Journal of Population Economics (2023) 36:1049–1097
https://doi.org/10.1007/s00148-022-00900-6

ORIGINAL PAPER

Gendered university major choice: the role of intergenerational transmission

Julia Philipp[1]

Received: 26 October 2020 / Accepted: 4 April 2022 / Published online: 6 June 2022
© The Author(s) 2022

Abstract

In this paper, I study the role of gender-typical parental occupation for young adults' gender-typical university major choice using data on a recent cohort of university students in Germany. Results show significant intergenerational associations between the gender typicality in parental occupation and young adults' majors. As to why these effects occur, findings suggest that the transfer of occupation-specific resources from parents to their children plays an important role and that a transmission of gender roles explains at least some of the father-son associations. The paper contributes to existing literature by introducing a novel measure that operationalises the extent to which majors and occupations are 'typically female' or 'typically male' and by studying different transmission channels.

Keywords Gender norms · Gender roles · University major choice · Intergenerational transmission

JEL codes: I23 · J16 · J24 · Z13

1 Introduction

Gender differences in the labour market persist despite narrowing gaps between men and women in labour force participation, earnings, and occupations since the mid-twentieth century. The gender earnings gap in particular has received increased attention over the past decade. One fact emerging from research is that the gender gap in earnings tends to be wider among university graduates than among those with lower education levels (Goldin et al., 2017; OECD, 2020).

Responsible editor: Klaus F. Zimmermann

✉ Julia Philipp
j.k.philipp@lse.ac.uk

[1] London School of Economics, Houghton Street, London WC2A 2AE, UK

Existing literature suggests that an important part of the gender pay gap among university graduates stems from choices made earlier in the life course, namely university majors (Brown and Corcoran, 1997; Charles and Bradley, 2002; Machin and Puhani, 2003; Black et al. , 2008). Men are more likely than women to study STEM (science, technology, engineering, mathematics) fields. Women are overrepresented in humanities, social sciences, and educational sciences (Leuze and Strauß, 2009).

Women are more likely to choose majors that typically lead to occupations with lower earnings and fewer opportunities for career progression (Charles and Bradley, 2002; Blau and Kahn, 2017). Gendered major choices thus have direct consequences on occupational segregation, on wage gaps, and on so-called glass ceilings—the idea that there are invisible barriers that prevent women from achieving top incomes and positions (Ponthieux and Meurs 2015; Bertrand, 2018). Sex segregation by university major also has important indirect consequences. For example, it may reinforce existing gender norms and stereotypes, thereby limiting the perceived educational choices of future generations (Charles and Bradley, 2009).

Most research seeking to explain the determinants of gendered major choices focuses on one of two types of factors. Some show the relevance of individual-level characteristics. These include personality traits such as competitiveness, beliefs about enjoying coursework, and preferences over expected jobs (Antecol and Cobb-Clark, 2013; Zafar, 2013). Others focus on the role of the social environment such as teacher role models or sex of high school peers (Carrell et al., 2010; Brenoe and Zoelitz, 2019). However, few studies have investigated the role of parents in shaping the choice of university major (e.g. Humlum et al. 2018; Vleuten et al. 2018). This is despite the fact that parents transmit occupation-specific resources to their children (Vleuten et al., 2018). Moreover, children observe and learn from the gender roles enacted by their parents (Crouter et al., 1995; Platt and Polavieja, 2016). For example, children learn about the degree to which their parents follow traditional gender roles by observing their occupations (Polavieja and Platt, 2014). This is because occupations differ in the degree to which they are regarded as typically female or typically male.

The aim of this paper is to analyse whether the degree of femininity of mothers' occupation and the degree of masculinity of fathers' occupation affect whether their adult children choose gender-typical majors at university and to study underlying transmission channels, using Germany as a case study. Specifically, I distinguish between the transmission of occupation-specific parental resources and the transmission of gender norms. To capture the degree to which a mother's occupation is regarded as typically female, I construct a rank-based measure based on the share of women in the occupation she held when her child was aged 15. I call this measure 'femininity rank of mothers' occupation' or 'mothers' rank'. Similarly, I construct masculinity rank in fathers' occupations (fathers' rank), masculinity rank in sons' majors (sons' rank), and femininity rank in daughters' majors (daughters' rank). I use the term 'gender-typicality rank' to refer to masculinity and femininity rank at the same time. Similarly, I use 'gender-typical' when referring to typically male and typically female majors simultaneously.

I exploit unique survey data of a nationally representative cohort of first-year undergraduate students in Germany in 2010. Using regression analysis, I examine the association between femininity rank of mothers' occupation and masculinity rank of fathers' occupation on the one hand and the gender-typicality rank of young adults' university majors on the other hand. I thereby capture intergenerational positional changes in each person's position relative to others of the same cohort and sex.

Germany is an important case study because its labour market exhibits low occupational mobility. This means that initial major choices at university have long-lasting effects on career outcomes, such as lifetime earnings (Aisenbrey and Brückner, 2008). Approximately three-quarters of the gender earnings gap at labour market entry in Germany is explained by university major choice (Braakmann, 2008). This matters especially given that the gender pay gap in Germany is particularly high among university graduates. In 2006, women with Abitur (school-leaving certificate) and a vocational qualification earned 38% less than equally qualified men, while tertiary-educated women earned 42% less than men with comparable qualifications (OECD, 2008).

I find that sons choose less typically male majors if their fathers worked in less typically male occupations, as measured by their respective 'masculinity rank'. Sons' choice is not correlated with their mother's occupation. Daughters choose more typically female majors if their fathers worked in less typically male occupations and if their mothers worked in more typically female occupations. While the father-son and father-daughter associations hold generally, the mother-daughter association is statistically significant only under certain conditions: if mothers possess tertiary education, if mothers were employed, and among those living in East Germany. Moreover, the relationship between mother's occupation and child's major appears to be linear, whereas for fathers there are important nonlinearities. Specifically, results from quantile regressions and heterogeneity analyses show that the significant effects appear to be driven by fathers and students in less gender-typical occupations and university majors, suggesting that fathers in gender-atypical occupations can help break gender stereotypes and that the findings of the paper are at least partially driven by sons and daughters who defy gender-stereotypical major choices. In terms of effect size, a one standard deviation increase in masculinity rank in fathers' occupation is associated with a 3% decrease in daughters' femininity rank and a 5% increase in sons' masculinity rank in major.

As to why these effects occur, a large part of the results appears to be driven by children choosing a major that is closely related to parental occupation.[1] This supports a 'direct transfer of resources' channel, that is, the transfer of occupation-specific skills, resources, and networks from parents to their children. The results also suggest that at least some of the father-son associations are due to a transmission of gender roles, as embodied by fathers via the gender typicality of their occupation.

[1] I use the verbs 'associated with' or 'correlated with' when describing regression results in this paper as the results cannot be interpreted as causal effects. I use the noun effect in a non-causal way throughout the paper.

The findings from this study have important implications. First, the relevance of parental socialisation points to the importance of policies that address early roots of gendered major choices. Second, the interactive effect of parental education with masculinity/femininity in parental occupation suggests that the status of role models may matter more than their sex for young people to identify with them. Third, the finding that intergenerational associations are strongest between fathers and sons points to a need for policy to focus on men (and not predominantly on women) when attempting to tackle sex segregation in the labour market. While it is important to encourage women to enter highly paid STEM fields, policy should also aim at changing men's attitudes and encouraging them to enter traditionally female-dominated fields. The finding that sons with fathers in less gender-typical occupations choose less typically male university majors is therefore encouraging.

I make three contributions to existing literature. First, the paper improves the understanding of gendered major choices by providing the first analysis on the role of gender typicality of parental occupation in Germany. Second, I introduce a new rank-based measure, which is used in research on intergenerational income mobility (Chetty et al., 2014) but has not been applied to gendered occupational and major choices. This is unfortunate because previously used measures, based on the share of women in an occupation/major, are affected by changes in the sex composition of the workforce as a whole. Instead, rank measures capture positional mobility between parents and their children, whereby each person's position is relative to others of the same cohort and sex. Finally, I am able to distinguish between two different transmission channels by disentangling the transmission of parental resources from that of gender norms. I thereby contribute to the literature on the intergenerational transmission of gender norms, which mainly draws evidence from intergenerational associations in female labour force participation and does not allow for such a distinction. Identifying transmission channels is important for the design of effective policies to address sex segregation in university majors.

The remainder of the paper is organised as follows. Section 2 reviews existing evidence on the determinants of gender differences in university major choice, and describes how university major choice operates in Germany. Section 3 presents the data and methods. Section '4' reports the results, section '5' studies transmission channels, and the last section concludes.

2 Gender differences in university major

2.1 Determinants of gender differences in major choices

University major choice is complex and influenced by many factors, including expected earnings, perceived own ability, and exposure to a given major, among others (see Altonji et al. 2016 for a recent review). A subset of this literature studies the drivers behind gender differences in major choices. Empirical research interested in

the determinants of gendered major choices tends to focus on one of two types of factors.

Some argue that individual-level factors determine gendered major choices. For example, research has shown that gender differences in personality traits such as competitiveness, beliefs about enjoying coursework, and preferences over expected jobs all contribute to the gender gap in majors (Antecol and Cobb-Clark, 2013; Zafar, 2013). While important, these papers ignore that gendered preferences and self-conceptions are a result of gender socialisation processes (Cech, 2013).

Other research studies the role of the social environment for the probability to choose specific groups of majors. This strand of research shows that the social environment directly affects gendered major choices in many cases. For example, a recent paper finds that a higher proportion of female high school peers reduces women's probability and increases men's probability to choose a STEM major (Brenoe and Zoelitz, 2019). Having female teachers increases women's likelihood to choose a STEM degree (Carrell et al., 2010; Bottia et al., 2015). And having a sister increases men's likelihood to study economics, business, or engineering (Anelli and Peri, 2015).

While important in its own right, using STEM as an outcome measure when studying sex segregation by university major more broadly has several shortcomings. First, there is substantial within-group heterogeneity in sex composition within STEM majors and other broad groups of majors. This constitutes a shortcoming for those interested in the factors underlying the persistent gender differences in major choices. Moreover, a binary STEM measure tends to put strong emphasis on the lack of women in STEM fields while ignoring the underrepresentation of men in certain other fields as the flip side of sex segregation in majors. To overcome these shortcomings, I introduce a novel measure of gender typicality, which I describe in section '3'.

Although the family is a key agent of primary socialisation (Bandura, 1977), only few papers study the role of parental transmission for gendered major choices. In particular, there is not much evidence on the importance of parents' occupation and specifically the degree to which these occupations are typically male or female. Two recent studies address this gap by analysing the association between share of women in parents' occupation or educational field and share of women in offspring's educational field, with different results. A study in Denmark finds a positive association between the female share in the education of mothers and the female share in the major of their daughters, as well as between the female share in the education of fathers and that of their sons (Humlum et al., 2018). A related paper studying field of study choice at secondary education level in the Netherlands also finds a positive relationship between the female share in mothers' occupation and in daughters' field of study (Vleuten et al., 2018). However, there is no father-son correlation. Instead, mothers employed in more female occupational fields are more likely to have sons in more male-dominated fields.

These papers use the sex composition to identify the degree to which a major is gendered. While this is a useful measure, it warrants further improvement. I build

on this small set of literature by introducing a rank-based measure of the degree to which an occupation or major is typically male or female. This measure is described in more detail in section '3'.

2.2 Channels of intergenerational transmission

Socialisation theories in sociology (e.g. (Eagly, 1987; Okamoto and England, 1999)) and in social psychology (e.g. (Bandura, 1977)) argue that parents act as key agents of socialisation to their children. Gender socialisation theories suggest that children specifically emulate the behaviour of the same-sex parent (Vleuten et al., 2018). Gendered behaviours can either result from children observing the behaviour of their same-sex parent and actively choosing to imitate them (cognitive developmental theory; Kohlberg 1966), or because parents encourage them to adhere to gender roles (social learning theory; Bandura 1977). Therefore, from an early age, children form beliefs about what constitute culturally appropriate behaviours and preferences for girls and boys, including appropriate types of jobs.[2]

In economics, cultural transmission and socialisation processes have been incorporated into economic models since the start of this century (e.g. (Akerlof and Kranton, 2000; Alesina and Giuliano, 2015; Bisin and Verdier, 2001; Bisin and Verdier, 2011; Escriche, 2007)). Within this literature strand, a number of empirical studies have tried to identify the existence of gender social norms through the study of female labour supply decisions. For example, Fernández and Fogli (2009) demonstrate that second-generation immigrant American women whose ancestry is from countries with higher female labour force participation work more. Olivetti et al. (2020) show that a woman's labour supply in early adulthood is affected by the labour force participation of past high school peers' mothers. These correlations in labour force participation are interpreted as evidence of the existence and intergenerational transmission of gender norms. However, a key shortcoming of this empirical research is that it is not possible to distinguish whether the intergenerational associations in labour force participation are due to a transmission of gender norms or due to other reasons such as a transfer of resources or imitation.

I address this limitation and contribute to this strand of literature by studying a different outcome, university major, which allows me to distinguish between the relative importance of two transmission channels: the gender-typicality *per se* and the transfer of occupation-specific resources. This is possible because occupations and university majors can be classified along two dimensions—their broad field as well as their gender typicality. This distinction is not possible when studying female labour supply decisions.

[2] Evidence suggests that as early as in second grade, children think that maths is for boys and not for girls (Cvencek et al., 2011). Gender socialisation even affects school performance. For example, a significant part of the gender gap in maths test scores in secondary school can be attributed to the transmission of cultural beliefs concerning gender roles (Nollenberger et al., 2016). Moreover, compared to boys, girls aspire to occupations that have a higher share of women and pay less (Polavieja and Platt, 2014; Platt and Parsons, 2017).

More specifically, two main channels can account for intergenerational associations between gender-typicality rank in parents' occupation and rank in offsprings' major: a direct transfer of resources on the one hand and a transmission of gender roles or gender norms on the other hand (Vleuten et al., 2018).[3]

A direct transfer of resources takes place when young adults choose a major that is similar to their parents' occupational field. This encompasses what is commonly referred to as the transfer of occupation-specific human capital (e.g. (Humlum et al., 2018)) and the inheritability of parental endowments (e.g. (Becker and Tomes, 1979)) in economics, and the transfer of occupation-specific resources within sociology (e.g. (Jonsson et al., 2009)). Taking a broad definition, this channel includes the transfer of occupation-specific and financial resources, social networks, human capital, traits, and abilities (Vleuten et al., 2018; Aina and Nicoletti, 2018).[4] It occurs, for example, if the child whose parent is a doctor studies medicine. Each occupation and each major differs in the degree to which it is gendered. Consequently, direct transfer mechanically leads to positive intergenerational associations between parents and children's femininity or masculinity rank in occupation and major, respectively. It is reasonable to assume that young adults are more likely to identify with and use the resources of the more influential parent whose social position dominates that of their spouse (Dryler, 1998), for example in terms of occupational status, income, or educational level.

A second 'indirect channel' is present if children choose majors that are unrelated to their parents' occupations but we still observe a significant association between gender typicality in parental occupation and gender typicality in children's majors. The presence of an indirect channel can be interpreted as strong evidence for gender socialisation and the transmission of gender norms. This is because the possibility of a direct transfer is very limited and instead the gender-typicality rank *per se* matters for gendered major choices. Empirically, this can be tested by studying heterogeneous effects across those children who choose majors that are related to the same field as their parents' occupations and those whose majors are unrelated to parents' occupations.

These two competing transmission channels are interrelated and cannot be considered completely independent, both from a theoretical and from an empirical

[3] Gender norms and gender roles in this paper refer to the perceived appropriate roles of men and women concerning university major and occupational choice. I use the definition of gender norms from Pearse and Connell (2016), who define them as "collective definitions of socially approved conduct [...] applied to groups constituted in the gender order - mainly, to distinctions between men and women" (p. 31). The concept of gender norms is related but different to that of stereotypes, understood as 'consensual expectations about what members of a group actually do' (Eagly and Karau, 2002). In contrast, in this paper, I do not study gender role attitudes. Attitudes are evaluations of behaviour or people as good or bad; they vary on a positive/negative scale and can be expressed by statements such as 'I like/dislike' or 'I agree with/disagree with' (Bicchieri, 2017). Therefore, attitudes towards gender roles are individual evaluations of these gender roles and norms; and a positive attitude would reflect an endorsement of the collective gender norm in the society. Individuals' stated gender role attitudes and the gender roles disclosed in their behaviours are often conflicting (Hochschild and Machung, 1989).

[4] Such traits and abilities may or may not be due to genetic inheritance and this distinction is not a focus of this paper.

perspective. From a theoretical perspective, parents may be more likely to transmit occupation-specific resources to their children if these are in line with cultural gender norms. For example, fathers in STEM occupations are found to transmit their occupation-specific preferences to their daughters only in the absence of a son (Oguzoglu and Ozbeklik, 2016). From an empirical perspective, it is possible that a transmission of gender roles occurs *within* groups of students who choose majors closely related to their parents' occupation. In other words, there may still be a transmission of gender norms even if we do not find empirical evidence for the 'indirect' transmission channel. In light of these considerations, empirical evidence of the existence of the 'indirect' transmission channel therefore provides an even stronger case for the existence of gender norms.

There is little empirical research that has tried to disentangle these transmission channels and identify the existence of gender norms in the context of gendered university major choices (but see e.g. Humlum et al. 2018). Studies on related but different outcomes such as occupational choices, occupational aspirations, and field of study choices in secondary school have produced mixed results. While some studies find support for a transmission of gender roles (e.g. (Polavieja and Platt, 2014; Vleuten et al., 2018)), others find no such support (e.g. Dryler 1998).

2.3 Major choice in tertiary education in Germany

In 2010, 49% of secondary school graduates obtained a school-leaving certificate qualifying them for tertiary education. Of those, 69% obtained Abitur (Allgemeine Hochschulreife) and the rest obtained a subject-linked school-leaving certificate (Brugger et al., 2012). Abitur is a school-leaving certificate obtained at the end of upper secondary education for students who attend the 'highest' Gymnasium school track.[5] In principle, this certificate provides eligibility to study any major at any university. In contrast, subject-linked school-leaving certificates (Fachhochschulreife or fachgebundene Hochschulreife) restrict eligibility either to certain majors or to university of applied sciences (Fachhochschulen). In addition to qualifying for entry to university via a school-leaving certificate, a small share of students enters university education via a 'non-traditional' route without a school-leaving certificate. These students qualify through other criteria such as vocational training (Neugebauer and Schindler, 2012). The entry rate into tertiary education in 2010 was 45% (Brugger et al., 2012).

When applying for an undergraduate degree, students choose a major (Studienfach), such as mathematics, German studies, or mechanical engineering. Students also take two additional decisions particular to the German tertiary education system. First, they choose one of two main types of tertiary education institutions, traditional research universities (Universitaeten) and universities of applied sciences

[5] Access to tertiary education in Germany is characterised by high social inequality, which is partly due to an early tracking into different school types in lower secondary school. Students with parents who possess tertiary education are much more likely to attend the highest school track (Gymnasium) at lower secondary school (Müller and Schneider , 2013).

(Fachhochschulen). While universities offer degrees in all majors, universities of applied sciences have a more applied focus and offer a limited range of applied sciences majors (Jacob and Weiss, 2010). Second, with many majors, a student can choose between graduating with a 'regular' undergraduate degree or with a 'teaching' degree. The latter type is necessary to become a school teacher.

Therefore, in studying major choices I distinguish between 58 majors as well as the three mutually exclusive 'types' of degree, namely university, university of applied sciences, and teaching degree. Since not all 58 majors are available for each of the three degree types, their combination yields 134 distinct categories.

Choosing a university major is an important decision because the German labour market has strong linkages between majors and occupations (Leuze, 2007). In fact, the German labour market is known "as a prototypical case of an occupational labour market where job applicants are matched to jobs according to their occupation-specific credentials" ((Klein, 2016), p. 46). Around three-quarters of the gender differences in earnings at job market entry of graduates can be explained by gender differences in university major (Braakmann, 2008). Moreover, low occupational mobility means that initial major choices at university have long-lasting effects on career outcomes, such as lifetime earnings (Aisenbrey and Brückner, 2008).

University major choice in Germany is not only an important decision from the individual's perspective, but its study also has a number of advantages compared to studying related choices such as the one of occupation. While gender differences in university majors and occupational sex segregation are closely related, the choice of a major is less influenced by demand factors than the choice of an occupation. Determinants of occupational segregation include supply side factors such as individual preferences as well as demand side factors such as gender stereotypes of employers enacted when employers select job candidates (Hausmann and Kleinert, 2014) and current labour market conditions. Compared to that, major choice allows a focus on supply side factors and is therefore a closer reflection of individual preferences.

One concern is that major choices may not adequately reflect people's preferences because many majors have admission restrictions to manage high demand. In this paper's sample, 70% of students entered a programme with admission restrictions, with the high school GPA (Abiturnote) being the most important and often sole criterion. This means that only students who graduate with a GPA above a certain threshold (called numerus clausus) are admitted to the programme. This means that on the other hand 30% of programmes have no admission restrictions, that is, students with a school-leaving certificate can enrol directly at the respective university without the need to fulfil any additional requirements.

To alleviate part of the concern that major choice may not adequately reflect individuals' preferences, in Section '4' I conduct a robustness check on students who graduated with a GPA above the median and a robustness check on students who state that they entered their desired major. These restrictions do not change results. Furthermore, while not all students may be able to enter their preferred major, from a policy perspective, it can be argued that studying the actual choices students make given their constraints is more important than studying idealistic aspirations.

Literature on the determinants of university major choice in Germany suggests that social origin plays a role in university major choice. For example, individuals

whose father possesses a tertiary degree are more likely to choose majors that are considered prestigious, such as medicine or law (e.g. (Reimer and Pollak, 2010; Georg and Bargel, 2017)). Apart from that, the choice of a university major is treated as largely self-determined in the literature. This is supported by evidence that intrinsic motives, in particular interest in the major, are an important factor for major choice while conformance with friends' and parents' expectations is found to be less important (Heine et al., 2008; Ochsenfeld, 2016). Moreover, teacher recommendations or evaluations are not usually needed for entry to university and are not commonly included as an independent variable in regression models. In line with this, self-reported information from students indicates that the three most-used sources to inform major choice are the internet, friends, and information material provided by universities (Heine et al., 2008). On the other hand, much fewer students cite conversations with teachers as a source of information and only a fifth of those who name teachers as a source evaluate them as useful.

Additionally, a few characteristics of the tertiary education system make Germany a well-suited case to study major choices as a relatively 'free choice' that closely proxies individual preferences. First, the choice of major is not restricted by earlier field of study or track choices at secondary school. This is in contrast to other countries such as the UK or Italy, where entry to some university majors is conditional on having taken certain exams or tracks in secondary school[6]. Second, in contrast to other countries such as the USA, it is not possible to enter university without declaring a major. Therefore, the choice of major takes place (just) before a student enters university, at the time when he or she applies for a degree. Third, the high selectivity into certain prestigious universities in countries such as the UK or USA does not exist in Germany. Instead, universities are considered more equal in quality and there is no strong hierarchy among universities (Jacob and Weiss, 2010). Finally, university education in 2010 was free in most of the 16 federal states. Even in the five federal states that charged tuition fees in 2010, usually at EUR 500 per semester, they were relatively low in international comparison.

3 Data and methods

3.1 Data sources and sample

The main dataset used is the Starting Cohort 5 of the German National Educational Panel Study (NEPS-SC5, see Blossfeld and Roßbach 2011). The NEPS-SC5 contains rich data of a nationally representative cohort of 17,910 first-year undergraduate students who started their degree in October 2010, and who are enrolled for the first time in a public or state-approved higher education institution in Germany (see Zinn et al. 2017). Wave 1 interviews were conducted between December 2010 and

[6] For example, evidence from Italy shows that written teacher track recommendations are an important determinant of high school track choice and this track choice is strongly correlated with subsequent choice of university major (Carlana, 2019).

January 2012 and, to date, 9 waves of data are available, following individuals up until 2015. For the analysis, a cross-sectional dataset is constructed, using information from the wave 1 survey and from spell data on schooling.

The analysis sample is restricted to individuals between 18 and 25 years old who obtained Abitur (Allgemeine Hochschulreife). The age restriction allows for a focus on the transition from high school to university by excluding individuals who pursue a university degree as a second career later in life. The restriction to individuals with Abitur ensures that students are eligible for any degree at any type of university. However, robustness checks including individuals with other types of school-leaving certificates are shown in Section 4, and indicate that results remain substantially the same. I also drop observations with missing values on key variables.

Since information on parental characteristics is provided by students, this restriction implies that only individuals who know the educational level, age, and occupation of both parents are included. A parent is defined as the person who the student identifies with as mother or father. Therefore, I include controls for the family structure an individual grew up in, which distinguish between biological and adoptive parents on the one hand, and step and foster parents on the other hand.[7] I also run analyses on subsamples of different family structures, and the results do not change substantially. The final analysis sample consists of 9640 individuals (6100 female students and 3540 male students).[8] Table 10 in the Appendix shows how the different sample restrictions affect sample size and summary statistics. Overall, the changes in the mean values of key variables due to sample restriction are minimal.[9]

I use supplementary data from four sources. To construct the dependent variables, I use information on the total number of female and male students by university major and by degree type in Germany in the academic year 2010/2011 from administrative data of the Federal Statistical Office (Statistisches Bundesamt, 2011). For the key regressors, I use administrative data from the Federal Labour Office, which contains information on occupational group of all female and male employees subject to social security contributions in Germany (Statistik der Bundesagentur für Arbeit, 2014). The median income by occupational group is used as a control variable and is also obtained from the Federal Labour Office (Statistik der Bundesagentur

[7] The survey reports adoptive parents in the category of biological parents and groups step parents and foster parents.

[8] The initial full survey sample consists of 60% female students and the final analysis sample consists of 63% female students. The overrepresentation of women in the sample is primarily due to a higher survey response rate among women and to a lesser extent due to the exclusion of more observations on male students due to missing values on key covariates. The difference in nonresponse between male and female students is accounted for in the survey weights. For details on weighting procedures, see Zinn et al. (2017).

[9] There are two exceptions. The first is that when moving from the initial full sample to the one restricted to students who are aged 18 to 25 and hold a general school-leaving certificate, parents are more likely to have higher levels of education. This is expected because students with parents who possess tertiary education are more likely to attend the highest school track (Gymnasium) at lower secondary school (Müller and Schneider, 2013). Moreover, the average rank in university major for men reduces from 55.3 to 52.5. Restricting the sample further by dropping observations with missing values on key variables does not change the mean values of any of the variables.

für Arbeit, 2018). The NEPS does not have good information on earnings. Therefore, estimates of average returns to major are obtained from the 2005 and 2009 DZHW Graduate Panel Survey (Brandt et al. , 2018; Briedis et al., 2019), and used as a control variable in a robustness check. The DZHW Graduate Panel Survey is a four-yearly survey of higher education graduates administered by the German Centre for Higher Education Research and Science Studies (DZHW). It enables to study the transition of higher education graduate cohorts to professional careers. Finally, I use data from Starting Cohort 4 of the National Educational Panel Survey (NEPS-SC4) for a robustness check on the selectivity of the sample of university students in the main dataset NEPS-SC5. NEPS-SC4 is a nationally representative sample of students who were in grade 9 of compulsory education in the academic year 2010/2011, who are followed throughout their subsequent school careers (Blossfeld and Roßbach, 2011).

3.2 Methods

Before detailing the rank-based measures of gender typicality in university major and occupation in the next subsection, I describe the regression model. The regression model resembles 'rank-rank' income regressions, which have been used in research on relative mobility in income (Chetty et al., 2014). The following baseline 'rank-rank' gender-typicality regression model, estimated via OLS, is used to study the association between gender-typicality rank of the occupation that mother and father held when the individual was aged 15 and the gender-typicality rank in daughters'/sons' university major:

$$R_i = \beta_0 + \beta_1 RM_i + \beta_2 RF_i + \beta_3 X_i + \beta_4 P_i + \delta_s + \varepsilon_i \quad (1)$$

where R_i is the gender-typicality rank of individual's university major, RM_i is the femininity rank of the occupation the mother held when the individual was aged 15, and RF_i is the masculinity rank of the occupation the father held when the individual was aged 15. X_i includes individual characteristics, namely seven age dummies, two birth order dummies, three dummies for family structure growing up, and a binary variable indicating 1st- or 2nd-generation immigrant. P_i are parental characteristics and include mothers' and fathers' age, a binary variable indicating the parent was employed when the individual was aged 15, three dummies for educational level, and controls for the median income in mothers' and fathers' occupational group, respectively. δ_s are federal state fixed effects.[10] These variables are chosen to control, as good as possible, for variables that are correlated with both the gender-typicality rank in major and the gender-typicality rank in parental occupations. Summary statistics of all variables are reported in the Appendix in Table 11.

The regression model captures intergenerational positional changes by identifying the correlation between parents' and children's position in their respective gender-typicality distribution, holding constant key parental and individual characteristics

[10] There are 16 federated states in Germany, known as Bundeslaender.

as well as federal state. All analyses are weighted using the cross-sectional sampling weights for wave 1, to account for the complex sampling design and to correct for non-response among the recruited students.[11] Since parents' behaviour may affect sons' and daughters' choices in different ways, separate regressions are conducted for female and male students.

A key assumption of the regression model is that gender typicality is linearly transmitted from parent's occupation to child's major. Yet it is possible that the transmission of gender typicality occurs non-linearly or at certain points in the distribution only. For example, it may be that only fathers in occupations with a relatively low masculinity rank are associated with students' rank in major. Similarly, it may be possible that any associations hold only at certain points of the gender-typicality rank distribution of university majors. While I conduct OLS regressions as a starting point, I also explore potential non-linearities by discussing results from quantile regressions and heterogeneous effects across the distribution of key regressors (subsection '4.3'). Nevertheless, I argue in the next subsection that imposing linear transmission on rank-based measures possesses advantages compared to the two approaches used in existing research. The first uses linear regressions with measures based on the share of women/men in occupations and majors. The second uses categorical regressors, which necessarily use arbitrary cutoffs of what constitutes a gender-typical occupation or major.

The analysis also suffers from a few data limitations. In particular, there is no information on parents' income or work hours, which would be useful to study relative parental status (e.g. relative income) in more detail. Moreover, sibling sex is not contained in the data, which has been identified as a relevant factor affecting gender-stereotypical behaviour (Anelli and Peri, 2015).

3.3 Measures of gender typicality in university major and in occupation

To measure the degree to which a university major is typically female, I rank each female student relative to the population of all female students in the academic year 2010/2011 in Germany based on the share of women in her university major. I call this measure 'daughters' femininity percentile rank in university major', or 'daughters' rank' in short, and it takes values between 1 and 100. The femininity rank indicates a female student's relative position in the distribution of all female students, based on the share of women in their university major. For example, a woman enrolled in a psychology major at university is assigned a femininity rank of 85, indicating that 15% of female students are enrolled in a major with a higher share of women. Analogously, for male students, 'masculinity rank in university major' is constructed based on the student's relative position in the national distribution of all male students' share of men in university major.

[11] Specifically, the decision of contacted students to participate is modelled and considered variables are sex, nationality, type of institution, year of birth, intended university degree, and type of contact. For further details on the target population, sample sizes, and weighting procedures, see Zinn et al. (2017).

Table 1 Most common majors/occupations and their rank

	Daughters' university major	Femininity rank	Sons' university major	Masculinity rank
1	Economics (FH)	31	Economics (Uni)	44
2	Economics (Uni)	21	Mechanical & process engineering (Uni)	84
3	Psychology (Uni)	85	Mechanical & process engineering (FH)	73
4	Law (Uni)	42	Economics (FH)	34
5	Human medicine (Uni)	56	Law (Uni)	24
6	Social sciences (Uni)	49	Computer science (FH)	78
7	German Studies (teaching)	90	Physics, astronomy (Uni)	68
8	Biology (Uni)	61	Industrial engineering & management, economics focus (FH)	60
9	Social sector (FH)	82	Industrial engineering & management economics focus (Uni)	61
10	German Studies (Uni)	78	Computer science (Uni)	89
	Mothers' occupation	**Femininity rank**	**Fathers' occupation**	**Masculinity**
1	Office administrator	39	Businessman/manager	43
2	Primary/lower secondary school teacher	59	Primary/lower secondary school teacher	4
3	Nurse/midwife	66	IT professional	50
4	Stenographer/typist	92	Doctor	27
5	Salesperson	56	Office administrator	12
6	Kindergarden teacher	94	Unskilled worker	36
7	Social worker/social care worker	62	Architect/construction engineer	42
8	Doctor's receptionist	99	Banking professional	19
9	Banking professional	22	Electrician	82
10	Doctor	13	Mechanical engineer	68

Sources: NEPS-SC5, author's calculations. Notes: *Uni* indicates university, *FH* (Fachhochschule) indicates university of applied sciences.

Table 1 shows the 10 most common major choices for men and women, and their respective rank measure. Since each person's rank is based on the distribution of students of the same sex, the measures are sex-specific. For example, Table 1 shows that the femininity rank of an economics major at university is 21, while the masculinity rank of an economics major at university is 44.

As mentioned in Section '2', university majors are distinguished not only by 58 fields of study but also by 3 different degree types, namely, teaching degree, university degree, and university of applied sciences degree. Their combination yields 134 distinct university majors, from which the femininity rank and masculinity rank measures are constructed. In cases in which students declare more than one major, I use the one they declare as their first major.

The key regressors are the femininity and masculinity percentile rank in the occupation of mothers and fathers, respectively. There are 334 distinct occupational groups based on the German occupational classification KldB88. Following the same logic as for the dependent variables, I construct a measure of the degree to which a mother's occupation is typically female. Specifically, I rank mothers based on the share of women in their occupation relative to all other employed women in Germany.[12] The 'femininity rank of mothers' occupation' or 'mothers' rank' takes values between 1 and 100, and higher numbers indicate a more 'typically female' occupation. For example, the rank associated with a mother who is a kindergarden teacher is 94, indicating that 6% of mothers work in occupations with a higher female share. On the other hand, the rank associated with a mother who is a doctor is 13, suggesting that 87% of mothers work in occupations with a higher share of women. I also construct measures for a masculinity rank in fathers' occupations in an analogous way, ranking fathers based on the share of men in their occupation relative to all other employed men in Germany. By construction, the rank measures follow a uniform distribution with mean and median 50.[13]

[12] The survey records the occupational group a parent held when the individual was aged 15. This allows studying the association between gender typicality of parental occupation during adolescence for students' gendered university major choices in early adulthood. To construct rank measures for mothers' (fathers') occupations, I therefore use information on the female (male) share by occupational group corresponding to the year in which the individual was aged 15. Since the sample is restricted to individuals aged 18 to 25 in the year 2010, I use administrative data (Statistik der Bundesagentur für Arbeit 2014) on the female (male) share by occupational group for one of the years in the period between 2000 and 2007, depending on each individual's age. While the sex composition of individual occupations may have changed by 2010, using data from the year in which the individual was aged 15 best captures the degree of gender typicality that the occupation represented when the individual was an adolescent.

[13] There are important differences in the gender typicality of different occupations across different countries. Ideally, for the descendants of immigrants, I would therefore construct parental rank measures based on the sex composition of occupations in their home country at the time when the individual was aged 15. Unfortunately, this is not feasible given that country-specific occupational classifications used in different countries are not easily matched to the German KldB88 classification used in this paper. Moreover, while there is information on parental birth country, this is not necessarily the same as what the parent considers their home country. I therefore include a dummy taking a value of 1 for individuals who are first- or second-generation immigrants (based on recorded birth country) in all analyses, and I perform a robustness check excluding those individuals from the analysis (see Table 13).

Students report information on the occupation that their parents held when they were aged 15. Therefore, the measures capture the role of parental occupation during adolescence for students' gendered university major choices in early adulthood.[14] The ten most common occupations for mothers and fathers and their respective rank are shown in Table 1.

The generation of parents studied in this paper often follows a traditional gender division of work. In total, 17.6% of students' mothers in the sample are 'inactive', that is, they have not been employed since the student was born (as opposed to 0.9% of fathers) and have therefore no occupation recorded in the survey. However, excluding all these students from the analysis would lead to a highly biased sample, leaving out those who have parents with the most gender-traditional household allocation of work. Moreover, having an inactive mother has been shown to negatively affect daughters' labour force participation (e.g. (Morrill and Morrill, 2013)). Similarly, prior research has shown that the relative income of mothers compared to fathers is related to the gender typicality in sons' major choices (Humlum et al. , 2018). While inactive mothers cannot transmit occupation-specific resources to their children, their inactivity gives signals about appropriate gender roles to children, which may translate into major choices.

Therefore, I create a fictitious profession corresponding to the parents who were not employed in the period from the birth of the individual and the individual reaching age 15. I calculate the gender-typicality rank based on the sex composition of this fictitious profession.[15] A robustness check performed in Section 4 shows that their exclusion does not substantially alter results. To test the possiblity that growing up with a mother out of the labour force may directly affect students' university major choices, I perform a robustness check with a dummy for mother being inactive (see Table 14).

There are several advantages that these rank measures possess over alternative measures used in prior research. Previous studies have operationalised the degree to which occupations or majors are typically female by using the share of women as a measure (Humlum et al., 2018; Vleuten et al., 2018). Figure 2 in the Appendix illustrates how the female (male) share by major/occupation corresponds to the femininity (masculinity) rank. Share-based measures have two undesired properties.

First, the share of women within a given occupation may depend on the structure of occupational classifications. Specifically, the occupational classification KldB88 from the year 1988 reflects the occupational structures of the industrial society of the 1960s, with typically male occupations categorised into a higher number of

[14] There may be concerns about the relevance of this measure if there is a high degree of occupational mobility among parents. However, I argue that the measure is appropriate for the purpose of this paper for several reasons: First, capturing parental occupation at age 15 is meaningful as the focus of this paper is studying the role of parental occupation during adolescence in the context of gender socialisation. Second, the German labour market is characterised by low occupational mobility (Aisenbrey and Brückner, 2008). Third, the measure is based on 334 occupational groups, which aggregate 1991 different occupations of similar nature. Therefore, if parents switch occupation to a closely related one of similar nature, this would be captured within the same occupational group.

[15] The femininity rank for inactive mothers is 82 and the masculinity rank for inactive fathers is 2.

smaller groups compared to female occupations (Hausmann and Kleinert, 2014). If typically male occupations are systematically more detailed in occupational classifications than typically female ones, this may bias the sex composition within occupations. Specifically, it may partly explain why men tend to work in more segregated occupations while women bunch in a smaller number of occupations (Hausmann and Kleinert, 2014). Moreover, the sex distribution of occupations is more dispersed than the distribution of university majors, partly due to the fact that the occupational classification is more detailed. Rank measures do not suffer from this problem because they capture the position of individuals relative to others of the same cohort and sex. A change in the sex composition of a university major affects the rank of a student only insofar as it alters the student's position relative to the position of others.

Second and more importantly, the share of women in an occupation is affected by the sex composition of the workforce as a whole. That is, an increasing proportion of women within a certain occupation may be explained by an increase in female labour force participation, even if there is no change in the propensity of women or men to choose that particular occupation (England et al., 2007). Therefore, the fact that the overall female share among the 2010 university student population is higher than the female share among the total workforce in their parents' generation is reflected in share-based measures. This complicates a meaningful interpretation of share-based measures as measures of the concept 'gender typicality' in a regression model as specified in Eq. 1. On the other hand, rank measures capture positional mobility between parents and their children, whereby each person's position is relative to others of the same sex and cohort. Therefore, coefficients from a rank-rank regression model as in Eq. 1 have a meaningful and straightforward interpretation. Specifically, coefficients can be interpreted as the association between a parent's relative position in their sex-specific occupational rank distribution and a student's relative position in their sex-specific university major rank distribution.

Occupations and university majors are also commonly categorised into 'male-dominated' and 'female-dominated' ones. For example, majors (or occupations) with a female share of 70% or above are often referred to as female-dominated, while those with a female share below 30% are labelled as male-dominated (e.g. (Hausmann and Kleinert, 2014)). A key disadvantage of such categorisation is that these cutoffs are arbitrary. This is especially problematic in regression analysis because coefficients on binary or categorical regressors are interpreted relative to a baseline cateogory. Changing the cutoff then also necessarily changes the baseline. For example, there is no theoretical reason for why estimating the effect of being in an occupation with a female share of 70% or above (compared to the baseline category of being in an occupation with a female share of less than 70%) is more meaningful than, for example, estimating the effect of being in an occupation with a female share of 66.67 (two-thirds) percent (compared to being in an occupation with a female share below 66.67%). A second key disadvantage of categorical regressors, at least in the context of this paper's focus, is that a categorisation, independent of which cutoffs are chosen, implies a substantial loss of information regarding the degree of gender typicality of occupations.

In sum, rank measures have the advantage that they are independent of the structure of occupational/major classifications and independent of the overall sex composition of the population. Therefore, estimating a linear relationship between parental and children's rank in their respective distribution has a straightforward interpretation. In the case of fathers and sons, for example, it captures the association between a sons' and a fathers' relative position in their respective distribution.

3.4 Summary statistics

The left part of Table 2 presents selected summary statistics for key variables, separately for sons and daughters. The average age of students is around 20 years, and their average rank in major approximately 51. As mentioned in Section '2', this is a sample of individuals who enter university and hence their parents are disproportionately highly educated. Therefore, in order to check the degree of selectivity, summary statistics are compared to those of NEPS-Starting cohort 4, a sample of grade 9 students which includes the full population of students in regular schools. These are reported in the right part of Table 2. The age difference between mothers and fathers of the two cohorts corresponds approximately to the age difference of the students across the two cohorts. Moreover, the share of mothers who were not in employment since the student was born is similar across both cohorts. Not surprisingly, the share of tertiary educated mothers and fathers in the undergraduate student cohort (SC5) is much higher compared to the average parent in the cohort of compulsory schooling grade 9 pupils (SC4). This is in line with previous research which shows that intergenerational educational mobility is low in Germany (Heineck and Riphahn, 2009).

By construction, the rank measures have a mean of 50 if they are nationally representative. However, the highly educated parents of the study sample are not nationally representative. Indeed, the femininity rank in mothers' occupation is slightly higher in the cohort of university students, while fathers' rank is over 10 percentile points lower compared to starting cohort 4. This suggests that high-skilled mothers' occupations are more gender-typed while high-skilled fathers' occupations are less gender-typed compared to lower-skilled occupations. This can partly be explained by the fact that many occupations with a very high share of men, such as carpenters, truck drivers, and electricians, do not require tertiary education. A full set of summary statistics are reported in the Appendix in Table 11.

4 Results

4.1 OLS results

Panel A of Table 3 presents results on the relationship between gender-typicality rank in parental occupation and masculinity rank in university major for sons. Columns 1 to 3 do not include any controls or fixed effects. Column 1 considers femininity rank in mothers' occupation only, while column 2 includes masculinity rank

in fathers' occupation only. The coefficient on mothers' rank in column 1 is positive but not statistically significant. In contrast, column 2 reveals a positive relationship between the degree to which fathers' occupation is typically masculine and the degree to which sons' major is typically masculine. A 1 percentile (i.e. 1 unit in masculinity percentile rank) increase in fathers' rank is associated with a 0.12 percentile increase in sons' rank. Column 3 jointly includes mothers' and fathers' rank, and the coefficients stay almost identical. This suggests that fathers' rank is independently associated with sons' rank and that assortative mating is not driving the results.[16]

The size and significance of the estimated coefficient on father's rank does not vary substantially when progressively adding fixed effects and individual level controls in columns 4 to 6. Column 4 includes federal state fixed effects. Column 5 adds a set of parental characteristics, namely educational level, age, and a dummy for being employed when their child was aged 15, for mothers and fathers, respectively. Column 6 additionally controls for the natural logarithm of the median income in mothers' and fathers' occupation. Column 6 also adds the following individual characteristics: categorical variables for age, birth order, family structure when growing up, and whether the individual has an immigrant background.[17]

The coefficient on fathers' rank decreases slightly (from 0.123 to 0.113), but remains statistically significant at the 1% level. In the most restrictive specification in column 6, a 24 percentile increase in fathers' rank (corresponding to one standard deviation, see Table 2) is associated with a 2.7 percentile increase in sons' rank, which corresponds to a 5% increase compared to the mean of sons' rank in the sample. The positive same-sex relationship between fathers and sons is compatible with both a direct transfer of resources and with a transmission of gender roles. The coefficient on mothers' rank becomes smaller and then turns negative as fixed effects and control variables are added (from 0.019 to −0.013) and is never statistically significant. The level of education of mothers and fathers is not associated with the masculinity rank in sons' major, as shown in columns 5 and 6.

Panel B of Table 3 presents the estimates for the sample of daughters. Section 2 mentioned that the transmission of gender roles happens primarily via the same-sex parent. If a transmission of gender roles occurs, we would expect a positive same-sex relationship between rank in mothers' occupation and daughters' major. However, column 1 shows that the coefficient on mothers' rank is positive but small and not statistically significant. In contrast, column 2 indicates that fathers in more typically masculine occupations have daughters in less typically feminine, that is, more typically masculine majors. These findings stay very similar when mothers' and fathers' rank are jointly included (column 3) and when state fixed effects and individual level controls are successively introduced (columns 4 to 6).

[16] Results from robustness checks in which interaction effects betwen rank in mothers' occupation and rank in fathers' occupation are included confirm that there are no interactive effects between mothers' and fathers' rank. Instead, they appear to operate independently from each other. These results are shown in Table 12.

[17] The full set of coefficients are not shown due to space limitations but are available upon request.

Table 2 Selected summary statistics

	Starting cohort 5				Starting cohort 4			
	Sons		Daughters		Sons		Daughters	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Rank in major	51.6	24.4	51.2	31.3				
Age	20.5	1.2	20.2	1.5	14.8	0.6	14.8	0.7
Rank mother's occupation	53.4	25.9	53.1	32.1	52.5	27	49	30.5
Rank father's occupation	42.8	23.6	43.2	29.3	53.9	28.1	55.3	31.2
Mother inactive	0.19		0.17		0.18		0.16	
Mother's age	49.3	4.4	49.2	5.4	43.9	5.5	43.4	5.5
Father's age	52.1	5.2	51.9	6.4	46.5	5.5	46.2	6
Mother: tertiary education	0.31		0.3		0.08		0.1	
Father: tertiary education	0.44		0.42		0.12		0.09	

Survey weights used. Mother inactive indicates that mother was not in employed in the time period between the child's birth and the child reaching age 15. Sources: NEPS-SC4 and NEPS-SC5

In the most restrictive specification in column 6, a one percentile increase in fathers' masculinity rank is associated with a decrease in daughters' femininity rank by 0.05 percentiles. An increase of one standard deviation in fathers' rank (29 percentiles) is associated with a decrease in daughters' rank by 1.6 percentiles, corresponding to a 3% fall compared to the mean femininity rank of daughters' major in the sample. This coefficient is roughly half the size in absolute terms compared to fathers' rank in the specification for sons presented in column 6 of Panel A. This negative opposite-sex relationship between fathers' and daughters' rank is compatible with a direct transfer of resources between fathers and daughters. The result that fathers'—but not mothers'—rank is associated with the degree to which young women's major choices are typically female may be related to the fact that German families of the parental generation (typically 1950s/1960s birth cohorts) often follow a traditional division of work in which the father is the main breadwinner. Therefore, fathers may be more likely to transmit occupation-specific resources to their daughters and/or act as a role model compared to mothers. In line with this, the theory of direct transfer predicts that a child is more likely to draw upon the resources of the higher-status parent (Vleuten et al. , 2018). This will be further investigated in section '5'.

Columns 5 and 6 of Panel B show that while fathers' educational level is not associated with the femininity rank in daughters' major, mothers' education is. Having a mother with a high school degree and having a mother with tertiary education is associated with an increase in daughters' rank in major by roughly 3.1 percentiles and 3.4 percentiles respectively, compared to having a mother with only basic schooling or less. The association between mothers and their daughters' major choices appears to operate not through mothers' occupation but through their educational level. Those mothers who have a high level of education are more likely to have a successful career or high-status occupation, which may explain why the mother effect operates through educational level in the context of a parental

Table 3 Baseline rank-rank regressions estimated via OLS

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. Subsample of sons. Dependent variable: Masculinity rank son's major						
Rank mother's occup.	0.0192 (0.0155)		0.0190 (0.0157)	0.0112 (0.0141)	−0.0027 (0.0148)	−0.0125 (0.0160)
Rank father's occup.		0.1226*** (0.0210)	0.1226*** (0.0209)	0.1260*** (0.0193)	0.1070*** (0.0190)	0.1129*** (0.0195)
Mother interm. schooling					0.7077 (1.4142)	0.6125 (1.4064)
Mother high school					0.5955 (1.6223)	0.5568 (1.5909)
Mother tertiary degree					−2.1632 (1.5710)	−2.2416 (1.5490)
Father interm. schooling					0.2406 (1.5991)	0.3231 (1.6323)
Father high school					−2.6718 (1.8445)	−2.4875 (1.8231)
Father tertiary degree					−1.1029 (1.6224)	−0.8256 (1.6943)
Observations	3540	3540	3540	3540	3540	3540
R-squared	0.0004	0.0141	0.0145	0.0432	0.0473	0.0573
Panel B. Subsample of daughters. Dependent variable: Femininity rank daughter's major						
Rank mother's occup.	0.0176 (0.0148)		0.0185 (0.0148)	0.0115 (0.0147)	0.0242 (0.0160)	0.0258 (0.0165)
Rank father's occup.		−0.0452** (0.0192)	−0.0456** (0.0191)	−0.0517*** (0.0180)	−0.0540*** (0.0182)	−0.0547*** (0.0183)
Mother interm. schooling					1.7392 (1.2968)	1.7473 (1.3004)
Mother high school					2.9125* (1.6489)	3.1032* (1.6393)
Mother tertiary degree					3.3214** (1.6213)	3.4145** (1.6192)
Father interm. schooling					−1.2377 (1.2461)	−1.2547 (1.2490)
Father high school					−2.1357 (1.4909)	−2.1735 (1.5084)
Father tertiary degree					−1.8790 (1.2893)	−1.7104 (1.3144)
Observations	6100	6,100	6100	6100	6100	6100

Table 3 (continued)

	(1)	(2)	(3)	(4)	(5)	(6)
R-squared	0.0003	0.0018	0.0021	0.0289	0.0311	0.0344
State FE	No	No	No	Yes	Yes	Yes
Parental characteristics	No	No	No	No	Yes	Yes
Individual characteristics	No	No	No	No	No	Yes
Parental income	No	No	No	No	No	Yes

Table shows estimates from OLS regressions. The dependent variable is the masculinity/femininity percentile rank of sons'/daughters' university major. The key regressors are femininity percentile rank of mother's occupation and masculinity percentile rank of father's occupation. Parental characteristics include age, a dummy indicating the parent was employed when offspring aged 15, three dummies for parental educational level (each separately for mothers and fathers, respectively) . Individual characteristics include two dummies for birth order, three dummies for family structure when growing up, and a binary variable indicating (1st or 2nd generation) immigrant background. Parental income is the natural logarithm of the median income in mother's and father's occupational group, respectively. Survey weights used. Standard errors in parentheses. Levels of significance ***$p<0.01$, **$p<0.05$, *$p<0.1$. Sources: NEPS-SC5, Federal Labour Office, Federal Statistical Office

generation that often follows a traditional male breadwinner model. This interpretation, highlighting the importance of 'parental status', is supported by results from a heterogeneity analysis in which mothers' rank is interacted with a variable indicating that the mother has tertiary education (see Table 7).[18]

4.2 Robustness checks

As mentioned in section 3, 17.6% of mothers were not in employment between their child's birth and age of 15, and do not have an occupation recorded. A traditional division of work in which the father works and the mother is not in employment, also known as 'traditional male breadwinner' model is common among the parental generation, especially in West Germany (Bauernschuster and Rainer, 2012). Excluding these mothers would lead to a highly biased sample in which less traditional families are overrepresented. Therefore, these mothers for who information on occupation is not recorded are assigned a femininity rank of 82, based on the fictitious occupation of 'being inactive'. Correspondingly, inactive fathers are assigned a masculinity rank of 2.

To analyse whether this decision affects results, a robustness check in which these mothers and fathers without recorded occupation are excluded from the analysis is conducted, and the results are presented in Table 4. Columns 1 and 2 show results for sons and columns 3 and 4 those for daughters. While columns 1 and 3 present results without any controls, columns 2 and 4 include the full set of controls and fixed effects. The positive association between fathers' rank and sons' rank (columns 1 and 2) and the negative association between fathers' rank and daughters' rank (columns 3 and 4) both remain, and the size of coefficients is similar to those from the full sample (see Table 3). The coefficient on mothers' rank in the specification for sons (columns 1 and 2) remains small and not statistically significant. Interestingly, the positive coefficients on mothers' rank in the sample of daughters (columns 3 and 4) are slightly larger compared to those of the full sample, and the coefficient becomes marginally significant at the 10% level in column 4.

The full specification for daughters in column 4 suggests that women choose more typically female university majors if their mothers worked in more typically female occupations and if their fathers worked in less typically male occupations, and the effect of fathers is slightly larger compared to that of mothers. Therefore, the decision to include mothers without occupation in the main set of results masks the positive effect of those mothers who have been in employment on their daughters' major choices. This finding may again be related to the fact that parents often follow a traditional division of work in which the father is the main breadwinner. Families in which the mother has been employed are less likely to follow a male breadwinner model; mothers are more likely to have a higher status, and are more likely to transmit occupation-specific resources to their daughters and act as role models.[19]

[18] In the remainder of the paper, I will present results using the specification with full set of fixed effects and control variables. Where space permits, I will also include results without any control variables.

[19] Results from postestimation tests showed that none of the coefficients on mothers' and fathers' rank shown in Table 4 is significantly different from those of the main sample reported in Table 3, using a conventional 5% significance level.

Nevertheless, the effect of fathers on daughters' rank in major is still stronger than the one of mothers. To further explore in how far the relevance of rank in mothers' occupation depends upon their status, as suggested by the direct transfer theory, additional analyses are presented in Section '5'.

In Section '2', I discussed the concern that students' major choices may not accurately reflect their preferences. Specifically, students may not be able to study their desired major due to admission criteria. The main admission criterion of majors for which demand exceeds supply is high school GPA (Abiturnote). Therefore, Table 5 presents results from a robustness check in which the sample is restricted in one of two ways. First, a sample in which only students with a high school GPA at least as good as the median GPA of 2.2 are included (columns 1 for sons and 3 for daughters); and second, a sample in which only students who indicate they were able to realise their desired major are included (column 2 for sons and 4 for daughters). The rationale is that students in these restricted samples are more likely to have entered a major that represents their actual preferences. Results do not change substantially compared to those considering the full sample of students. Column 4 reveals that for the subsample of daughters who state that they were able to realise their desired major, the positive coefficient on mothers' rank becomes weakly significant. Without further analysis, it is difficult to know why this weak link appears but it is possible that daughters do draw on the occupation-specific resources of their mothers if they are given the chance or, alternatively, that the characteristics of mothers in this subsample of daughters differ from those in the main sample.

A number of additional robustness checks are performed and their results are reported in Tables 13 and 14 of the Appendix. Results from Table 13 show that the main results are robust to various variations on the analysis sample, namely including students with subject-specific school-leaving certificates (fachgebundene Hochschulreife/Fachhochschulreife, columns 1 and 2), excluding students who study towards a teaching degree (columns 3 and 4), including only those who grew up living with both biological parents (columns 5 and 6), and excluding those who are first- or second-generation immigrants (columns 7 and 8)[20]. The robustness of results to the inclusion of additional controls, some of which are potentially endogenous, is studied in Table 14. Results do not change substantially when including fixed effects at the level of administrative district (401 Landkreise, columns 1 and 2), or controlling for students' high school GPA (columns 3 and 4), high school maths grade relative to German grade (columns 5 and 6), average financial returns by major (columns 7 and 8)[21], or a dummy indicating that the mother is inactive (columns 9 and 10). Moreover, the coefficients on the dummy indicating that the mother is inactive are not statistically significant, suggesting that this variable is not independently associated with rank in sons' or daughters' major.

[20] The sex composition of parental occupations will vary by country and therefore I exclude those who are foreign-born or have a foreign-born parent in this robustness check.

[21] Average financial returns by major are obtained from regressions of the average salary paid in the first job after graduation on group of university major, controlling for age and square of age at graduation, federal state of the job, female dummy, dummy for having studied at FH (university of applied sciences), and year of graduation. The underlying data are the 2005 and 2009 DZHW Graduate Panel Survey.

Table 4 Robustness check: excluding mothers and fathers without recorded occupation

Dependent variable	Sons: Masculinity rank major		Daughters: Femininity rank major	
	(1)	(2)	(3)	(4)
Rank mother's occupation	0.0010 (0.0157)	−0.0209 (0.0181)	0.0267 (0.0163)	0.0329* (0.0185)
Rank father's occupation	0.1154*** (0.0230)	0.1057*** (0.0216)	−0.0459** (0.0205)	−0.0452** (0.0198)
Observations	2866	2866	5027	5027
R-squared	0.0125	0.0573	0.0025	0.0365
State FE	No	Yes	No	Yes
Parental characteristics	No	Yes	No	Yes
Individual characteristics	No	Yes	No	Yes
Parental income	No	Yes	No	Yes

Table shows estimates from OLS regressions. The dependent variable is the gender-typicality percentile rank of sons'/daughters' university major. The key regressors are femininity percentile rank of mother's occupation and masculinity percentile rank of father's occupation. Parental characteristics include age, a dummy indicating the parent was employed when offspring aged 15, three dummies for parental educational level (each separately for mothers and fathers, respectively). Individual characteristics include two dummies for birth order, three dummies for family structure when growing up, and a binary variable indicating (1st or 2nd generation) immigrant background. Parental income is the natural logarithm of the median income in mother's and father's occupational group, respectively. Survey weights used. Standard errors in parentheses. Levels of significance ***$p<0.01$, **$p<0.05$, *$p<0.1$. Sources: NEPS-SC5, Federal Labour Office, Federal Statistical Office

Finally, to check how the selectivity of the sample of highly educated students affects results, I use NEPS data of a sample of grade 9 school students (NEPS-SC4). NEPS Starting Cohort 4 is a sample of a nationally representative cohort of students in compulsory schooling. I estimate regressions of the probability to enter university on fathers' masculinity rank and mothers' femininity rank in occupation. The results are reported in the Appendix in Table 15. Overall, results indicate that the rank in parental occupation has no effect on sons' and very small effects on daughters' likelihood to enter university. On the other hand and in line with prior research documenting low intergenerational educational mobility (Heineck and Riphahn , 2009), there are large effects of parental level of education on sons' and daughters' probability of starting a university degree and they are mainly same-sex intergenerational correlations. Taken together, this subsection showed that the paper's main findings are robust to a number of robustness checks, including different subsamples and additional control variables.

To sum up, results suggest that daughters choose more typically female university majors if their fathers worked in less typically male occupations and if their mothers worked in more typically female occupations. The positive same-sex correlation between mothers and daughters is significant only when excluding mothers who have not been employed since their child was born. Sons select more typically male university majors if their fathers worked in more typically male majors, and

Table 5 Robustness check: testing free choice

Sample	GPA 2.2 or better	Desired major realised	GPA 2.2 or better	Desired major realised
Dependent variable	Sons: Masculinity rank major		Daughters: Femininity rank major	
	(1)	(2)	(3)	(4)
Rank mother's occupation	−0.0003 (0.0285)	0.0031 (0.0211)	0.0182 (0.0222)	0.0394* (0.0201)
Rank father's occupation	0.1263*** (0.0317)	0.0993*** (0.0245)	−0.0700*** (0.0252)	−0.0820*** (0.0224)
Observations	1591	2316	3053	4033
R-squared	0.0817	0.0657	0.0504	0.0451
State FE	Yes	Yes	Yes	Yes
Parental characteristics	Yes	Yes	Yes	Yes
Individual characteristics	Yes	Yes	Yes	yes
Parental income	Yes	Yes	Yes	Yes

Table shows estimates from OLS regressions. The dependent variable is the gender-typicality percentile rank of sons'/daughters' university major. The key regressors are femininity percentile rank of mother's occupation and masculinity percentile rank of father's occupation. Parental characteristics include age, a dummy indicating the parent was employed when offspring aged 15, three dummies for parental educational level (each separately for mothers and fathers, respectively). Individual characteristics include two dummies for birth order, three dummies for family structure when growing up, and a binary variable indicating (1st or 2nd generation) immigrant background. Parental income is the natural logarithm of the median income in mother's and father's occupational group, respectively. Survey weights used. Standard errors in parentheses. Levels of significance ***$p<0.01$, **$p<0.05$, *$p<0.1$. Sources: NEPS-SC5, Federal Labour Office, Federal Statistical Office

this effect is roughly twice the size in absolute terms compared to the father-daughter correlations. The association between mothers' and sons' ranks is close to zero and never statistically significant.

The positive same-sex correlations are compatible with both a direct channel of resource transfer and an indirect channel of the transmission of gender roles. In contrast, the negative opposite-sex correlations between fathers and daughters are only compatible with a direct transfer of resources. These potential channels will be explored in more detail in Section '5'.

4.3 Non-linearity of intergenerational transmission

I next investigate how these findings vary across the distribution in the gender-typicality rank of university major. Figure 1 presents the coefficents and 95% confidence intervals on rank in mother's occupation (top panel) and father's occupation (bottom panel) from quantile regressions at the 10th to the 90th percentiles of the distribution in major rank, for daughters (left-hand side) and sons (right-hand side). All specifications include the full set of control variables. Overall, the statistically significant positive father-son and negative father-daughter correlations and the finding that mothers' rank is not related to sons' nor daughters' major choices hold across the majority of points in the distribution of rank in students' major.

Moreover, the coefficient on mothers' rank is quite stable across the different quantiles in the distribution of daughters' and sons' rank in major. The size of the father effect, on the other hand, varies across the distribution of rank in major. It takes an approximate (albeit skewed) U-shape for the sample of daughters and a (skewed) inverse U-shape for the sample of sons. For both the sample of daughters and the sample of sons, the coefficient on fathers' rank is largest in terms of absolute size between the 20th and the 50th percentiles of the dependent variables. This suggests that the effect of fathers' rank is driven by daughters who choose less typically feminine (gender-atypical) and by sons who choose less typically male (gender-atypical) university majors. In particular, there appear to be stronger associations up until roughly the median of the distributions in sons' and daughters' rank. This suggests that the main results are driven by sons and daughters who defy gender-stereotypical major choices.

Next, I explore whether the strength of these intergenerational associations not only varies across the distribution of the dependent variable, but also across the distribution of the key regressors. To this end, I perform regressions in which I interact the rank in mothers' occupation with a binary variable taking a value of 1 if the rank in mothers' occupation is at least 50 (and 0 otherwise), and interact the rank in fathers' occupation with a binary variable taking a value of 1 if the rank in fathers' occupation is at least 50 (and 0 otherwise). I choose rank 50 as a cutoff to indicate a 'gender-typical' occupation as this roughly appears to be the turning point for the dependent variables, as shown in Fig. 1. The results are presented in Table 6. In line with previous results, the coefficients on mothers' rank do not appear statistically significant (neither for sons nor for daughters) and this holds true for both the lower half as well as the upper half of the distribution in mother's rank. The coefficients on

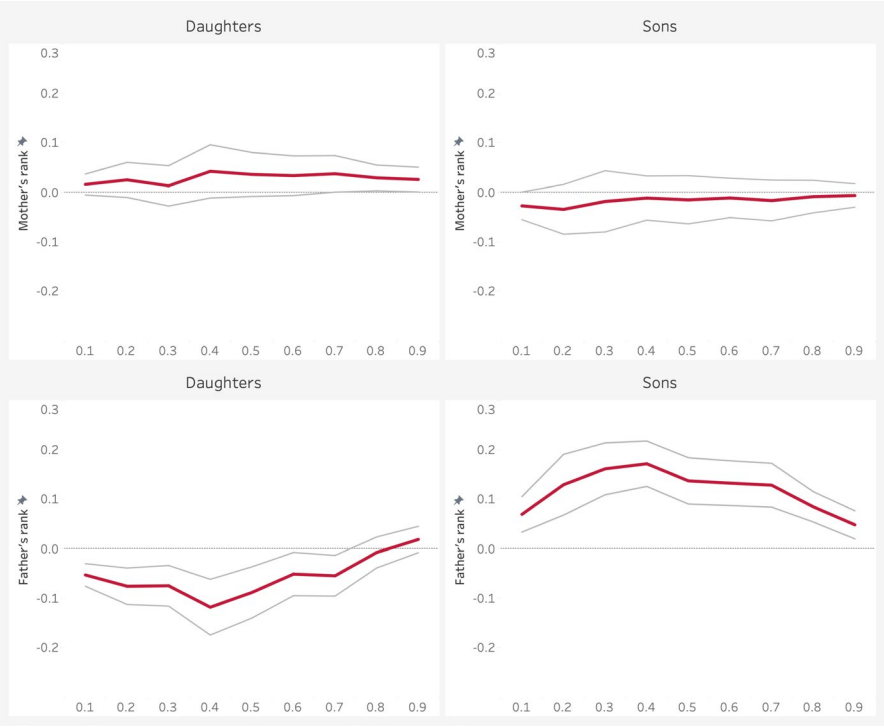

Fig. 1 Quantile regressions. Notes: Figures show coefficients and 95% confidence intervals from quantile regressions at different quantiles of the dependent variable. The dependent variable is the gender-typicality percentile rank of sons'/daughters' university major. The key regressors are femininity percentile rank of mother's occupation and masculinity percentile rank of father's occupation. The full set of control variables is included: age, a dummy indicating the parent was employed when offspring aged 15, three dummies for parental educational level (each separately for mothers and fathers, respectively), two dummies for birth order, three dummies for family structure when growing up, a binary variable indicating (1st or 2nd generation) immigrant background, and natural logarithm of the median income in mother's and father's occupational group, respectively. Survey weights used. Sources: NEPS-SC5, Federal Labour Office, Federal Statistical Office

the interaction effect between mothers' rank and a dummy indicating rank is larger than 50 are not statistically significant either.

For fathers, on the other hand, there is again evidence for a non-linear effect in intergenerational transmission. Results for the sample of sons (columns 1 and 2) show that the positive association between father's rank and sons' rank is statistically significant only for fathers with a rank below 50. For fathers with a rank of 50 or above, the coefficient on fathers' rank is close to 0 and not statistically signicant (as indicated by the linear combination of estimates) and this difference compared to fathers with a rank of at least 50 is statistically significant, as indicated by the interaction effect. The results for the sample of daughters (columns 3 and 4) paint a similar picture. The negative association between masculinity rank in fathers' occupation and femininity rank in daughters' major is statistically significant only for fathers'

ranks up to 50. For ranks of 50 and higher, the coefficient is close to 0 and not statistically significant (linear combination of estimates) and this difference is statistically significant, as indicated by the interaction effect.

Taken together, results from Fig. 1 and Table 6 support the main takeaways in terms of statistical significance and signs of key regressors from the linear regression results presented in Table 3. Moreover, they reveal important non-linear effects in intergenerational tranmission. They show that the positive father-son correlations and the negative father-daughter correlations are driven by those in gender-*atypical* occupations and university majors. Sons with fathers in gender-atypical occupations choose less typically male university majors, thus breaking gender stereotypes. Daughters with fathers in gender-atypical occupations choose more typically female majors, though this effect seems to disappear for daughters choosing majors with a very high femininity rank. These non-linearities are important to bear in mind when interpreting the results and considering resulting policy implications.

5 Direct versus indirect channel of intergenerational transmission

Section '2' described direct resource transfers and transmission of gender roles as two potential channels that can account for the results presented in Section '4'. In this section, I study the presence of these two channels through a number of different heterogeneity analyses.

5.1 Direct transfer of resources

Results presented in the previous section showed that fathers'—but generally not mothers'—rank is significantly correlated with the degree to which young women's and men's major choices are typically female and male, respectively. Results also revealed that mothers in more typically female occupations have daughters in more typically female majors, if these mothers were employed at some stage while raising children. Taken together, these findings suggest that the more important role of fathers in the study sample may be related to the fact that German families of the parental generation often follow a traditional division of work in which the father is the main breadwinner. That is, the father typically works full-time and the mother does not work or works part-time (Holst and Wieber, 2014). Indeed, according to the theory of direct transfer ('direct channel'), young adults are more likely to identify with and use the resources of the higher-status parent (Vleuten et al., 2018).

To test the plausibility of a direct transfer of resources, I analyse whether results vary across parental status. To do so, I perform three different heterogeneity analyses, presented in Table 7.[22] In the first, I interact mothers' and fathers'

[22] Ideally, heterogeneity analyses would study how results vary across different family working time arrangements and relative parental income. Unfortunately, there is no information available on whether a parent worked part-time or full-time or on parental income, so this is not possible. I therefore conduct alternative heterogeneity analyses to proxy relative parental status.

Table 6 Interaction effects to test linearity of intergenerational transmission

Dependent variable	Sons: Masculinity rank major		Daughters: Femininity rank major	
	(1)	(2)	(3)	(4)
Rank mother's occup.	0.0773 (0.0557)	0.0309 (0.0563)	−0.0178 (0.0520)	−0.0176 (0.0514)
Dummy rank mother ≥ 50	−5.8181* (3.3341)	−2.7167 (3.5664)	3.6310 (2.9201)	2.3164 (2.9015)
Rank mother's occup. × rank ≥ 50	0.0237 (0.0670)	0.0011 (0.0687)	−0.0154 (0.0634)	0.0040 (0.0622)
Rank father's occup	0.1551*** (0.0428)	0.1867*** (0.0415)	−0.1398*** (0.0364)	−0.1480*** (0.0374)
Dummy rank father ≥ 50	8.7344** (4.2616)	9.0137** (4.5767)	−8.4503* (4.4005)	−7.1802* (4.0591)
Rank father's occup. × rank ≥ 50	−0.1362* (0.0698)	−0.1731** (0.0731)	0.1813*** (0.0657)	0.1654*** (0.0617)
Linear combination of estimates				
Lincom mother	0.101** (0.0422)	0.0320 (0.0476)	−0.0332 (0.0353)	−0.0136 (0.0364)
Lincom father	0.0189 (0.0570)	0.0136 (0.0596)	0.0414 (0.0585)	0.0174 (0.0533)
Observations	3540	3540	6100	6100
R-squared	0.0174	0.0596	0.0048	0.0364
State FE	No	Yes	No	Yes
Parental characteristics	No	Yes	No	Yes
Individual characteristics	No	Yes	No	Yes
Parental income	No	Yes	No	Yes

Table shows estimates from OLS regressions. The dependent variable is the gender-typicality percentile rank of sons'/daughters' university major. Parental characteristics include age, a dummy indicating the parent was employed when offspring aged 15, three dummies for parental educational level (each separately for mothers and fathers, respectively). Individual characteristics include two dummies for birth order, three dummies for family structure when growing up, and a binary variable indicating (1st or 2nd generation) immigrant background. Parental income is the natural logarithm of the median income in mother's and father's occupational group, respectively. Survey weights used. Standard errors in parentheses. Levels of significance ***$p<0.01$, **$p<0.05$, *$p<0.1$. Sources: NEPS-SC5, Federal Labour Office, Federal Statistical Office

rank with a dummy indicating whether they have tertiary education. The rationale is that tertiary education is an indicator of social status and results from Table 3 showed that mothers' educational level is associated with daughters' femininity rank in major. In the second heterogeneity analysis, I interact the parental rank variables with a dummy for whether the individual went to school in East Germany when aged 15. The rationale behind this variable is that couples in East Germany on average have a more equal division of work, which is a result of the differences in family policy between East and West Germany during the divided years (Bauernschuster and Rainer, 2012; Holst and Wieber, 2014). Specifically, while West German policy encouraged a traditional male breadwinner model in which fathers worked and mothers stayed at home, East German policy encouraged a reconciliation of motherhood and work (Bauernschuster and Rainer, 2012). Finally, I interact the parental rank variables with a dummy for whether the individual grew up living with the mother only. While this is a measure of intensity of parental contact, mothers in the sample who raise children living without a partner are also more likely to have higher status. Specifically, they are more likely to possess a tertiary degree and be employed at the time their daughter or son was 15.

Columns 1 to 3 of Table 7 present results for the sample of sons and columns 4 to 6 for daughters. Column 1 shows that mothers' rank is not significantly associated with sons' major, independently of her educational level. The positive effect of fathers' masculinity rank on sons' masculinity rank holds independently of fathers' education, but it is significantly stronger if fathers have tertiary education. Column 2 shows that the effect of parental rank does not depend on whether the son grew up living in East Germany. Finally, column 3 indicates that there is a positive father-son correlation in masculinity rank, independently of whether the son grew up living with both parents. However, the coefficient on the interaction between mothers' rank and the dummy variable of living with the mother only is negative and statistically significant. Mothers in a more typically female occupation have sons in less typically male majors, for those who grew up living with the mother only.

Moving on to daughters, column 4 shows that the coefficients on mothers' rank and fathers' rank, which show the effect for those mothers and fathers without a tertiary degree, are not statistically significant. Fathers in more typically male occupations who have tertiary education, however, have daughters in less typically female majors, and the interaction term is statistically significant. Moreover, mothers in more typically female occupations who are tertiary-educated have daughters in more typically female majors (the coefficient is statistically significant at the 10% level). However, the interaction term is not statistically significant. Column 5 presents the results distinguishing between East and West Germany. For the sample of daughters going to school in West Germany, only the father-daughter correlation is statistically significant. On the other hand, for those growing up in East Germany the coefficient on mothers' rank increases to 0.062 and becomes significant at the 10% level (though the coefficient on the interaction term is not statistically significant). Finally, column 6 shows that the negative father-daughter correlation is only statistically significant for daughters who grew up living with both parents. On the other hand, the coefficient on mothers' rank is larger (but imprecisely estimated) for daughters who

Table 7 Channel: direct transfer of resources

Dependent variable	Sons: Masculinity rank major			Daughters: Femininity rank major		
	(1)	(2)	(3)	(4)	(5)	(6)
Rank mother's occup.	−0.0081 (0.0194)	−0.0012 (0.0185)	−0.0019 (0.0164)	0.0133 (0.0187)	0.0155 (0.0189)	0.0251 (0.0170)
Mother tertiary degree	−1.5331 (2.6666)			1.3336 (2.1872)		
Mother: tertiary × rank	−0.0051 (0.0407)			0.0383 (0.0311)		
Rank father's occup.	0.0759*** (0.0230)	0.1092*** (0.0202)	0.1111*** (0.0196)	−0.0263 (0.0196)	−0.0437** (0.0200)	−0.0589*** (0.0194)
Father tertiary degree	−6.6496*** (2.5014)			2.9826 (2.0209)		
Father: tertiary × rank	0.1387*** (0.0406)			−0.1159*** (0.0373)		
Dummy East Germany		−8.1227 (5.7517)			17.4141*** (5.3234)	
East × mother's rank		−0.0472 (0.0326)			0.0462 (0.0373)	
East × father's rank		0.0151 (0.0418)			−0.0475 (0.0399)	
Mother only			5.5460 (4.3333)			−1.4653 (4.0261)
M. only × mother's rank			−0.1668*** (0.0590)			0.0196 (0.0562)
M. only × father's rank			0.0293 (0.0651)			0.0627 (0.0575)
Linear combination of estimates						
Lincom mother	−0.0132 (0.0333)	−0.0485* (0.0281)	−0.169*** (0.0574)	0.0516* (0.0278)	0.0617* (0.0326)	0.0446 (0.0550)
Lincom father	0.215*** (0.0344)	0.124*** (0.0404)	0.140** (0.0647)	−0.142*** (0.0350)	−0.0912** (0.0366)	0.0038 (0.0538)
Observations	3540	3540	3513	6100	6100	6058
R-squared	0.0603	0.0577	0.0595	0.0366	0.0351	0.0344
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Parental characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Individual characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Parental income	Yes	Yes	Yes	Yes	Yes	Yes

Table shows estimates from OLS regressions. The dependent variable is the gender-typicality percentile rank of sons'/daughters' university major. The key regressors are femininity percentile rank of mother's occupation and masculinity percentile rank of father's occupation. Parental characteristics include age, a dummy indicating the parent was employed when offspring aged 15, three dummies for parental educational level (each separately for mothers and fathers, respectively). Individual characteristics include two dummies for birth order, three dummies for family structure when growing up, and a binary variable indicating (1st or 2nd generation) immigrant background. Parental income is the natural logarithm of the median income in mother's and father's occupational group, respectively. Survey weights used. Standard errors in parentheses. Levels of significance ***$p<0.01$, **$p<0.05$, *$p<0.1$. Sources: NEPS-SC5, Federal Labour Office, Federal Statistical Office

grew up living with mothers only, even though the interaction term is not statistically significant.

In sum, the coefficient on fathers' rank in the sample of sons is positive and statistically significant independently of fathers' status, but the effect size is significantly larger when fathers have tertiary education. Sons' choice is significantly associated with mothers' rank only if they grew up living with the mother only. This could be explained by the higher intensity of contact with the mother (providing support for the the relevance of direct transfers of resources other than genetic inheritance), and by the fact that single mothers on average have higher status (providing support for a direct transfer of resources).[23] For daughters, the coefficient on mothers' rank is larger if the latter possess a tertiary degree, and if daughters grew up living in the East or grew up living with the mother only, but the interaction terms are not statistically significant. In contrast, the significant effect of fathers on daughters disappears for fathers without tertiary education and for daughters who grew up living with a mother only. Taken together, these results indicate that parental status does indeed matter for the correlation between rank in parental occupation and offspring's major choice. This suggests that the direct transfer of resources from parents to their children constitutes a relevant channel for the correlation between gender-typicality rank in parental occupation and gender-typicality rank in offsprings' major.

5.2 Transmission of gender roles

Section '2' stated that, in addition to a direct resource transfer, a second 'indirect channel' is likely present if children choose majors that are unrelated to their parents' occupations and we still observe a significant association between gender typicality in parental occupation and gender typicality in children's majors. In such a case, the possibility of direct resource transfers is much more limited, and therefore a significant association can suggest that the transmission of gender roles plays a role. Empirically, this can be tested by studying heterogeneous effects across those children who choose majors that are related to the same field as their parents' occupations and those whose majors are unrelated to parents' occupations.

To do so, it is necessary to map each major with an occupational field. The appropriate mapping of parental occupational fields to groups of majors is in many cases not obvious. Therefore, I use a classification developed for the German Student Survey, which maps university majors to occupational fields (see (Georg and Bargel, 2017)).[24] The mapping is shown in Table 8. The table shows that each of nine broad groups of university majors is mapped to one of nine broad fields of occupations. The broader the groups, the more likely it is

[23] The data confirms that single mothers have on average higher status as proxied by tertiary educational level. As mentioned in Section '3.1', information on parental occupation is reported by students, implying that students included in the sample know their father's occupation even if they grew up living with the mother only.

[24] The German Student Survey (Studierendensurvey) is a survey of students at German universities conducted by the research group on higher education at the University of Konstanz. It aims to provide information on student orientations and the study situation, and has been conducted regularly since the 1980s.

that fields are sufficiently distinct from each other so that the direct transfer of resources is indeed blocked as a channel as good as possible. For example, all university majors within natural sciences, mathematics, and computer science constitute one group and are mapped to all occupations within the natural sciences sector, such as laboratory assistants.

In addition to similarity of field, as demonstrated, direct resource transfer is more likely if parents have a higher status. Therefore, I define a dummy variable called 'direct transfer mother' which takes a value of 1 if the following two conditions are met: the mother has tertiary education and the student chooses a major that is in the same broad field as mother's occupation, according to Table 8. The variable takes a value of 0 otherwise. I define a dummy variable called 'direct transfer father' in the same way.

Table 9 presents the results in which I interact mothers' and fathers' rank with the 'direct transfer' variables. The table reports results for sons without any controls (column 1) and with federal state fixed effects and individual level controls (column 2), and for daughters without and with controls (columns 3 and 4, respectively). The coefficients on the interaction effects between parental rank and the 'direct transfer' indicators are statistically significant and large in absolute terms in all cases. The linear combination of estimates shown at the bottom of the table indicates that in the cases in which 'direct transfer' occurs, there is a positive and statistically significant same-sex association between rank of fathers and sons, as well as between mothers and daughters. Moreover, there is a negative and significant opposite-sex association between mothers and sons, as well as between fathers and daughters. The effects are quite large compared to the main results reported in Section '4'. For example, for daughters who choose a major in which direct transfer from the father occurs, a one percentile increase in fathers' masculinity rank is associated with a 0.83 decrease in daughters' femininity rank in major.

In contrast, the coefficients on mothers' rank and fathers' rank are not statistically significant in most cases. This means that in those cases where the 'direct transfer' is blocked, mothers' and fathers' ranks are not significantly associated with offsprings' choices. The only exception is the coefficient on fathers' rank in the sample of sons. In the full specification in column 2 it takes a value of approximately 0.06, suggesting that in those cases where sons choose a major where the direct transfer of resources is unlikely to occur, a one percentile increase in fathers' masculinity rank is associated with a 0.06 increase in masculinity rank in sons' major.

Overall, the 'direct transfer of resources' channel seems to account for a large part of the results. There is no direct evidence for the existence of an 'indirect channel' for the associations between fathers, and daughters and mothers and daughters, as well as mothers and sons. However, a transmission of gender roles may still occur *within* the group of students who choose a major closely related to parental occupation. Given the broad categories of the mapping of majors to occupations, the potential importance of this possibility should not be discarded. Moreover, findings suggest that the transmission of gender roles is a relevant channel for the associations in masculinity rank between fathers' occupations and sons' majors.

Table 8 Mapping of occupations to university majors

University majors	Occupations
Humanities, social sciences, theology, languages	Print media, electronic media, librarianship, foreign languages (e.g. journalism, publishing, librarianship)
Social sciences, education, pedagogy, psychology	Education and social services (e.g. nursery school teacher, social service provider, youth services)
Legal studies	Administrative, legal, security (e.g. paralegal, police, air traffic controller)
Economics and industrial engineering	Commercial sector/trade/banking (e.g. administrative assistant, actuary, trade association)
Medicine, dentistry, veterinary medicine, pharmacy	Health care, nursing, optometry, pharmacy (e.g. medical assistant, medical technicians, opticians, dental technician)
Natural sciences, mathematics, computer science	Natural science sector (e.g. chemical laboratory assistant, laboratory assistant)
Engineering and architecture	Technology, metallurgy, electronics, building, timber/lumber industry, IT (e.g. locksmith, mechanic, electrician)
Agronomy, forestry, and nutritional science	Nutrition, gastronomy/hotel, catering (e.g. baker, cook, waiter); agriculture and home economics, horticulture (e.g. gardener, florist, agricultural manager)
Fine arts, music, theatre, film school	Fine art, design, music sector (e.g. photographer, interior decorator, coutourier)
Other disciplines	Other occupations

Source: Georg and Bargel (2017)

6 Conclusion

Using data of a nationally representative cohort of first-year undergraduate students in Germany, I examined whether femininity of mothers' occupation and masculinity of fathers' occupation are related to whether their adult children choose typically male or female majors at university, and if so, why.

The findings indicate that the gender-typicality rank in parental occupation matters for students' gendered university major choices. While the effect sizes are modest, I identified a consistent and robust association despite only considering one specific aspect of parental behaviour. Results from quantile regressions and heterogeneity analyses suggest that fathers in gender-atypical occupations can help break gender stereotypes and that the findings of the paper are at least partially driven by sons and daughters who defy gender-stereotypical major choices.

It is important to note that intergenerational transmission is not the same for mothers and fathers: heterogeneity analyses by parental education showed that fathers' rank is significantly associated with sons' rank independently of their status but with daughters' rank only if they have a tertiary degree. Mothers often have less successful careers than fathers and lower levels of education; their

Table 9 Channel: transmission of gender roles

Dependent variable	Sons: Masculinity rank major		Daughters: Femininity rank major	
	(1)	(2)	(3)	(4)
Rank mother's occupation	0.0127 (0.0162)	−0.0068 (0.0157)	0.0100 (0.0148)	0.0063 (0.0165)
Direct transfer mother	−2.2087 (4.0679)	−1.7456 (4.2721)	−3.4149 (2.7905)	−3.3175 (2.8414)
Direct transfer mother × mother's rank	−0.3789*** (0.0919)	−0.3356*** (0.0960)	0.2678*** (0.0625)	0.2625*** (0.0598)
Rank father's occupation	0.0784*** (0.0218)	0.0591*** (0.0204)	−0.0187 (0.0184)	−0.0219 (0.0177)
Direct transfer father	−31.2764*** (3.9216)	−29.7093*** (3.6297)	19.8305*** (2.9039)	18.5075*** (2.7351)
Direct transfer father × father's rank	0.8146*** (0.0748)	0.8139*** (0.0731)	−0.8228*** (0.0750)	−0.8088*** (0.0708)
Linear combination of estimates				
Lincom mother	−0.366*** (0.0893)	−0.342*** (0.0952)	0.278*** (0.0637)	0.269*** (0.0605)
Lincom father	0.893*** (0.0721)	0.873*** (0.0710)	−0.842*** (0.0743)	−0.831*** (0.0711)
Observations	3540	3540	6100	6100
R-squared	0.0599	0.0982	0.0326	0.0631
State FE	No	Yes	No	Yes
Parental characteristics	No	Yes	No	Yes
Individual characteristics	No	Yes	No	Yes
Parental income	No	Yes	No	Yes

Table shows estimates from OLS regressions. The dependent variable is the gender-typicality percentile rank of sons'/daughters' university major. The key regressors are femininity percentile rank of mother's occupation and masculinity percentile rank of father's occupation. Direct transfer indicates that major matches parents' occupational group according to Table 8 and parent has tertiary education. Parental characteristics include age, a dummy indicating the parent was employed when offspring aged 15, three dummies for parental educational level (each separately for mothers and fathers, respectively). Individual characteristics include two dummies for birth order, three dummies for family structure when growing up, and a binary variable indicating (1st or 2nd generation) immigrant background. Parental income is the natural logarithm of the median income in mother's and father's occupational group, respectively. Survey weights used. Standard errors in parentheses. Levels of significance ***$p<0.01$, **$p<0.05$, *$p<0.1$. Sources: NEPS-SC5, Federal Labour Office, Federal Statistical Office

rank in occupation is only significantly associated with daughters' rank under certain conditions, and is not correlated with sons' rank. These asymmetries highlight the need to study both same-sex and opposite-sex intergenerational correlations between mothers and fathers on the one hand, and daughters and sons on the other hand. Much of previous research on intergenerational transmission of income and education has focused solely on fathers (e.g. Lefgren et al. 2012).

I identified two distinct channels through which these intergenerational correlations can operate, a direct transfer of resources, and a transmission of gender roles. Findings suggest that the transfer of occupation-specific resources from parents to their children plays an important role and that a transmission of gender roles explains at least some of the father-son associations.

The finding that a transmission of gender roles occurs predominantly between fathers and sons is in line with the observation that despite the increasing number of women entering male-dominated occupations, men continue to be reluctant to enter into female-dominated occupations (England, 2010). Previous research also suggests that male gender norms are more restrictive (Koenig, 2018). This points to a shortcoming of existing literature on intergenerational transmission of gender roles, where the predominant focus has been on women (e.g. (van Putten et al., 2008; Morrill and Morrill, 2013; Fernández and Fogli, 2009; Olivetti et al., 2020)). In light of this, the finding that the positive association between rank in fathers' occupation and rank in sons' major is primarily driven by fathers and sons in less typically masculine occupations/majors is therefore especially encouraging.

The results from this study cannot be interpreted in a causal way. Nevertheless, some suggestive policy implications arise from the findings of this paper. First, the relevance of parental occupation shows the importance of policies that address roots of segregation that happen early in life through socialisation. One example is to invest in educational programmes designed to encourage 'atypical' choices among teenagers and to promote new role models, as showcased by initiatives such as 'Girls' day' and 'New pathways for boys' in Germany (Bettio and Verashchagina, 2009). These initiatives intend to widen the occupational aspirations of girls and boys. Results from this paper suggest that especially men in 'gender-atypical' occupations may encourage boys to aspire to less typically male occupations.

Second, the interactive effect of parental status with masculinity/femininity in parental occupation suggests that high-status parents may serve as role models independent of whether they are of the same sex as their child. It also suggests that successful role model identification is contingent on status and perceived desirability.

Third, while it is important to encourage women to enter highly paid STEM fields, policy should also aim at changing men's attitudes and encouraging them to enter traditionally female-dominated fields. Results from this paper suggest that one avenue could be to stimulate men's interest in typically female fields by challenging traditional stereotypes.

This paper has focused in detail on gender typicality in parental occupation, a previously unexplored determinant of the persistence of gendered university major choices in Germany. Future research could extend this in various ways. Specifically,

the paper has focused on choice of major when entering university. It would be interesting to study how gender typicality of parental occupation and entry to a gender-typical major affect the probability to drop out, switch major, and successfully obtain a university degree. With regard to external validity, it is possible that results are different among individuals with lower levels of education. Therefore, future research could explore whether the intergenerational transmission and its underlying channels are different when studying for example vocational education choices. Moreover, findings from this paper suggest important non-linearities in intergenerational associations. Future research could build on the rank measure used in this paper by further modeling non-linear relationships in ways that do not impose arbitrary cutoffs in what constitutes a gender-typical occupation or university major. Finally, most papers, including this one, focus on one specific determinant of major choice. Future research that considers the relative importance of different socialisation agents, including peers and teachers, would therefore be valuable.

Appendix

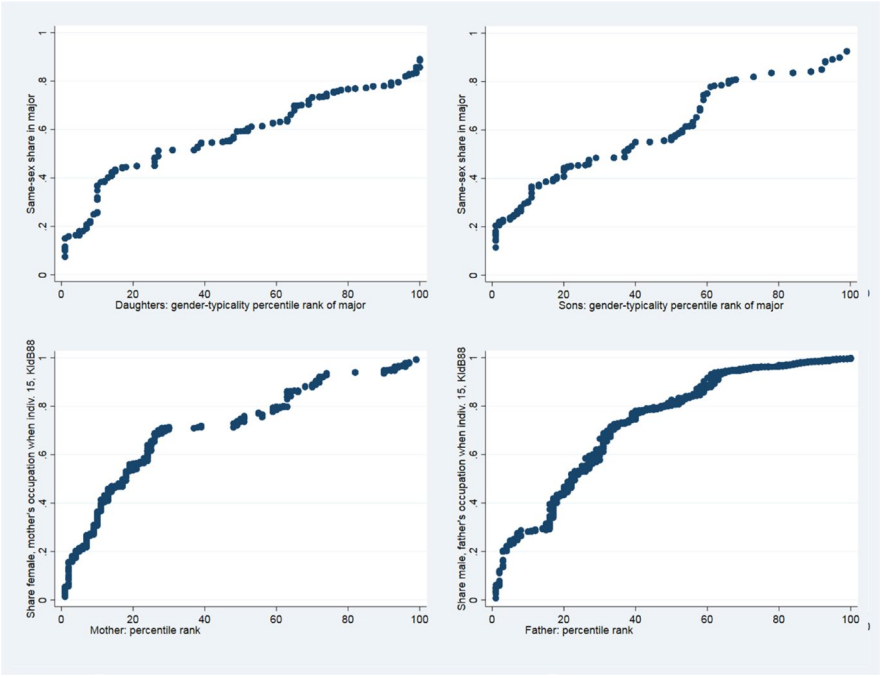

Fig. 2 Scatterplot: share- vs. rank-based measures of gender-typicality. Sources: NEPS-SC5, Federal Labour Office, Federal Statistical Office

Table 10 Sample selection

	Initial full sample				Aged 18 to 25 with general school leaving certificate				Final sample: missing obs. on key covariates dropped			
	Men		Women		Men		Women		Men		Women	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Mother employed	0.71		0.75		0.72		0.75		0.71		0.74	
Father employed	0.95		0.94		0.96		0.95		0.96		0.95	
Mother lower secondary or less	0.2		0.19		0.15		0.15		0.15		0.16	
Mother intermediate secondary	0.37		0.37		0.37		0.37		0.37		0.36	
Mother upper secondary	0.17		0.17		0.18		0.18		0.17		0.18	
Mother tertiary degree	0.25		0.27		0.3		0.3		0.31		0.30	
Father lower secondary or less	0.23		0.23		0.18		0.2		0.18		0.19	
Father intermediate secondary	0.26		0.26		0.26		0.25		0.26		0.25	
Father upper secondary	0.13		0.13		0.13		0.14		0.13		0.14	
Father tertiary degree	0.38		0.38		0.43		0.42		0.44		0.42	
School aged 15 in East Germany	0.2		0.22		0.21		0.21		0.20		0.20	
Gender-typicality rank major	55.3	24.7	50.8	32.1	52.5	24.4	50.3	31.3	51.6	24.4	51.2	31.3
Age	21.7	3.4	21.5	4.8	20.5	1.2	20.2	1.5	20.5	1.2	20.2	1.5
Rank mother's occupation	54.6	26	53.8	32.4	53.3	25.9	53.2	31.9	53.4	25.9	53.1	32.1
Rank father's occupation	44.4	24.1	43.8	30.1	42.9	23.7	43.1	29.4	42.8	23.6	43.2	29.3
Mother's age	50	5.5	50.1	6.9	49.2	4.5	49.2	5.4	49.3	4.4	49.2	5.4
Father's age	53	6.2	52.9	7.7	52.2	5.4	51.9	6.4	52.1	5.2	51.9	6.4
N	7082		10,828		5,169		8881		3540		6100	

Lower secondary school or less means Hauptschulabschluss or no secondary school leaving certificate. Intermediate secondary means Mittlere Reife. Upper secondary means general or subject-linked school leaving certificate (Allgemeine Hochschulreife or Fachhochschulreife). Survey weights used. Standard errors in parentheses. Levels of significance ***$p<0.01$, **$p<0.05$, *$p<0.1$. Source: NEPS-SC5

Table 11 Summary statistics

	Men		Women		Total	
	Mean	SD	Mean	SD	Mean	SD
Gender-typicality percentile rank in major	51.6	24.4	51.2	31.3	51.4	28.2
Dummy university of applied sciences (FH)	0.277		0.209		0.240	
Dummy teaching degree	0.067		0.164		0.119	
Age	20.5	1.2	20.2	1.5	20.3	1.4
Femininity rank of mother's occup.	53.4	25.9	53.1	32.1	53.2	29.3
Masculinity rank of father's occup.	42.8	23.6	43.2	29.3	43	26.8
Mother's age	49.3	4.4	49.2	5.4	49.3	5
Father's age	52.1	5.2	51.9	6.4	52	5.8
Mother inactive	0.187		0.167		0.176	
Father inactive	0.007		0.010		0.009	
Mother employed	0.711		0.736		0.725	
Father employed	0.964		0.953		0.958	
Mother lower secondary or less	0.146		0.158		0.152	
Mother intermediate secondary	0.371		0.364		0.367	
Mother upper secondary	0.174		0.178		0.176	
Mother tertiary degree	0.309		0.301		0.305	
Father lower secondary or less	0.180		0.193		0.187	
Father intermediate secondary	0.258		0.252		0.255	
Father upper secondary	0.125		0.138		0.132	
Father tertiary degree	0.437		0.417		0.426	
Ln median income in mother's occup. group	6.4	2.8	6.6	3.2	6.5	3
Ln median income in father's occup. group	8	0.7	7.9	0.9	8	0.8
Birth order: first born	0.377		0.377		0.377	
Birth order: second or higher born	0.480		0.489		0.485	
Birth order: only child	0.143		0.134		0.138	
Grew up living w. biological parents	0.906		0.896		0.901	
Grew up living w. mother only	0.064		0.066		0.065	
Grew up living w. mother & stepfather	0.022		0.030		0.026	
Grew up living w. other	0.008		0.009		0.008	
Dummy 1st or 2nd generation immigrant	0.152		0.149		0.150	
Dummy school at age 15 in East Germany	0.197		0.199		0.198	

Survey weights used. Standard errors in parentheses. Levels of significance ***$p<0.01$, **$p<0.05$, *$p<0.1$. Mother/father inactive means that they have not been employed in the period between the birth of the individual and the individual reaching age 15. Lower secondary school or less means Hauptschulabschluss or no secondary school-leaving certificate. Intermediate secondary means Mittlere Reife. Upper secondary means general or subject-linked school-leaving certificate (Allgemeine Hochschulreife or Fachhochschulreife). Source: NEPS-SC5

Table 12 Interactive effect of mother's and father's gender-typicality rank in occupation

Dependent variable	Gender-typicality rank in major			
	Sons		Daughters	
	(1)	(2)	(3)	(4)
Rank mother's occupation	−0.0245 (0.0297)		0.0349 (0.0281)	
Rank father's occupation	0.0981** (0.0383)		−0.0437 (0.0354)	
Rank mother's × father's occup.	0.0003 (0.0006)		−0.0002 (0.0006)	
Dummy rank mother's occup. ≥ 50		−1.3343 (1.0258)		2.5344** (1.0406)
Dummy rank father's occup. ≥ 50		5.1224*** (1.4820)		−0.8409 (1.5532)
Dummy mother's × father's rank ≥ 50		−0.5435 (1.7883)		−1.7001 (2.0177)
Observations	3540	3540	6100	6100
R-squared	0.0574	0.0538	0.0344	0.0336
State FE	Yes	Yes	Yes	Yes
Parental characteristics	Yes	Yes	Yes	Yes
Individual characteristics	Yes	Yes	Yes	Yes
Parental income	Yes	Yes	Yes	Yes

Table shows estimates from OLS regressions. The dependent variable is the gender-typicality percentile rank of sons'/daughters' university major. Parental characteristics include age, a dummy indicating the parent was employed when offspring aged 15, three dummies for parental educational level (each separately for mothers and fathers, respectively). Individual characteristics include two dummies for birth order, three dummies for family structure when growing up, and a binary variable indicating (1st or 2nd generation) immigrant background. Parental income is the natural logarithm of the median income in mother's and father's occupational group, respectively. Survey weights used. Standard errors in parentheses. Levels of significance ***$p<0.01$, **$p<0.05$, *$p<0.1$. Sources: NEPS-SC5, Federal Labour Office, Federal Statistical Office

Table 13 Additional variations on the analysis sample

Dependent variable	Gender-typicality percentile rank in major							
Sample	All school leaving certificates		No teaching degrees		Biological parents only		No immigrant background	
	Sons	Daughters	Sons	Daughters	Sons	Daughters	Sons	Daughters
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Rank mother's occupation	−0.0082 (0.0146)	0.0199 (0.0150)	−0.0058 (0.0167)	0.0205 (0.0193)	−0.0002 (0.0167)	0.0253 (0.0170)	−0.0079 (0.0166)	0.0190 (0.0174)
Fank father's occupation	0.1031*** (0.0175)	−0.0417** (0.0172)	0.0974*** (0.0212)	−0.0440** (0.0220)	0.1054*** (0.0197)	−0.0604*** (0.0204)	0.1278*** (0.0219)	−0.0619*** (0.0203)
Observations	4341	6748	2715	3387	3218	5502	3063	5266
R-squared	0.0663	0.0321	0.0657	0.0347	0.0552	0.0358	0.0649	0.0319
State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Parental characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Individual characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Parental income	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table shows estimates from OLS regressions. The dependent variable is the gender-typicality percentile rank of sons'/daughters' university major. The key regressors are femininity percentile rank of mother's occupation and masculinity percentile rank of father's occupation. Parental characteristics include age, a dummy indicating the parent was employed when offspring aged 15, three dummies for parental educational level (each separately for mothers and fathers, respectively). Individual characteristics include two dummies for birth order, three dummies for family structure when growing up, and a binary variable indicating (1st or 2nd generation) immigrant background. Parental income is the natural logarithm of the median income in mother's and father's occupational group, respectively. Survey weights used. Standard errors in parentheses. Levels of significance ***$p<0.01$, **$p<0.05$, *$p<0.1$. Sources: NEPS-SC5, Federal Labour Office, Federal Statistical Office

Table 14 Additional control variables

Dependent variable	Gender-typicality rank in major									
Sample	Sons	Daughters	Sons	Daughters	Sons	Daughters	Sons	Daughters	Sons	Daughters
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Rank mother's occupation	−0.0011 (0.0161)	0.0256 (0.0160)	−0.0147 (0.0162)	0.0273 (0.0167)	0.0026 (0.0156)	0.0254 (0.0163)	0.0037 (0.0137)	0.0276* (0.0154)	−0.0156 (0.0180)	0.0332* (0.0185)
Rank father's occupation	0.1143*** (0.0194)	−0.0543*** (0.0159)	0.1071*** (0.0193)	−0.0520*** (0.0180)	0.1002*** (0.0196)	−0.0532*** (0.0179)	0.0956*** (0.0181)	−0.0490*** (0.0177)	0.1123*** (0.0194)	−0.0536*** (0.0183)
High school GPA			5.3453*** (1.4722)	−2.4343 (1.5228)						
Relative math grade					2.2674*** (0.1815)	−1.7327*** (0.1712)				
Expected income							71.81*** (8.67)	−61.76*** (9.29)		
Mother inactive									−6.78 (14.92)	16.00 (13.36)
Observations	3538	6092	3529	6092	3491	6001	3540	6100	3540	6100
R-squared	0.2040	0.1456	0.0703	0.0369	0.1317	0.0733	0.2536	0.1526	0.0574	0.0347
State FE	Landkreis	Landkreis	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Parental characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Individual characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Parental income	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table shows estimates from OLS regressions. The dependent variable is the gender-typicality percentile rank of sons'/daughters' university major. The key regressors are femininity percentile rank of mother's occupation and masculinity percentile rank of father's occupation. Parental characteristics include age, a dummy indicating the parent was employed when offspring aged 15, three dummies for parental educational level (each separately for mothers and fathers, respectively). Individual characteristics include two dummies for birth order, three dummies for family structure when growing up, and a binary variable indicating (1st or 2nd generation) immigrant background. Parental income is the natural logarithm of the median income in mother's and father's occupational group, respectively. Columns 1 and 2 include fixed effects at the level of the 401 administrative districts (Landkreise) instead of the 16 federal states (Bundeslaender). High school GPA (Abiturnote) can take values from 1 to 6, with lower values indicating better GPA. Relative maths grade is maths grade minus german grade, each taking values from 1 to 15, with higher values indicating better results. Expected income is obtained using earnings information by university major from the DZHW Graduate Panel Survey. Mother inactive is defined as the mother not having been employed since the individual was born. Survey weights used. Standard errors in parentheses. Levels of significance ***$p<0.01$, **$p<0.05$, *$p<0.1$. Sources: NEPS-SC5, Federal Labour Office, Federal Statistical Office, DZHW Graduate Panel Survey

Table 15 Probability to enter university (marginal effects after logit)

Dependent variable	Enters uni and has obtained general school-leaving certificate			
Sample	Sons		Daughters	
	(1)	(2)	(3)	(4)
Rank mother's occupation	−0.0004 (0.0004)	−0.0002 (0.0004)	0.0002 (0.0006)	0.0008* (0.0004)
Rank father's occupation	−0.0010** (0.0005)	−0.0000 (0.0004)	−0.0022*** (0.0005)	−0.0014*** (0.0004)
Mother intermediate schooling		0.0701*** (0.0222)		0.0297 (0.0234)
Mother high school		0.0420 (0.0280)		0.1787*** (0.0509)
Mother tertiary degree		0.0415 (0.0369)		0.1924*** (0.0669)
Father intermediate schooling		−0.0171 (0.0225)		−0.0395 (0.0325)
Father high school		0.1031*** (0.0359)		0.0323 (0.0502)
Father tertiary degree		0.1010** (0.0444)		0.0013 (0.0491)
Observations	1731	1731	1799	1799
State FE	No	Yes	No	Yes
Parental characteristics	No	Yes	No	Yes
Individual characteristics	No	Yes	No	Yes
Parental income	No	Yes	No	Yes

Sample includes all students who participated in all survey waves, and are aged between 14 and 16 in grade 9 of secondary school. Survey weights used. Standard errors in parentheses. Levels of significance ***$p<0.01$, **$p<0.05$, *$p<0.1$. Source: NEPS-SC4, Federal Labour Office

Acknowledgements I thank Berkay Ozcan, Joan Costa-Font, Lucinda Platt, Almudena Sevilla, editor Klaus F. Zimmermann, managing editor Madeline Zavodny, three anonymous reviewers, and the audiences at the 2018 Annual Conference of the European Society for Population Economics (ESPE), at the 2018 Verona Winter School on Inequality and Social Welfare Theory, at the 2018 3rd International NEPS Conference of the Leibniz Institute for Educational Trajectories, at the 2019 Away Day of the Centre for Analysis of Social Exclusion (CASE), at the 2019 LSE Workshop on the Economics of Family, Gender and Old-Age, and members of the LSE Social Policy departmental reading group for useful comments and suggestions on this paper.

Funding Not applicable.

Availability of data and material This paper uses data from the National Educational Panel Study (NEPS): Starting Cohort First-Year Students, doi:10.5157/NEPS:SC5:14.0.0. as well as Starting Cohort Grade 9, doi:10.5157/NEPS:SC4:10.0.0. From 2008 to 2013, NEPS data was collected as part of the Framework Program for the Promotion of Empirical Educational Research funded by the German Federal Ministry of Education and Research (BMBF). As of 2014, NEPS is carried out by the Leibniz Institute for Educational Trajectories (LIfBi) at the University of Bamberg in cooperation with a nationwide network. The database was accessed via remote access to a controlled server environment and NEPS data access is restricted to holders of a Data Use Agreement with the Leibniz Institute for Educational Trajectories.

Declarations

Conflict of interest The authors declare no competing interests.

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by/4.0/.

References

Aina C, Nicoletti C (2018) The Intergenerational Transmission of Liberal Professions. Labour Economics 51:108–120. https://doi.org/10.1016/j.labeco.2017.12.003

Aisenbrey S, Brückner H (2008) Occupational Aspirations and the Gender Gap in Wages. European Sociological Review 24(5), 633–649. https://doi.org/10.1093/esr/jcn024

Akerlof GA, Kranton RE (2000) Economics and Identity. Quarterly Journal of Economics 115(3), 715–753

Alesina A, Giuliano P (2015) Culture and Institutions. Journal of Economic Literature 53(4), 898–944. https://doi.org/10.1257/jel.53.4.898

Altonji JG, Arcidiacono P, Maurel A (2016) Chapter 7 - The Analysis of Field Choice in College and Graduate School: Determinants and Wage Effects. In: Hanushek E, Machin S, Woessmann L (eds) Handbook of the Economics of Education, vol 5, Elsevier, pp 305–396

Anelli M, Peri G (2015) Gender of Siblings and Choice of College Major. CESifo Economic Studies 61(1), 53–71. https://doi.org/10.1093/cesifo/ifu028

Antecol H, Cobb-Clark D (2013) Do Psychosocial Traits Help Explain Gender Segregation in Young People's Occupations? Labour Economics 21:59

Bandura A (1977) Social Learning Theory. Prentice-Hall, London

Bauernschuster S, Rainer H (2012) Political Regimes and the Family: How Sex-Role Attitudes Continue to Differ in Reunified Germany. Journal of Population Economics 25(1), 5–27. https://doi.org/10.1007/s00148-011-0370-z

Becker GS, Tomes N (1979) An Equilibrium Theory of the Distribution of Income and Intergenerational Mobility. Journal of Political Economy 87(6), 1153–1189. https://doi.org/10.1086/260831

Bertrand M (2018) Coase Lecture - The Glass Ceiling. Economica 85(338), 205–231. https://doi.org/10.1111/ecca.12264

Bettio F, Verashchagina A (2009) Gender Segregation in the Labour Market - Root Causes, Implications and Policy Responses in the EU. European Commission's Expert Group on Gender and Employment (EGGE), European Commission

Bicchieri C (2017) Norms in the Wild: How to Diagnose, Measure, and Change Social Norms. Oxford University Press, New York

Bisin A, Verdier T (2001) The Economics of Cultural Transmission and the Dynamics of Preferences. Journal of Economic Theory 97(2), 298–319. https://doi.org/10.1006/jeth.2000.2678

Bisin A, Verdier T (2011) Chapter 9 - The Economics of Cultural Transmission and Socialization. In: Jess Benhabib ABaMOJ (ed) Handbook of Social Economics, vol 1, North-Holland, pp 339–416

Black DA, Haviland AM, Sanders SG, Taylor LJ (2008) Gender Wage Disparities among the Highly Educated. Journal of Human Resources 43(3), 630–659. https://doi.org/10.3368/jhr.43.3.630

Blau FD, Kahn LM (2017) The Gender Wage Gap: Extent, Trends, and Explanations. Journal of Economic Literature 55(3), 789–865. https://doi.org/10.1257/jel.20160995

Blossfeld HP, Roßbach HG (eds) (2011) Education as a Lifelong Process: The German National Educational Panel Study (NEPS). Edition ZfE, VS Verlag für Sozialwissenschaften. https://doi.org/10.1007/978-3-658-23162-0

Bottia MC, Stearns E, Mickelson RA, Moller S, Valentino L (2015) Growing the Roots of STEM Majors: Female Math and Science High School Faculty and the Participation of Students in STEM. Economics of Education Review 45:14–27. https://doi.org/10.1016/j.econedurev.2015.01.002

Braakmann N (2008) Non scholae, sed vitae discimus! - The Importance of Fields of Study for the Gender Wage Gap Among German University Graduates During Labor Market Entry and the First Years of their Careers. Working Paper Series in Economics 85, University of Lüneburg, Institute of Economics

Brandt G, Briedis K, Fabian K, Klüver S, Rehn T, Trommer M (2018) DZHW-Absolventenpanel 2009. Datenerhebung: 2010-2015. Version: 1.0.1. Datenpaketzugangsweg: Download-SUF. Hannover: FDZ-DZHW. Datenkuratierung: Baillet, F., Franken, A., & Weber, A. https://doi.org/10.21249/DZHW:gra2009:1.0.1

Brenoe AA, Zoelitz U (2019) Exposure to More Female Peers Widens the Gender Gap in STEM Participation. Journal of Labor Economics. https://doi.org/10.1086/706646

Briedis K, Euler T, Grotheer M, Isleib S, Minks K, Netz N, Schaeper H, Trennt N, Trommer M (2019) DZHW-Absolventenpanel 2005. Datenerhebung: 2006-2016. Version: 2.0.0. Datenpaketzugangsweg: Download-SUF. Hannover: FDZ-DZHW. Datenkuratierung: Baillet, F., Franken, A., & Weber, A. https://doi.org/10.21249/DZHW:gra2005:2.0.0

Brown C, Corcoran M (1997) Sex-Based Differences in School Content and the Male-Female Wage Gap. Journal of Labor Economics 15(3):431. https://doi.org/10.1086/209867

Brugger P, Threin M, Wolters M (2012) Hochschulen auf einen Blick. Statistisches Bundesamt, Wiesbaden

Carlana M (2019) Implicit Stereotypes: Evidence from Teachers' Gender Bias. The Quarterly Journal of Economics 134(3), 1163–1224. https://doi.org/10.1093/qje/qjz008

Carrell SE, Page ME, West JE (2010) Sex and Science: How Professor Gender Perpetuates the Gender Gap. The Quarterly Journal of Economics 125(3), 1101–1144

Cech EA (2013) The Self-Expressive Edge of Occupational Sex Segregation. American Journal of Sociology 119(3), 747–789

Charles M, Bradley K (2002) Equal but Separate? A Cross-National Study of Sex Segregation in Higher Education. American Sociological Review 67(4), 573–599. https://doi.org/10.2307/3088946

Charles M, Bradley K (2009) Indulging Our Gendered Selves? Sex Segregation by Field of Study in 44 Countries. American Journal of Sociology 114(4), 924–976. https://doi.org/10.1086/595942

Chetty R, Hendren N, Kline P, Saez E (2014) Where is the Land of Opportunity? The Geography of Intergenerational Mobility in the United States. Quarterly Journal of Economics 129(4), 1553–1623

Crouter AC, Manke BA, McHale SM (1995) The Family Context of Gender Intensification in Early Adolescence. Child Development 66(2), 317–329. https://doi.org/10.1111/j.1467-8624.1995.tb00873.x

Cvencek D, Meltzoff AN, Greenwald AG (2011) Math-Gender Stereotypes in Elementary School Children. Child Development 82(3), 766–779. https://doi.org/10.1111/j.1467-8624.2010.01529.x

Dryler H (1998) Parental Role Models, Gender and Educational Choice. The British Journal of Sociology 49(3), 375–398. https://doi.org/10.2307/591389

Eagly AH (1987) Sex Differences in Social Behavior: A Social Role Interpretation. Earlbaum, Hillsdale, NJ

Eagly AH, Karau SJ (2002) Role Congruity Theory of Prejudice Toward Female Leaders. Psychological Review 109(3), 573–598. https://doi.org/10.1037/0033-295X.109.3.573

England P (2010) The Gender Revolution: Uneven and Stalled. Gender & Society 24(2), 149–166. https://doi.org/10.1177/0891243210361475

England P, Allison P, Li S, Mark N, Thompson J, Budig MJ, Sun H (2007) Why Are Some Academic Fields Tipping toward Female? The Sex Composition of U.S. Fields of Doctoral Degree Receipt, 1971-2002. Sociology of Education 80(1):23–42

Escriche L (2007) Persistence of Occupational Segregation: The Role of the Intergenerational Transmission of Preferences. Economic Journal 117(520), 837–857. https://doi.org/10.1111/%28ISSN%291468-0297/issues

Fernández R, Fogli A (2009) Culture: An Empirical Investigation of Beliefs, Work, and Fertility. American Economic Journal: Macroeconomics 1(1), 146–177. https://doi.org/10.1257/mac.1.1.146

Georg W, Bargel E (2017) Parental Qualifications as Determinants of University Entrance and Choice of a Field of Study in Germany. European Journal of Higher Education 7(1), 78–95. https://doi.org/10.1080/21568235.2017.1265777

Goldin C, Kerr SP, Olivetti C, Barth E (2017) The Expanding Gender Earnings Gap: Evidence from the LEHD-2000 Census. American Economic Review 107(5), 110–114. https://doi.org/10.1257/aer.p20171065

Hausmann AC, Kleinert C (2014) Berufliche Segregation auf dem Arbeitsmarkt: Männer- und Frauendomänen kaum verändert. IAB Kurzbericht Nr. 9, IAB. https://doi.org/10.1007/978-3-658-01707-1

Heine C, Willich J, Schneider H, Sommer D (2008) Studienanfänger Im Wintersemester 2007/08. Wege Zum Studium, Studien- Und Hochschulwahl, Situation Bei Studienbeginn. HIS Forum Hochschule, Hannover

Heineck G, Riphahn R (2009) Intergenerational Transmission of Educational Attainment in Germany - The Last Five Decades. Jahrbücher für Nationalökonomie und Statistik 229(1), 36–60. https://doi.org/10.1515/jbnst-2009-0104

Hochschild A, Machung A (1989) The Second Shift: Working Parents and the Revoluation at Home. Viking Penguin, New York

Holst E, Wieber A (2014) Eastern Germany Ahead in Employment of Women. DIW Economic Bulletin 4(11), 33–41

Humlum MK, Nandrup AB, Smith N (2018) Closing or Reproducing the Gender Gap? Parental Transmission, Social norms and Education Choice. Journal of Population Economics pp 1–46. https://doi.org/10.1007/s00148-018-0692-1

Jacob M, Weiss F (2010) From Higher Education to Work Patterns of Labor Market Entry in Germany and the US. Higher Education 60(5), 529–542. https://doi.org/10.1007/s10734-010-9313-y

Jonsson JO, Grusky DB, Di Carlo M, Pollak R, Brinton MC (2009) Microclass Mobility: Social Reproduction in Four Countries. American Journal of Sociology 114(4), 977–1036. https://doi.org/10.1086/596566

Klein M (2016) The Association Between Graduates' Field of Study and Occupational Attainment in West Germany, 1980–2008. Journal for Labour Market Research 49(1), 43–58. https://doi.org/10.1007/s12651-016-0201-5

Koenig AM (2018) Comparing Prescriptive and Descriptive Gender Stereotypes About Children, Adults, and the Elderly. Frontiers in Psychology 9:1086. https://doi.org/10.3389/fpsyg.2018.01086

Kohlberg L (1966) A Cognitive-Developmental Analysis of Children's Sex-Role Concepts and Attitudes. In: Maccobi E (ed) The Development of Sex Differences, Stanford University Press, Stanford, CA

Lefgren L, Lindquist MJ, Sims D (2012) Rich Dad, Smart Dad: Decomposing the Intergenerational Transmission of Income. Journal of Political Economy 120(2), 268–303. https://doi.org/10.1086/666590

Leuze K (2007) What Makes for a Good Start? Consequences of Occupation-Specific Higher Education for Career Mobility: Germany and Great Britain Compared. International Journal of Sociology 37(2), 29–53.https://doi.org/10.2753/IJS0020-7659370202
Leuze K, Strauß S (2009) Lohnungleichheiten zwischen Akademikerinnen und Akademikern: Der Einfluss von fachlicher Spezialisierung, frauendominierten Fächern und beruflicher Segregation. Zeitschrift für Soziologie 38(4), 262–281. https://doi.org/10.1515/zfsoz-2009-0401
Machin S, Puhani PA (2003) Subject of Degree and the Gender Wage Differential: Evidence from the UK and Germany. Economics Letters 79(3), 393–400. https://doi.org/10.1016/S0165-1765(03)00027-2
Morrill MS, Morrill T (2013) Intergenerational Links in Female Labor Force Participation. Labour Economics 20:38–47. https://doi.org/10.1016/j.labeco.2012.10.002
Müller S, Schneider T (2013) Educational Pathways and Dropout from Higher Education in Germany. Longitudinal and Life Course Studies 4(3). https://doi.org/10.14301/llcs.v4i3.251
Neugebauer M, Schindler S (2012) Early Transitions and Tertiary Enrolment: The Cumulative Impact of Primary and Secondary Effects on Entering University in Germany. Acta Sociologica 55(1), 19–36. https://doi.org/10.1177/0001699311427747
Nollenberger N, Rodríguez-Planas N, Sevilla A (2016) The Math Gender Gap: The Role of Culture. American Economic Review: Papers & Proceedings 106(5), 257–261. https://doi.org/10.1257/aer.p20161121
Ochsenfeld F (2016) Preferences, constraints, and the process of sex segregation in college majors: A choice analysis. Social Science Research 56:117–132. https://doi.org/10.1016/j.ssresearch.2015.12.008
OECD (2008) Education at a Glance 2008. OECD Indicators. OECD, Paris
OECD (2020) OECD Family Database. http://www.oecd.org/social/family/database.htm. Accessed 10 September 2020
Oguzoglu U, Ozbeklik S (2016) Like Father, Like Daughter (Unless There Is a Son): Sibling Sex Composition and Women's STEM Major Choice in College. IZA Discussion Paper No. 10052, Institute for the Study of Labor (IZA)
Okamoto D, England P (1999) Is There a Supply Side to Occupational Sex Segregation? Sociological Perspectives 42(4), 557–582. https://doi.org/10.2307/1389574
Olivetti C, Zenou Y, Patacchini E (2020) Mothers, Peers, and Gender-Role Identity. Journal of the European Economic Association 18(1), 266–301
Pearse R, Connell R (2016) Gender Norms and the Economy: Insights from Social Research. Feminist Economics 22(1), 30–53. https://doi.org/10.1080/13545701.2015.1078485
Platt L, Parsons S (2017) Is the Future Female? Educational and Occupational Aspirations of Teenage Boys and Girls in the UK. Centre for Longitudinal Studies Working Paper 2017/17, UCL Institute of Education
Platt L, Polavieja J (2016) Saying and Doing Gender: Intergenerational Transmission of Attitudes Towards the Sexual Division of Labour. European Sociological Review 32(6), 820–834
Polavieja JG, Platt L (2014) Nurse or Mechanic? The Role of Parental Socialization and Children's Personality in the Formation of Sex-Typed Occupational Aspirations. Social Forces 93(1), 31–61
Ponthieux S, Meurs D (2015) Chapter 12 - Gender Inequality. Handbook of Income Distribution, vol 2. Elsevier, pp 981–1146
Reimer D, Pollak R (2010) Educational Expansion and Its Consequences for Vertical and Horizontal Inequalities in Access to Higher Education in West Germany. European Sociological Review 26(4), 415–430
Statistik der Bundesagentur für Arbeit (2014) Sozialversicherungspflichtig und geringfügig Beschäftigte sowie Auszubildende nach Berufsordnungen (3-Steller) der KldB 1988, sowie Geschlecht und Nationalität in Deutschland ab dem Stichtag 30.06.2001 bis 30.06.2011 (Quartalsdaten). Datenstand November 2014, Nürnberg
Statistik der Bundesagentur für Arbeit (2018) Median der monatlichen Bruttoarbeitsentgelte von sozialversicherungspflichtig Vollzeitbeschäftigten der Kerngruppe nach ausgeübter Tätigkeit (KldB 1988). Stichtag 31.12.2001 bis 31.12.2010, Nürnberg
Statistisches Bundesamt (2011) Studierende an Hochschulen. Fachserie 11, Reihe 4.1, WS2010/11, Wiesbaden
van Putten AE, Dykstra PA, Schippers JJ (2008) Just Like Mom? The Intergenerational Reproduction of Women's Paid Work. European Sociological Review 24(4), 435–449. https://doi.org/10.1093/esr/jcn030

Vleuten M, Jaspers E, Maas I, van der Lippe T (2018) Intergenerational Transmission of Gender Segregation: How Parents' Occupational Field Affects Gender Differences in Field of Study Choices. British Educational Research Journal 44(2):294–318. https://doi.org/10.1002/berj.3329
Zafar B (2013) College Major Choice and the Gender Gap. Journal of Human Resources 48(3), 545–595
Zinn S, Steinhauer HW, Aßmann C (2017) Samples, Weights, and Nonresponse: The Student Sample of the National Educational Panel Study (Wave 1 to 8). NEPS Survey Paper No. 18, Bamberg

Publisher's note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.