



Why do women opt for gender-atypical fields of study? The increasing role of income motivation over time

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Abstract

Gender segregation in fields of study represents an important explanation for gender inequalities in the labor market, such as the gender wage gap. Research shows that horizontal gender segregation in higher education persists for a variety of reasons, including women's greater communal goals and men's greater motivation to earn high incomes. Yet with the male breadwinner model in decline, a key question is whether women's motivation to earn high incomes might contribute to increasing women's participation in female-atypical fields of study. Using data from the German Student Survey over a period of 30 years, our findings show that the proportion of women enrolled in female-atypical fields of study increased from 1984 to 2015. Moreover, women's motivation to earn high incomes mediates the effect of time on enrollment in female-atypical fields of study. Their motivation to earn high incomes might thus be a factor contributing to the disruption of gender segregation in fields of study over time. Furthermore, contrary to expectations, the motivation to earn high incomes as a driving force for women to opt for gender-atypical fields of study is not stratified by social background.

Keywords Gender · Fields of study · Motivation · Income · Time · Social background

Introduction

Women started to outnumber men in higher education as early as the 1980s in some countries (e.g., France, Portugal, Sweden, and the USA) and much later in others (e.g., 2005 in Germany) (Vincent-Lancrin, 2008). At the same time, we observe ongoing horizontal gender segregation in fields of study (England, 2010; England & Li, 2006; Quadlin, 2017). While women are more likely to self-select into the humanities and social sciences, men are overrepresented in other areas, especially technical and engineering fields (Charles & Bradley, 2002; DiPrete & Buchmann, 2013; Kahn & Ginther, 2018; McNally, 2020; Smyth & Steinmetz, 2008). These gender differences in subject choice are problematic in two ways. First, from a macroeconomic perspective, many countries are in need of more highly qualified workers in technical occupations (Moakler Jr. & Kim, 2014). Attempting

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to increase the representation of women in these occupational fields is therefore a logical step. Second, graduates from male-dominated technical and engineering fields are known to have more favorable working conditions and substantially higher incomes than their counterparts in female-dominated fields, such as the humanities (Barone, 2011; Davies & Guppy, 1997; Ma & Savas, 2014; Reimer et al., 2008). Women's underrepresentation in these fields is thus an important explanation for gender inequalities, such as women's lower wages (Blau & Kahn, 2017).

From earlier studies, we know that this horizontal gender segregation in subject choice can be explained by various factors. Most importantly, men and women seem to develop different interests throughout their socialization, with women encouraged toward subjects where they achieve communal goals (e.g., working with or helping other people) that are not perceived to be met in science, technology, engineering, and mathematics (STEM) careers (Diekman et al., 2010; Pollmann-Schult, 2009; Wang & Degol, 2013). Moreover, women are socialized to be more skeptical than men regarding their mathematical competence, hindering their decisions to pursue STEM careers (Ceci & Williams, 2010; Correll, 2001; Morgan et al., 2001). Furthermore, women are more likely to avoid STEM careers because they might associate them with high costs of career success in comparison to gender-typical careers paths (Fiorentine & Cole, 1992). This particularly seems to be the case in liberal-egalitarian contexts, such as Germany, where structural features of the postindustrial labor market and modern educational systems appear to support the cultivation, realization, and display of gender-specific curricular affinities (Charles & Bradley, 2009).

In order to address economies' need for workers in engineering and technical fields as well as gender inequalities related to women's lower representation in these sectors, there have been many initiatives aimed at increasing young women's interest and self-confidence in STEM subjects (Barone et al., 2019; Szelényi et al., 2013) and motivating them to opt for careers where women are underrepresented (Buck et al., 2008; Foes & Gilardi, 2020; Olsson & Martiny, 2018). However, another motivational aspect behind women's decisions to enter STEM fields—the possibility of earning high incomes—has not garnered much attention. In this context, our study contributes to the higher education literature by scrutinizing women's motivation to earn high incomes as a potential route toward reducing gender segregation in higher education. Therefore, our study highlights women's instrumental motivation—related to calculations of monetary returns—as a relevant factor in women opting for gender-atypical fields of study.

Earlier studies suggest that men place more value on jobs that yield high incomes, power, and prestige compared to women (Abele & Spurk, 2011; Guo et al., 2018), which seems to impact negatively on women's decisions to enter STEM fields, especially in math-intensive fields (Diekman et al., 2010, 2015). The usual reasoning behind the gender gap in income motivation is that men are socialized into assuming the role of family breadwinner, meaning it is more important for them to earn high incomes. Yet, the male breadwinner model has been declining for several decades and has been superseded by a full-time/part-time arrangement in Germany—the so-called modified male breadwinner model (Trappe et al., 2015). The declining acceptance of the normative male breadwinner model (Cunningham, 2008) and the motivation for high incomes as a potential factor in women opting for gender-atypical fields of study raise the question of whether women's interest in opting for gender-atypical subjects in order to earn more has increased over historical time. To answer this question, our study considers a historical time period of 30 years in Germany, from 1984 to 2015. The case of Germany is especially interesting since our observation period covers the reunification of the country, whose two parts were characterized by important differences regarding women's

integration in the labor market in general (Trappe et al., 2015) and in technical occupations in particular (Plicht & Schreyer, 2002).

Although our main research interest is to assess women's motivation to earn high incomes over time, there is one important intersection that also warrants consideration, namely, differences between women from high and low social backgrounds. According to previous studies, young women with more highly educated parents are more likely to opt for male-dominated subjects when entering higher education (Seehuus, 2019), and this might be related to more liberal gender norms in more educated families or strategies for upward social mobility (England, 2010; Seehuus, 2019). At the same time, we know that students from advantaged socioeconomic backgrounds are less risk averse than those from disadvantaged backgrounds in pursuing different educational decisions (Breen & Goldthorpe, 1997). While our study does not directly measure gender norms or risk aversion, it adds to this discussion by analyzing the role of income motivation over time on women's decisions to enter male-dominated fields of study, depending on their parents' educational background. Greater income motivation for women from less educated families when choosing male-dominated subjects would point toward the importance of this mechanism for upward social mobility.

We conducted our study in Germany, a country in which the proportion of women in higher education has increased slowly compared to other countries (Vincent-Lancrin, 2008). Moreover, considering the historical context, it is important to note that at the end of World War II in 1945, Germany was divided in two, with a socialist regime in the east and a capitalist regime in the west. The country was not reunified until 1990. This history is related to important differences regarding mothers' role in society in the two parts of the country. In the west, the housewife model still dominated in the 1970s before gradually transforming into a modified male breadwinner model wherein mothers are mostly employed part-time. The East German state, however, successfully encouraged mothers of small children to participate full-time in the labor market (Matysiak & Steinmetz, 2008). In East Germany, as in other socialist countries, mothers' inclusion in employment was the norm and was institutionally supported by sufficiently available public childcare. At the same time, the choice of occupations and the possibility of higher education were largely controlled by the needs of the state's economic plan (Christmas-Best & Schmitt-Rodermund, 2001). Due to the demand for industrial workers, a much higher proportion of women worked in this sector in East Germany.

Conversely, in West Germany, women were free to choose their fields of study, yet they conformed to traditional gender ideology. Following Germany's reunification, the West German system of education and training, together with a greater degree of personal freedom and occupational choice, were extended to the east (Christmas-Best & Schmitt-Rodermund, 2001). This led to a decreasing interest in technical occupations among East German women and an increasing interest in commercial, financial, administrative, and health-related occupations (Vondracek et al., 1999), which is equal to a shift from male-dominated to gender-integrated and female-dominated occupational aspirations. This resonates with earlier findings that women's subject choices are more gender-typical in more developed (or individualized) societies, which has been interpreted as the possibility to "indulge our gendered selves" (Charles & Bradley, 2009). However, despite the institutional integration of the two parts of the country in 1990, cultural differences regarding mothers' employment persist because they were inherited by the postcommunist generations (Pfau-Effinger & Smidt, 2011; Rosenfeld et al., 2004). Given Germany's history, we heed the differences between the two parts of the country when considering our findings.

Why women chose gender-atypical subjects—and how this has changed over time

When trying to explain women's decisions to opt for gender-atypical subjects, we have to build first on theories that explain subject choice at entry to higher education in general. From earlier research, we know that individuals evaluate (1) the costs, (2) the benefits and (3) the likelihood of success when making educational choices (Breen & Goldthorpe, 1997; Gambetta, 1987; Jonsson, 1999). While a good match between one's interests and the subject as well as an expected high income associated with a specific area of study can be seen to increase the benefits of a subject choice, violating gender norms by choosing a gender-atypical subject can be considered to increase costs (Lörz et al., 2011). As the previous literature has shown, occupational choices seem to be related to the cultural belief in the male breadwinner model, wherein family responsibilities are attributed to women and the responsibility for earning the family's income falls to the male breadwinner (Cutillo & Centra, 2017; Lörz et al., 2011). Thus, earning a high income can be expected to be more important to men than women.

The question that we aim to answer is how these cost–benefit calculations might have developed over time. While it can be assumed that interest in a specific subject has always been a driving force behind young people's decisions to pursue a field of study, we assume that we might observe changes over time in how important it is for young women to earn high incomes. This expectation is based on empirical evidence that the male breadwinner model is declining in Western societies (Trappe et al., 2015; Zoch, 2021), as is the norm to conform with the male breadwinner model, which has led to family policies that support dual-earner models (Ostner, 2010). Since less traditional gender norms lower the cost for women who decide to choose gender-atypical fields of study, we expect the proportion of women in these fields to increase over time. Our first hypothesis is thus that *the proportion of women enrolled in gender-atypical fields of study increased from 1984 to 2015* (H1).

We also expect the motivation to earn a high income to have increased for young women over the same time frame. Since male-dominated subjects are associated with earning higher incomes, we expect that the increasing importance of earning a high income for women mediates their increasing representation in gender-atypical subjects. Our second hypothesis is thus that *income motivation mediates the effect of time on enrollment in gender-atypical fields of study* (H2).

However, as has been shown in earlier studies, the motivation to opt for gender-atypical fields of study is more widespread among women from more highly educated families compared to their counterparts from less educated families (Berggren, 2008; Dryler, 1998; England, 2010). Three theoretical explanations have been suggested for this finding. First, gender norms have been found to be more liberal in more highly educated families (Du et al., 2021). It can be expected that a gender-atypical subject choice might lead to fewer social costs for women from more highly educated families since their parents will more readily accept their gender-atypical choice. Second, students from advantaged socioeconomic backgrounds are less risk averse than those from disadvantaged backgrounds when it comes to pursuing different educational decisions (Breen & Goldthorpe, 1997). Thus, women from advantaged backgrounds might be less reluctant to enroll in fields of study where they will be in a minority and to flout gender-typical career paths. Third, women might choose gender-atypical subjects when it is their only chance to gain upward social mobility (England, 2010; Seehuus, 2019). For women whose parents did not attend higher education, any subject choice in higher education allows social upward mobility. In order

to minimize social costs due to the disapproval of their parents, women from lower socio-economic backgrounds might opt for gender-typical fields of study, rather than choose gender-atypical subjects. On the contrary, women whose parents graduated from higher education must strive for more prestigious fields of study in order to achieve social upward mobility. Thus, the choice of male-dominated fields of study, such as engineering and technical subjects, is an attractive option for these women, since these fields lead to better paid occupations than female-dominated subjects. We therefore expect that *the mediating effect of income motivation on enrollment in gender-atypical fields of study is stronger for women from a higher social background than for women from a lower social background* (H3).

Data, variables, and method

Data

This article uses the cross-sectional German Student Survey (*Studierendensurvey*), which provides representative survey data from students of both universities and universities of applied sciences¹ about their educational choices, experiences of higher education, and perspectives on work and politics. It contains 12 pooled cross-sectional representative surveys of German students, conducted every two to three years from 1982 to 2015 (Muller et al., 2017), though East German universities were not included in the sample until 1992. The sampling follows a two-step procedure. First, it includes a theoretical selection of universities according to their distribution across federal states and by size, institution type (university or university of applied sciences), and the range of academic disciplines offered. Second, a random sample of students is drawn from within these institutions.

A strength of this survey is that it offers repeated cross-sectional data for over 30 years, which makes it a particularly valuable resource in studying trends over time. Moreover, as the focus of this study is the participation of women in gender-atypical fields of study over time, another strength of the survey lies in the detailed categorization of fields of study at the subfield level. It is of particular relevance in the context of the differentiation of fields of study in higher education (Lucas, 2001) to take into account the variation between different subfields as some have a considerably higher proportion of men or women (Barone, 2011). Therefore, we conceptualize our variable of interest, gender-atypical fields of study, at the level of subfields (e.g., electrical engineering, information technology, and civil engineering) since broader categorizations of subject groups can overshadow substantial variations in gender segregation.

The initial sample contained 108,969 students (both men and women), yet we restrict the analytical sample to women (the focus of our analysis) and the survey years in which the variables of interest were included (the year 1982 is not considered for this reason). After considering these restrictions and missing data, the sample contains 37,208 observations. Figure 4 in the Appendix provides details regarding the restrictions on our analytical sample.

¹ Universities of applied sciences focus on practical knowledge, whereas universities are research oriented and provide theoretical knowledge within fields of study.

Variables

The dependent variable, *female-atypical fields of study*, was constructed by classifying fields of study as (1) female-atypical or (0) female-typical. A field of study was considered to be *female-atypical* when the proportion of women studying it was equal to or less than 30 percent.² Our dependent variable was constructed by using information from the official student statistics for Germany between 1984 and 2015, provided by the Federal Statistical Office. This information was then merged with the individual data from the German Student Survey. We consider female-atypical fields of study at the subfield level, and they are mainly in the field of technical and engineering subjects (for a full list, see Table 2 in the Appendix).

The main independent variable, *years*, was measured by the survey year in which the students completed the survey and it comprises 11 years: 1984, 1986, 1989, 1992, 1994, 1997, 2000, 2003, 2006, 2009, and 2015. The second independent variable was *income motivation* and was measured by the question “How important were income prospects to you when deciding on your current degree?”. Students’ motivation to earn a high income when enrolling in their current degree was assessed using a Likert scale ranging from zero (*income prospect is unimportant*) to six (*income prospect is very important*).

We included interest motivation, altruistic motivation, academic institutions, and grades to ensure that the relationship between time and income motivation on the one hand and enrollment in gender-atypical fields of study on the other were not confounded by these factors. *Interest motivation* was included in the analysis as it might be considered a potential confounder for income motivation (e.g., students might have an interest in some fields of study that coincidentally also have high income prospects). Interest motivation was measured by the question “How important was your interest in your subject when deciding on your current degree?” on a Likert scale ranging from zero (*interest is unimportant*) to six (*interest is very important*). We also included interest to help others—what we call *altruistic motivation*—in our analysis as it might also be a potential confounder for income motivation. It was measured by the question “How important was your interest in helping people later on when deciding on your current degree?” on a Likert scale ranging from zero (*helping is unimportant*) to six (*helping is very important*).

Academic institutions (both universities and universities of applied sciences) were included in the analysis as a series of 38 dummy variables to account for institutional quality, which might be relevant to the choice of gender-atypical fields of study. *Grades* were measured by a continuous variable (10 for the lowest grade, 60 for the highest grade),³ indicating students’ academic performance in the German baccalaureate (*Abitur*). Students’ *parental education* was used as a proxy for social background and was measured by a binary variable: (1) at least one parent has a higher education degree or (0) neither parent has a higher education degree. Table 3 in the Appendix presents the descriptive statistics of the main variables used in the analysis.

² This 30 percent threshold was used to measure female-atypical fields of study as these are subjects in which women are a minority (Kanter, 1977). Other studies also used the same threshold (Frome et al., 2006; Riegle-Crumb et al., 2016). Moreover, as a robustness check, we also conducted the analysis with slightly higher and lower thresholds, but the results remained substantially similar.

³ This scale was a reversion of the German grading scale, where 1.0 is the highest grade and 6.0 is the lowest grade. The second digit indicates the first decimal place, i.e., 10 indicates a grade of 1.0.

Method

To address our research questions, the analysis is divided in two parts. In the first part, we provide a descriptive analysis for (1) the proportion of women in gender-atypical fields of study over time for the entire sample, (2) the proportion of women in gender-atypical fields of study over time for East and West Germany, and (3) income motivation, interest motivation and altruistic motivation in choice of field of study over time. To illustrate the proportion of women in gender-atypical fields of study over time, we estimated the regression constant (intercept) of linear probability models without predictors. These regression models are designed to estimate the average proportion of women in atypical fields of study for each survey year. Therefore, in Eq. 1, Y_i is the proportion of women in gender-atypical fields of study in a given year, β_0 is the constant for each year, and ε_i is the error term.

$$Y_i = \beta_0 + \varepsilon_i \quad (1)$$

Following Eq. 1, we provide a descriptive summary of income motivation over time where Y_i is the income motivation in a given year and β_0 is the constant for each year. In the same way, we show interest motivation and altruistic motivation over time, where Y_i is the interest motivation/altruistic motivation in a given year and β_0 is the constant for each year.

In the second part of the analysis, linear probability models are used to estimate enrollment in female-atypical fields of study as a function of time and income motivation but also relevant controls in stepwise regression models. The models use robust standard errors in order to account for heteroscedasticity. In Eq. 2, gender-atypical fields of study (Y_i) is a binary variable and measures whether women are enrolled in a gender-atypical or typical field of study, β_1 is the corresponding coefficient of years, β_0 is the intercept, and ε_i is the error term (Model 1).

$$Y_i = \beta_0 + \beta_1 \text{years}_i + \varepsilon_i \quad (2)$$

In Model 2, we reproduce the analysis from Eq. 2 to estimate gender-atypical fields of study (Y_i), but we also include income motivation as a second independent variable. Moreover, in Model 3, we consider four control variables: interest motivation, altruistic motivation, grades, and academic institutions. In Model 4, we account also for parental education as a proxy for social background. Finally, Model 5 includes the interaction between parental education and income motivation. It is important to note that even though our analysis includes relevant factors concerning choice of gender-atypical fields of study, there are other influences, such as prior academic decisions, peer influence, and parental approval (Zafar, 2013), which cannot be considered in our analysis.

Results

Descriptive analysis

Figure 1 plots the estimated proportion of women in gender-atypical fields of study between 1984 and 2015 in Germany. As mentioned above, we consider fields of study as female-atypical when the proportion of women is 30 percent or less, but for descriptive purposes, we also construct the female-atypical fields of study when the proportion of women is 20 percent or less and 40 percent or less. Figure 1 shows the development of

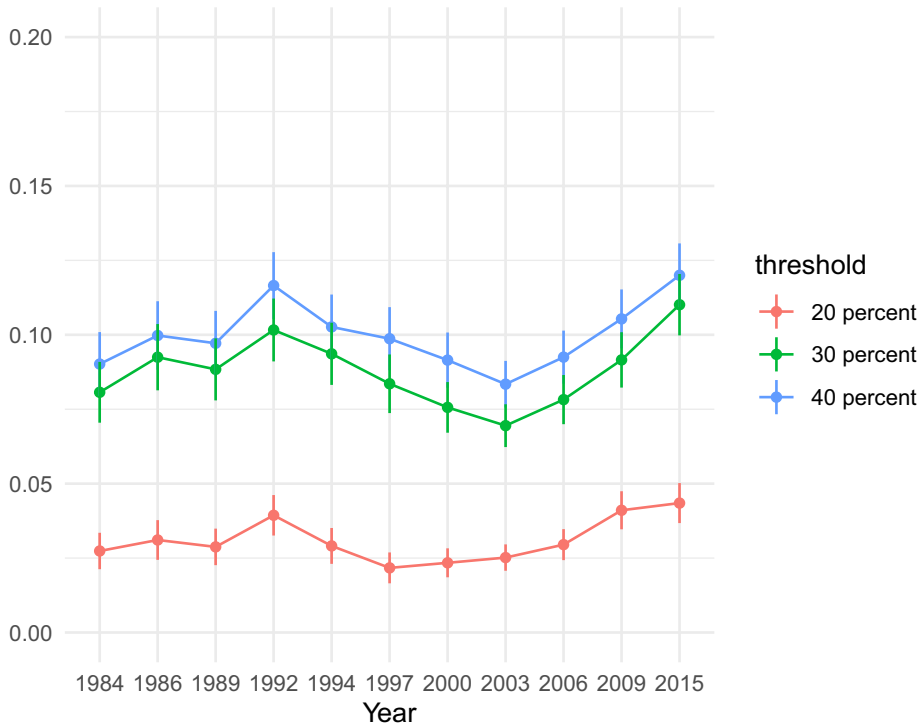


Fig. 1 Proportion of women in gender-atypical fields of study over time in Germany. Source: German Student Survey (1984–2015). Note: Bars denote 95% confidence intervals

the proportion of women in gender-atypical fields of study over time in Germany. Taking a threshold of 30 percent, in 1984, about eight percent of women were enrolled in female-atypical fields of study; the proportion had increased to 11 percent by 2015. Yet this figure also illustrates that most of the increase occurred in the last 2 years (2009 and 2015).

Moreover, as shown in Fig. 1, in 1992 there was a sharp increase in the proportion of women in female-atypical fields of study. This increase was followed by a gradual decrease from 1994 to 2000 and an increase in the subsequent years. A potential explanation for this increase might be the inclusion of East Germany in the sample from 1992. As discussed in the theoretical considerations, more women participated in the labor market in East Germany than West Germany (Matysiak & Steinmetz, 2008), and many more women worked in traditionally male-dominated occupations than in the west (Christmas-Best & Schmitt-Rodermund, 2001). To better understand this institutional context, Fig. 2 depicts the proportion of women in gender-atypical fields of study between 1984 and 2015 differentiating between East and West Germany.

As shown in Fig. 2, in 1992 the proportion of women in gender-atypical fields of study in East Germany was approximately 12 percent, compared to approximately nine percent in West Germany. Yet, after 1992, East Germany experienced a sharp decrease in the proportion of women in gender-atypical fields of study; from 1994 to 2003, the proportion of women in gender-atypical fields of study in the two parts of the country converged at approximately seven percent. From 2006 onwards, both East and West

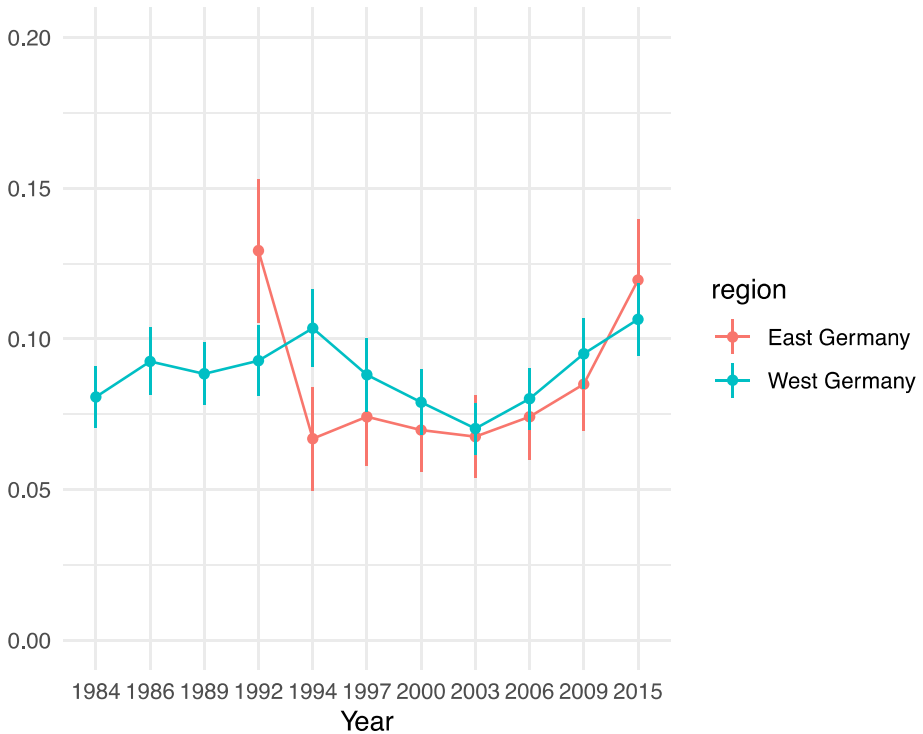


Fig. 2 Proportion of women in gender-atypical fields of study over time: East and West Germany. Source: German Student Survey (1984–2015). Note: Bars denote 95% confidence intervals

Germany experienced the same increase in the proportion of women in male-dominated fields of study. Hence, following Fig. 2, it seems plausible that the inclusion of East Germany in the sample could explain (at least to some extent) the increase of women in female-atypical fields of study for the total sample in 1992.

As discussed in our theoretical considerations, the increase in women's participation in gender-atypical fields of study (see Figs. 1 and 2) might be related to an increase in women's income motivation. Therefore, Fig. 3 plots income motivation in addition to interest motivation and altruistic motivation (as the last two might be confounded with income motivation) over the 30-year period. Figure 3 tells a clear story: while reported interest in the field of study remained constant over time (it was considered important over the entire period), women's motivation to enroll in a field of study due to the importance of income prospects in their future occupations has steadily increased over the 30-year period. More precisely, in 1984, the importance of income motivation was rated two (on a scale from zero to six), while the average increased to 3.3 by 2015. Moreover, Fig. 3 shows that there has also been an increase in altruistic motivation over time from 3.2 in 1984 to approximately four in 2015. The increase in both income motivation and altruistic motivation is fairly linear over time, with income motivation having a slightly steeper increase, while interest motivation remained stable over the 30-year period.

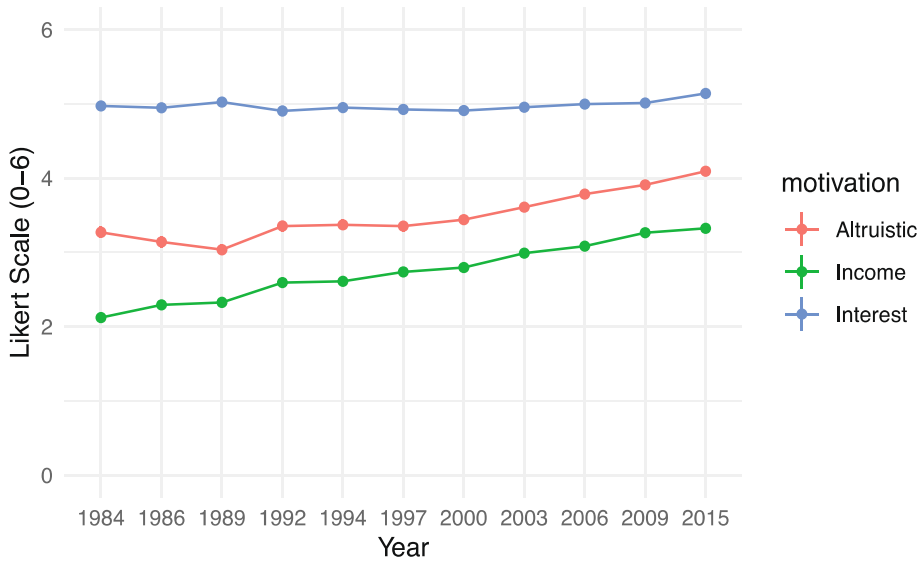


Fig. 3 Income motivation, interest motivation, and altruistic motivation in choice of field of study over time. Source: German Student Survey (1984–2015). Note: Bars denote 95% confidence intervals; The three types of motivations are measured on a 7-point Likert scale where higher values indicate greater importance

Multivariate analysis

Table 1 presents the results of the linear probability models used to predict enrollment in female-atypical fields of study. Model 1 shows the association between time and the probability of enrolling in female-atypical fields of study. The results show that women in recent years have a significantly higher chance of enrolling in gender-atypical fields of study compared to women in previous years. For example, compared to 1984, women in 2009 and 2015 are about one and three percentage points, respectively, more likely to be enrolled in gender-atypical fields of study. Therefore, our multivariate models also confirm our first hypothesis, which asserted that the proportion of women enrolled in gender-atypical fields of study increased from 1984 to 2015. Moreover, we see that the increase has been much steeper in recent years (since approximately 2009) than in the preceding decades.

In Model 2, we include income motivation as a potential explanatory factor that might predict women's enrollment in gender-atypical fields of study. As shown in Model 2, women's income motivation is positively associated with enrollment in gender-atypical fields of study. Moreover, the difference in enrollment for gender-atypical fields of study between years is reduced, especially in the last year (2015), and it becomes insignificant when income motivation is introduced into the model. Compared to Model 1, the association between time and enrollment in gender-atypical fields of study for 2009 and for 2015 decreases substantially. These findings indicate that income motivation mediates (part of) the effect of time on women's enrollment in gender-atypical fields of study, which confirms our second hypothesis.

Moreover, in Model 3, we include interest motivation and altruistic motivation and two controls for education, academic institutions and baccalaureate grades, which might be relevant in explaining enrollment in gender-atypical fields of study. Surprisingly, the

Table 1 Predicting enrollment in female-atypical fields of study

	Model 1		Model 2		Model 3		Model 4		Model 5	
	Coef	S.E	Coef	S.E	Coef	S.E	Coef	S.E	Coef	S.E
Years										
1984	Reference		Reference		Reference		Reference		Reference	
1986	0.011	(0.007)	0.008	(0.008)	0.006	(0.008)	0.006	(0.008)	0.006	(0.008)
1989	0.007	(0.007)	0.004	(0.007)	0.000	(0.007)	0.000	(0.007)	0.000	(0.007)
1992	0.020 *	(0.007)	0.013	(0.007)	0.013***	(0.007)	0.013	(0.007)	0.013	(0.007)
1994	0.013	(0.007)	0.004	(0.007)	0.006	(0.007)	0.006	(0.007)	0.006	(0.007)
1997	0.002	(0.007)	-0.007	(0.007)	-0.007	(0.007)	-0.006	(0.007)	-0.007	(0.007)
2000	-0.005	(0.006)	-0.016	(0.007)	-0.014*	(0.007)	-0.014*	(0.007)	-0.014*	(0.007)
2003	-0.011	(0.006)	-0.025***	(0.006)	-0.020**	(0.006)	-0.020**	(0.006)	-0.020**	(0.006)
2006	-0.002	(0.006)	-0.018*	(0.007)	-0.009	(0.007)	-0.009	(0.007)	-0.009	(0.007)
2009	0.010	(0.007)	-0.008	(0.007)	0.004	(0.007)	0.004	(0.007)	0.004	(0.007)
2015	0.030***	(0.007)	0.009	(0.007)	0.028***	(0.007)	0.028***	(0.007)	0.028***	(0.007)
Motivation income			0.016***	(0.000)	0.016***	(0.000)	0.016***	(0.000)	0.015***	(0.001)
Motivation interest					-0.013***	(0.001)	-0.013***	(0.001)	-0.013***	(0.001)
Altruistic motivation					-0.019***	(0.000)	-0.019***	(0.000)	-0.019***	(0.000)
Academic institutions					Included		Included		Included	
Grades					0.000	(0.000)	0.000	(0.000)	0.000	(0.000)
Parental education					0.002	(0.002)	0.002	(0.002)	-0.001	(0.004)
(ref. highly educated)										
Parental education *									0.001	(0.001)
Income motivation										
Constant	0.080***	(0.005)	0.045***	(0.005)	0.208***	(0.012)	0.208***	(0.026)	0.210***	(0.026)
Adjusted R²	0.002		0.012		0.033		0.033		0.033	
N	37,208		37,208		37,208		37,208		37,208	

German Student Survey (1984–2015); Linear probability models; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

results show a significant negative association between both interest motivation and altruistic motivation and enrollment in gender-atypical fields of study. While it is plausible that women with an interest in helping others are less likely to choose gender-atypical fields of study, it is surprising that women who are enrolled in gender-atypical fields of study seem not to be necessarily driven by their interest in these subjects. Regarding educational performance, there is a positive insignificant association between grades and gender-atypical fields of study. Interestingly, by including these new controls, the effect of time increases and becomes significant. This implies that while an increased motivation for income might propel women into gender-atypical fields of study, this might be counterbalanced by a stronger interest in other fields or a preference for helping others that are perceived to be at odds with such gender-atypical fields. Nevertheless, and most important for our purposes, the association between income motivation and enrollment in gender-atypical fields of study does not change and remains highly significant.

In Model 4, we also account for social background measured by parental education as a potential explanatory factor for women's enrollment in gender-atypical fields of study. The results show that social background has a small and insignificant effect in predicting women's enrollment in gender-atypical fields of study. To assess whether the mediating effect of income motivation on enrollment in gender-atypical fields of study is stronger for women from higher social backgrounds compared to women from lower social backgrounds, Model 5 shows the interaction between parental education and income motivation. The interaction coefficient is negligible and not significant. Therefore, we cannot confirm our third hypothesis that the effect of income motivation on women's enrollment in gender-atypical fields of study varies by social background.

Discussion and Conclusion

The choice of field of study continues to be one of the most significant sources of gender inequality (England, 2010; England & Li, 2006; Quadlin, 2017). Therefore, understanding what motivates women to follow gender-atypical fields of study is of great importance in achieving gender equality. While previous studies have shown that preferences and subject choice in secondary school are major reasons for this ongoing horizontal gender segregation in higher education (Häggglund & Lörz, 2020; Ochsenfeld, 2016), our study focuses on young girls' and women's motivation for high incomes in explaining enrollment in gender-atypical fields of study over a 30-year period in Germany. We add further empirical evidence to the higher education literature on the choice of gender-atypical fields of study by scrutinizing income motivation as an under-researched channel that has the potential to contribute to decreasing gender segregation in higher education and beyond.

Our study also examines whether the intersection between income motivation and choice of gender-atypical field of study varies by parental educational background. Our empirical results thus advance the existing research in several ways. First, our findings show that the proportion of women in gender-atypical fields of study has increased over time. Though the increase has been gradual, it has notably increased in the last few years (mainly in 2015) in Germany. This might be related to the decline of the male breadwinner model in recent decades, which has facilitated a change in attitudes toward gender norms regarding women's participation in the labor market (Cunningham, 2008). Moreover, interpreting the increased proportion of women in gender-atypical fields of study from a cost-benefit perspective (Breen & Goldthorpe, 1997), women's decision to enroll in

gender-atypical fields of study might be perceived as less costly in the presence of weaker gender roles in occupational choices.

Second, even if not the primary focus of our research, the analysis confirms a discrepancy between East and West Germany in the development of women's enrollment in gender-atypical fields of study. The high proportion of women in gender-atypical fields of study in East Germany compared to West Germany in the years soon after reunification reflects the higher pressure on women to enroll in technical fields in a socialist regime where occupational choices were much more dependent on macroeconomic needs than on individual preferences (Christmas-Best & Schmitt-Rodermund, 2001). The sudden collapse of East Germany led to an extension of Western institutions to the reunified country in many areas of life, including education and training, which allowed for preference-driven choices of fields of study and, subsequently, a higher gender-typicality of subject choices (Christmas-Best & Schmitt-Rodermund, 2001). In consequence, the widely discussed ongoing differences in cultural norms regarding maternal employment in East and West Germany (Zoch, 2021) do not hinder the increasing similarity of East and West German women's participation in male-dominated fields of study.

Third, our evidence indicates that women's motivation to earn high incomes increases the chances of enrollment in gender-atypical fields of study and mediates (part of) the effect of time on enrollment in gender-atypical fields of study. As female-atypical fields of study are associated with high earnings (Barone, 2011; Ma & Savas, 2014), it is likely that women are increasingly incentivized by the economic returns related to these subjects after graduation from higher education. Moreover, the analysis shows that the effect of income motivation on the probability of enrolling in female-atypical fields of study hardly changes when accounting for women's interest in subject choice or in helping others. Therefore, women's academic interest and their altruistic motivation in female-atypical fields of study cannot be considered potential confounders for income motivation.

So far, several studies have highlighted initiatives that aim to encourage girls' and young women's interest in male-dominated STEM subjects (Szelényi et al., 2013) and to increase their underrepresentation in gender-atypical careers (Buck et al., 2008; Foos & Gilardi, 2020; Olsson & Martiny, 2018). Yet, as our findings indicate, women's motivation for higher incomes is a relevant factor that policymakers should also consider. For example, exposing young women to transparent information about different career opportunities and earnings related to potential subject choices might increase the number of women opting to enter gender-atypical fields of study (Barone et al., 2019).

Finally, our findings show that the effect of income motivation on enrollment in female-atypical fields of study is not stratified by social background. Therefore, even though individuals from advantaged socioeconomic backgrounds are more likely to make "riskier" educational choices in general (Breen & Goldthorpe, 1997), this logic might not be applicable regarding women studying a gender-atypical subject. Likewise, we cannot confirm the assumption that upward social mobility in the sense of higher income motivation plays a more important role for students from lower socioeconomic backgrounds. There might be two potential explanations for this finding. First, gender-atypical fields of study might be a route for upward mobility for women from advantaged socioeconomic backgrounds (England, 2010; Seehuus, 2019). Yet, gender-balanced fields, such as law or medicine, also provide good opportunities to earn high incomes (Arcidiacono, 2004; Kim et al., 2015). Second, while parental educational attainment is a good proxy for students' gender norms, parental occupation also seems to be relevant when considering the differences in risk aversion or upward mobility intentions of students from different social backgrounds. Without other measures of social origins, our analysis is unlikely to fully capture the influence of

parental background on women's income motivation to enroll in gender-atypical fields of study over time.

The extent to which our results can be generalized to other countries is an important issue. In Germany, as in other OECD countries, more women than men have higher education degrees (OECD, 2020). Yet, compared to other OECD countries, Germany has a low proportion of women in male-dominated fields of study, such as natural sciences and engineering. From this perspective, Germany is comparable to the Netherlands, Belgium, and Finland (OECD, 2018). Therefore, future research might consider other national contexts where there is a higher proportion of women in male-dominated fields of study to investigate the potential mechanisms behind the historically larger increase over time.

At least two limitations of our study need to be considered when interpreting the findings. Income motivation was measured indirectly in relation to choice of field of study in higher education, rather than directly by examining students' subsequent actual occupational outcomes. As women in gender-atypical fields of study have a higher dropout rate than their male colleagues (Meyer & Strauß, 2019), it is likely that some of these women change their career paths later. Yet, students' occupational interests are strongly correlated with their degree choice (Hägglund & Lörz, 2020; Holland, 1997). In addition, we are unable to address (other) influences shaping women's choices of field of study prior to enrolling in higher education, therefore potentially confounding the effect of motivation for high incomes. For example, it may be that early specialization during high school (e.g., in mathematics) shapes both motivation for income as well as the likelihood of enrolling in gender-atypical fields of study. Yet, such pre-higher education specialization may in itself reflect motivation for high income and may therefore not be a confounding influence.

The increasing proportion of women in gender-atypical fields of study over time represents a potential route that could contribute to disrupting gender segregation in higher education and, ultimately, the labor market. This article demonstrates that this increase has been occurring, albeit slowly, over a 30-year period in Germany. Women's decisions to follow gender non-normative academic trajectories is influenced by several factors, and this article argued that income motivation is a *push* factor for women's enrollment in gender-atypical fields of study over time that has often been overlooked. Moreover, it shows that this factor has not been stable over time; instead, its importance has increased with the historical decline of the male breadwinner model. Therefore, future development of this line of research might consider not only women's interest in academic subjects but also their economic incentives when understanding women's decisions to study female-atypical subjects. At the same time, the increasing importance of motivation to earn high incomes behind women's choice of gender-atypical subjects is also an important message to policymakers designing programs to increase women's participation in male-dominated STEM fields. While the idea of increasing girls' interest in mathematics and technical fields is well acknowledged, the increasing importance of financial incentives to pull women into these subjects is still to be explored.

Appendix

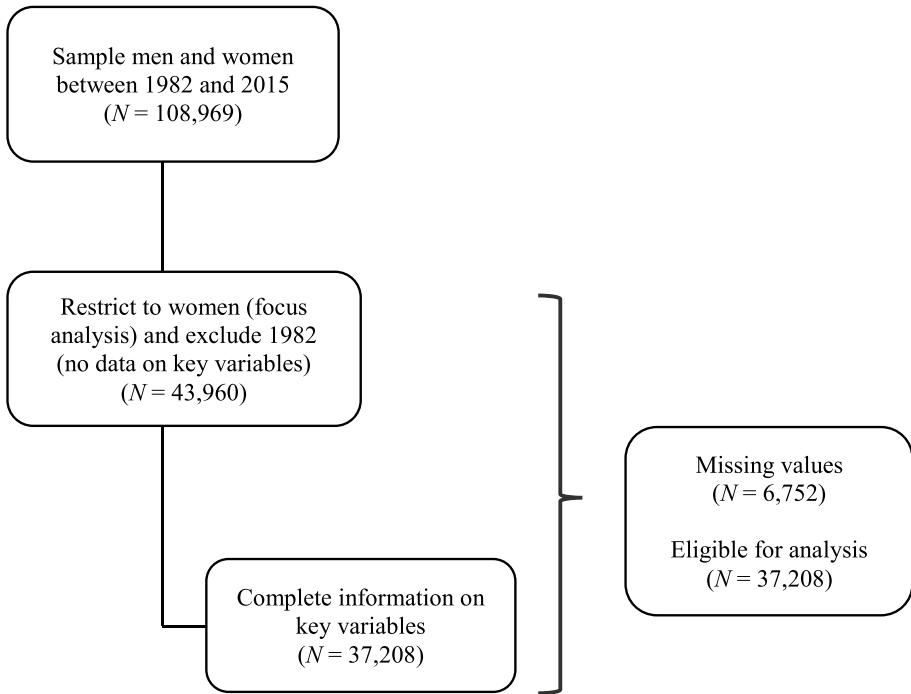


Fig. 4 Sample restriction. Source: German Student Survey (1984–2015); author calculations

Table 2 Proportion of women in gender-atypical fields of study (subfield level)

Field of study	Percentage of women enrolled
Electrical engineering and information technology	0.07
Traffic engineering, nautical engineering	0.09
Mechanical engineering/process engineering	0.16
Computer science	0.16
Mining, metallurgy	0.17
Forestry, wood industry	0.18
General engineering	0.19
Physics, astronomy	0.19
Industrial engineering with an engineering focus	0.20
Industrial engineering with an economics focus	0.21
Civil engineering	0.23
Materials science and materials engineering	0.24
Geodesy and geoinformation science	0.29

Sources: Federal Statistical Office; author calculations. Note: The proportion of women is calculated for 1984–2015

Table 3 Coding and descriptive statistics for the main variables

Variable	Coding	Mean/distribution or standard deviation										
		Years										
		1984	1986	1989	1992	1994	1997	2000	2003	2006	2009	2015
Female-atypical field of study	Dummy variable	Atypical field:	Atypical field:	Atypical field:	Atypical field:	Atypical field:	Atypical field:	Atypical field:	Atypical field:	Atypical field:	Atypical field:	Atypical field:
	1 indicates atypical field	8%	9%	9%	10%	9%	8%	8%	7%	8%	9%	11%
	0 indicates typical field											
Motivation income	How important were income prospects to you when deciding on your current degree?	2.12/1.70	2.29/1.74	2.33/1.70	2.59/1.72	2.61/1.71	2.74/1.68	2.79/1.73	2.99/1.67	3.08/1.67	3.26/1.71	3.32/1.64
	Likert scale ranging from 0 (unimportant) to 6 (very important)											

Table 3 (continued)

Variable	Coding	Mean/distribution or standard deviation										
		Years										
		1984	1986	1989	1992	1994	1997	2000	2003	2006	2009	2015
Motivation interest	<i>How important was your interest in your subject when deciding on your current degree?</i>	4.97/1.32	4.95/1.32	5.02/1.29	4.90/1.36	4.95/1.30	4.92/1.29	4.91/1.29	4.95/1.25	5.00/1.24	5.01/1.21	5.14/1.11
	Likert scale ranging from 0 (unimportant) to 6 (very important)											

Table 3 (continued)

Variable	Coding	Mean/distribution or standard deviation										
		Years										
		1984	1986	1989	1992	1994	1997	2000	2003	2006	2009	2015
Altruistic motivation	<i>How important was your interest in helping people later on when deciding on your current degree?</i>	3.27/2.02	3.14/2.03	3.03/1.99	3.35/1.93	3.37/1.94	3.35/1.97	3.44/1.92	3.61/1.85	3.78/1.81	3.91/1.75	4.09/1.69
	Likert scale ranging from 0 (unimportant) to 6 (very important)											

Table 3 (continued)

Variable	Coding	Mean/distribution or standard deviation										
		Years										
		1984	1986	1989	1992	1994	1997	2000	2003	2006	2009	2015
Parental education	Dummy variable	Higher educated: 46%	Higher educated: 44%	Higher educated: 42%	Higher educated: 44%	Higher educated: 44%	Higher educated: 45%	Higher educated: 53%	Higher educated: 53%	Higher educated: 56%	Higher educated: 54%	Higher educated: 52%
	1 indicates higher education degree											
	0 indicates no higher education degree											

Sources: German Student Survey (1984–2015). Note: Academic institutions and grades are not included in the descriptive statistics but are used in the analysis

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Code availability Code available upon request (R software).

Declarations

Ethics approval Not applicable.

Consent to participate Yes.

Consent for publication Yes.

Conflict of interest The authors declare no competing interests.

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