are generated in Microcensus (2000, 2003–2016). The Finnish models merge full-population data (FOLK) with the harmonized Structure of Earnings (2000–2018).

than men, as indicated by the larger effect sizes: A standard deviation increase in linkage strength is associated with a 7.8% wage gain among women, compared to 5.9% among men. The cross-level interaction between the education-employment linkage and the female slope confirms this pattern both for the pooled sample and the vast majority of graduate cohorts (see Table A5 and Fig. A5). Thus, the gender wage gap in Finland seems to be larger in weakly than in strongly linked fields.

Cohort-specific analyses further imply that the female-advantage attenuates over time and is somewhat weaker among more recent graduates in Finland (Fig. A5). This pattern aligns with our assumption that policy efforts to support 'father-only leave' could countervail discrimination against women (see also, Cooke et al., 2022). Yet our design cannot disentangle time trends. For Germany, neither the pooled nor the cohort-specific models establish gender differences in the association between education-employment linkages and wages.[12] Finally, contrary to previous studies on Germany (Leuze and Strauβ, 2014), we do not find substantial gender differences in the association between the gender composition of fields and wages.

Overall, our findings suggest that strong occupational pathways protect highly-educated women from lower-remunerated positions if the policy context institutionalizes women's responsibilities for family and work (*H2a*). However, this does not corroborate a more general interpretation of the 'welfare state paradox', according to which gender wage gaps at the top are larger in family-friendly policy contexts (Mandel, 2012). On the contrary, across all modelling steps gender gaps in hourly wages among tertiary educated men and women are fairly similar in Germany and Finland. Instead, the results lend some support to the intersection between skills and gender: Women seem to experience the lowest wages in weakly linked fields in countries, where employers' incentive to invest in them is lower (Estévez-Abe, 2006).

6. Discussion and conclusion

Previous research has repeatedly highlighted that fields of study are an important source of earnings inequality between tertiary educated men and women. So far, only a few studies have assessed cross-national variation in this relation. This study analyzed the gender wage gap during the first ten years after graduation in two different institutional contexts, namely Finland and Germany. We explored two distinct patterns: Skill regimes could allocate graduates from a given field of study to a corresponding position in the labor market, thereby generating gender differences in wages. On the other hand, fields of study could predict wages of men and women differently. Contrary to most earlier studies on gender wage inequality among higher education graduates, we employ a detailed, field-specific measure of the link between educational credentials and occupations (DiPrete et al., 2017).

This investigation yields several noteworthy findings. First, fields of study choices contribute to the gender wage gap in both Germany and Finland. In both countries we also find a negative association between the share of women in a field and hourly wages

[12] The coefficient estimate for the cross-level interaction between the 'education-employment linkage' and the female slope is 0.019 (SE: 0.005) in Finland and 0.002 (SE: 0.018) in Germany (Tables A4 and A5, appendix). A *t*-test shows that we cannot reject the null hypothesis of no difference at conventional levels. This is not surprising, as the estimate is imprecise for Germany. While the country difference is not statistically significant, several model specifications yield the same country pattern: Our analyses show little evidence in favour of gender-specific effects of education-employment linkages in Germany, but suggest a stronger association for women than men in Finland (see also discussion C).

once models adjust for field-specific education-employment linkages. As such, this finding is consistent with our assumptions: In countries, where educational degrees structure labor market trajectories, graduates from female-dominated fields should be more likely to enter lower remunerated (female-dominated) occupations and jobs (Reimer and Steinmetz, 2009). We cannot, however, disentangle if fields of study mainly operate through occupational sorting, or whether fields also shape wages through other mechanisms (Leuze and Strauβ, 2014). Future analyses would profit from considering a country with lower horizontal segregation and a weaker coupling between educational credentials and career progression. For instance, a higher share of women does not predict wage disadvantages in high-skilled or highly remunerated occupations in the UK and US (Brynin and Perales, 2016; Busch, 2018). Thus, the interplay between the level of horizontal segregation, education-employment linkages, and wages needs further scrutiny.

Second, education-employment linkages do not contribute to women's lower wages. On the contrary, in both countries women, on average, graduate from fields with stronger occupational pathways. As such, this finding is at odds with the assumption that women refrain from occupation-specific human capital due to anticipated interruptions. The lower wages attached to female-dominated fields do also not seem to reflect weaker education-employment linkages (see e.g., Tam, 1997). More specifically, the findings highlight the need to distinguish firm-specific on-the-job training from occupational specificity conceptually and empirically. Weaker occupational pathways could in certain fields reflect upward mobility and internal career ladders (Sacchi et al., 2016). The role of occupational pathways might also vary over the career trajectory and across sectors.

Finally, the final models suggest that the coupling between the educational system and the labor market is gender-specific in Finland. In Finland, the gender wage gap is larger among those who graduated from a weakly linked field of study. Theoretically, the findings support the assertion that highly educated women profit more from occupation-specific careers with lower employer involvement if policies institutionalize women's responsibilities for families (Estévez-Abe, 2006; Mandel, 2012). Occupational pathways might be less important for men, as they experience wage progression through promotion in skills-intense internal labor markets, whereas women might encounter difficulties in accessing such career ladders. For Germany we did not detect a similar pattern. Instead, our results imply that fields of study primarily allocate German higher education graduates to labor market positions gender-neutrally.

Although our findings do not support a general interpretation of 'the welfare state paradox', family formation on an institutional level seems to intervene in the matching process in Finland, hampering women's wages in fields, where employer involvement, presumably, is more important (Estévez-Abe, 2006). It is unclear whether these findings can be generalized to other family-friendly policy contexts, namely Scandinavia, or to countries aiming to strengthen their 'dual-earner/dual-carer' policies. For instance, by both Scandinavian and international standards Finnish parental leave regulations encourage long employment interruptions (Grönlund et al., 2017; Hook and Paek, 2020), and childbirth continues to affect Finnish mothers' careers more than fathers (Kela, 2020). We encourage future research to contrast the findings with a country offering meager family policies, such as the US. Nonetheless, it seems likely that the wage gap between tertiary educated men and women remains larger in weakly linked fields, if career trajectories are strongly gendered.

It is important to note that our analyses cannot elaborate on mechanisms. We suggested that the lower remunerations of weakly linked fields in Finland, more pronounced among women, reflect a restricted access to career ladders. Yet women might also opt for positions with more family-friendly working arrangements and lower wages. Overall, however, the results emphasize the need to explore the consequences of horizontal segregation from a cross-nationally comparative perspective. To understand *when and why* fields of study choices have long-term consequences for wage inequality between men and women, it is crucial to assess how horizontal segregation interacts with other institutional features.

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CRediT authorship contribution statement

Anna Erika Hägglund: Conceptualization, Formal analysis, Methodology, Writing – original draft, Writing – review & editing.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ssresearch.2024.103029.

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