DISCUSSION PAPER SERIES

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IZA DP No. 9415

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October 2015

Forschungsinstitut
zur Zukunft der Arbeit
Institute for the Study
of Labor

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IZA Discussion Paper No. 9415
October 2015

ABSTRACT

Are Sociocultural Factors Important for Studying a Science University Major?*

This paper examines the role of the sociocultural background of students for choosing STEM fields in university. We combine rich survey data on university graduates in Switzerland with municipality level information from the census as well as nationwide elections and referenda to characterize a student's home environment with respect to religious and political attitudes towards gender equality and science-related issues. Our empirical estimates are based on a structural Roy model which accounts for differences in costs (relative distance to the next technical university) and earnings across majors as well as for selection bias. Our findings suggest that male students from conservative municipalities are more likely to study a STEM field, whereas the sociocultural background plays little role for the major choice of females.

JEL Classification: I20, C81

Keywords: choice of field of study, gender differences, selection bias, sociocultural environment, STEM fields

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* We are grateful to seminar participants at the University of Fribourg, the University of St. Gallen, the Annual Congress of the International Institute of Public Finance (IIPF) 2014 in Lugano, the European Economic Association (EEA) 2014 in Toulouse, the German Economic Association (Verein für Socialpolitik) 2014 in Hamburg, the CESifo Area Conference in Economics of Education 2014 in Munich, and the 4th SOLE/EALE World Conference 2015 in Montreal for valuable comments and suggestions.

1 Introduction

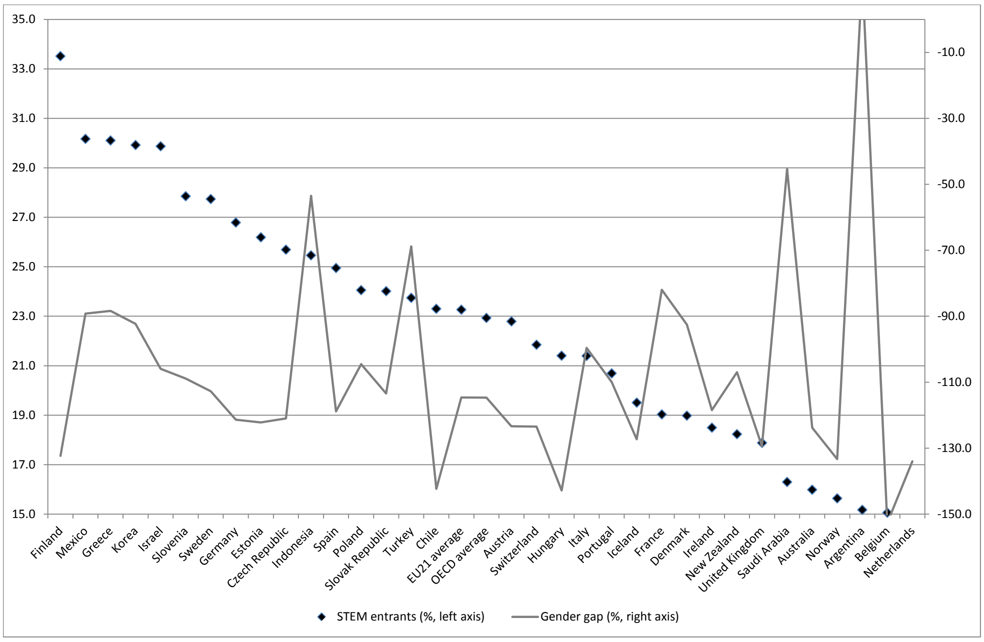
Modern growth theory suggests that economic growth is ultimately driven by technological progress. Cross-country evidence strongly supports the hypothesis that differences in per capita income primarily reflect differences in total factor productivity (e.g., Jones and Romer, 2010). Technological progress, in turn, relies on innovations that are created by scientists and engineers. There is consequently a widespread consensus that the so-called *STEM* (science, technology, engineering, and mathematics) skills are of major importance to sustain innovation and growth.[1] Yet, as Figure 1 illustrates, the share of young people studying a STEM field is rather low in many advanced countries. The average share of new entrants into STEM fields in OECD countries in the year 2011 was only about 25 percent. Moreover, there is a striking gender difference, even in countries with on average high enrolment rates. In the OECD countries, 39 percent of male students choose on average a STEM field, whereas only 14 percent of female students do so (Figure 1 and OECD, 2013, Tab. C3.3b). These figures cause concern to policymakers and employers who perceive a lack of qualified candidates for jobs requiring STEM skills.

Akerlof and Kranton (2000, 2002) point out that the social setting may be an important driver of educational choices. They propose a human capital model that incorporates social incentives in addition to the usual economic returns and constraints. Such a model may explain why observed educational choices are at odds with economic incentives. A recent macroeconomic literature highlights the role of cultural factors for economic growth (e.g., Guiso, Sapienza, and Zingales, 2006; Tabellini, 2008). However, the relevance of the sociocultural setting for microeconomic outcomes has proven difficult to establish empirically.

This paper sets out to explore to which extent the decision to study a STEM field is influenced by the sociocultural background of a student at the micro level. We investigate to which degree gender- and science-related progressive versus conservative religious and political attitudes in the environment of a high school graduate affect the

[1] Recent evidence also suggests that college graduates in STEM fields exert much larger human capital externalities to local labor markets than other college graduates (Winters, 2013).

Figure 1: Share of New Entrants in STEM Fields and Gender Gap in Advanced Countries, 2011



Source: OECD (2013) and accompanying material on the web, Tables C3.3a and C3.3b. Notes: The reference year for Argentina is 2010. The gender gap in new STEM entrants is calculated as the difference between the female and the male share relative to the overall share.

decision to study a STEM major. At first glance, one may think that a progressive environment contributes to developing a taste for science. Alternatively, however, STEM fields may be preferred in conservative environments vis-à-vis, for instance, social sciences which may be viewed as being oriented to left-wing political attitudes. One may also hypothesize that conservatism is related to a low fraction of females choosing a STEM field by creating an environment in which certain fields and occupations are perceived as being better suited for either males or females.

We propose a structural framework in order to account for differences in both pecuniary and sociocultural benefits and costs of studying STEM fields rather than other university majors. The main innovation of our study is to capture the sociocultural background of a student within a structural Roy (1951) model. The theoretical model motivates our econometric specification that we apply to rich data on graduates from

Swiss universities who finished their studies in the early 2000s. Switzerland is an ideal country to investigate university major choice, since at the time of our study all Swiss inhabitants graduating from upper secondary education (*Matura*) could freely choose which field and at which Swiss university to study. Study fees are very moderate in international comparison. They are similar across universities and the same for all majors within a university.

According to our theoretical model, individuals value material consumption, related to earnings over the life cycle, and directly derive utility from their field of study. Tastes for study majors depend on the sociocultural environment and the geographic proximity of a student's home municipality to the next technical university, given the distance to the next university. The relative geographic proximity of a technical university determines the pecuniary and nonpecuniary costs of studying a STEM major relative to other fields. The relative geographic proximity of a technical university is unrelated to the returns to different university majors (i.e. earnings), being salient for econometric identification.

The main pecuniary motivation for university major choice are earnings. Thus, we need to account for earnings differences across majors. However, we observe earnings of a university graduate only for the field he or she self-selected into. To address the potentially important selection bias, we construct the expected earnings difference across fields by alluding to the notion that rational individuals choose their major according to comparative advantage (Roy, 1951). We borrow from the literature on the choice of college participation, which is deals with a similar selection issue.[2]

We have access to a unique micro data set that contains rich information on Swiss university graduates five years after graduation. The variables include earnings, parental education, age, gender, and the home municipality in which the respondent lived at the end of high school. Switzerland exhibits a high degree of cultural diversity across regions. Even at a low jurisdictional level such as the municipality, of which there are about 2,600, one can expect important differences in social and cultural norms and

[2]Seminal papers include Heckman (1976) and Willis and Rosen (1979). See Heckman, Lochner, and Todd (2006) for a survey.

attitudes.[3]

We further exploit the unique opportunity of the direct democratic system in Switzerland to characterize a respondent's environment with respect to conservative or progressive attitudes on gender equality and science-related issues. We use results from nationwide referenda to construct objective measures of the sociocultural environment at the municipality level that are not contaminated by social desirability considerations. We select the following referenda in order to model the sociocultural environment of a student: on introducing equal rights of men and women in the constitution (referendum held in 1981), on providing addicts with medical prescriptions of heroin (1999), on the regulation of stem cell research (2004), and on the civil union of homosexual couples (2005), providing similar rights than to married couples (except for the right to adopt children and access to in vitro fertilization). We consider the latter referendum to be science-related because a large body of research has severely questioned the argument typically put forward by the religiously conservative that homosexuality is "unnatural". Scientific research, that contradicts the religiously conservative view, has largely affected the public discussion about equal rights for homosexual partnerships. Also the referendum on novel ways to cope with criminal activity of heroin addicts is an example of science-based changes in political attitudes. In addition to referenda results, we measure the impact on major choice of the fraction of votes that accrued to left-wing parties at the national parliamentary elections in 1995. Moreover, we examine the role of the distribution of religious denomination for major choice. A principal component analysis suggests that the outcomes of the four referenda, the vote share of left-wing parties, and religious denomination primarily load on a single principal component, which we therefore interpret as a measure of "progressivism".

Our main results are as follows. First, male students from municipalities with a high fraction of voters in favor of gender equality, the science-related issues and left-wing parties are significantly less likely to enter a STEM field in university, whereas in municipalities with a high share of Catholics, students are more likely to enter a

[3]Eugster, Lalive, and Zweimüller (2012) and Steinhauer (2013) also make use of the cultural diversity in Switzerland to study how culture affects unemployment and labor force participation of mothers, respectively.

STEM field. Thus, somewhat surprisingly, our results suggest that the probability of male students in tertiary education to choose a STEM field is higher when a student is socialized in a less progressive background.[4] However, in none of our specifications we find that women in a conservative or Catholic environment are more likely to study a STEM major than women in a progressive environment. In fact, sociocultural factors apparently have negligible effects for female students. Insofar as they matter for the major choice of men to a non-negligible extent, those factors contribute to understanding gender differences in the decision to study a STEM field. Finally, consistent with previous research, our results also suggest that female students are less motivated than men by earnings differences between STEM fields and other majors.

The paper is organized as follows. Section 2 discusses related literature. In Section 3, we present the theoretical background which motivates the structural econometric model. The econometric model and the identification strategy are discussed in Section 4. Section 5 describes the data and empirical specification. Section 6 shows the results. The last section concludes.

2 Related Literature

Our paper contributes to the literature on college major choice by employing a unique data set that allows us to examine the role of objective measures for the sociocultural environment based on a structural model. The main determinants of college major choice suggested by the previous literature were quantitative abilities (e.g., Arcidiacono, 2004; Wang, 2013), parental background (e.g., Boudarbat and Montmarquette, 2009; Sonnert, 2009), expectations on future labor force participation (e.g., Polachek, 1978; Blakemore and Low, 1984), and lifetime earnings (e.g., Berger, 1988; Eidea and Waehrer, 1998). Arcidiacono, Hotz, and Kang (2012) use surveys to elicit earnings expectations in different fields. They argue that, by accounting for students' expecta-

[4]In Switzerland, Catholics were typically associated with more conservative religious values compared to Protestants, which has been attributed to the Reformation process in Switzerland itself (e.g., Gordon, 2002). Altermatt (1979) argues that the relation between conservatism and Catholicism is less pronounced in modern times, however.

tions, ability and expected earnings are important determinants of college major choice. Boudarbat (2008) argues that lifetime earnings are more important if students have gained work experience before attending college. Moreover, Boudarbat and Montmarquette (2009) find that lifetime earnings seem to play a smaller role for the college major choice if the parent of the same gender as the student enjoyed university education. Humlum, Kleinjans, and Nielsen (2012) investigate the role of social identity for educational plans of young people. They rely on self-rated career and social orientations that enter as explanatory variables in reduced form choice models. They find economically important effects of identity on planned field of study and also point to some gender differences.

Recent studies elicit beliefs of students to understand how learning about one's abilities and the returns to different majors affect students' major choices over time. Using data on students at Berea college in the US, Stinebrickner and Stinebrickner (2014) find that students are overoptimistic with respect to their ability to perform well in science fields. They find that an extraordinarily high fraction of students in science fields change their major towards a non-science field once they acquire information about their true ability. Wiswall and Zafar (2015) devise an information experiment at New York University updating students' expectations about the earnings associated with different careers. Students respond rather inelastically to information about the true earnings distribution conditional on major choice, suggesting that rational expectations (as we do in our paper) is an acceptable assumption. Their evidence also suggests that unobserved tastes play an important role for major choice. Unlike these two studies, we want to shed light on the question to what extent the sociocultural environment in which young people grow up shapes their tastes for science fields. We set up a model for college major choice that is motivated by the fact that, in Switzerland, learning about one's abilities seems to be less important empirically. In fact, STEM field students are not more likely to drop out than non-STEM students (Wolter, Diem, and Messer, 2013).

With respect to gender differences in college major choice, Zafar (2013) finds that the gender gap can partly be attributed to a higher emphasis of men on pecuniary outcomes (see also Montmarquette, Cannings, and Mahseredjian, 2002) and higher emphasis of women on enjoying coursework and employment in potential jobs, and gaining the approval of parents. Our results are consistent with the hypothesis that earnings are less important for men than for women. Carell, Page, and West (2010) find that the gender of the professor plays a role for both females' performance in basic math and science classes and the choice of women with high quantitative skills to graduate from a STEM field. Their results suggest that role models are important for females to study STEM fields, but not for males. Kane and Mertz (2011) show that gender equality as measured by gender gaps in income and political participation is positively correlated with math performance of both male and female high-school students. However, gender inequality cannot explain the gender gap in math performance. None of these studies examine the question whether gender differences in major choice can be attributed to differential effects of sociocultural factors across genders.

3 Theoretical Considerations

We first develop a simple theoretical model of individual university major choice in order to motivate our structural estimation approach. We focus on the binary decision to study a STEM field (alternative A) or a non-STEM field (alternative B). This allows us to employ an identification strategy which is inspired by the literature on the (binary) college participation decision.

3.1 Set Up

Consider an infinitely-living individual i who chooses university major $j \in \{A, B\}$ in period 0 and earns wage income Y_{ijt} in period $t = 1, 2, 3, ...$ thereafter.

For simplicity and following standard arguments, suppose individuals cannot borrow against future income while attending university in period 0. We assume that, in period 0, individual i possesses and uses resources y_i^0 for consumption.[5] Moreover, suppose

[5] Sources of income in period 0 could be income from a sideline job during study, scholarships, transfers by parents or prior savings. Individuals may save in period 0 but provided that future

the growth rate of wage income in period $t \geq 1$ is time-invariant and independent of the university major (otherwise income differences across majors would diverge infinitely), but possibly is individual-specific. Let g_i denote the wage growth rate for individual i.[6] Moreover, let us denote the earnings of individual i in period 1, obtained initially after finishing university studies in field $j \in \{A, B\}$, by y_{ij}. Thus, earnings in period $t \geq 1$ read

$$Y_{ijt} = y_{ij}(1 + g_i)^{t-1}. \tag{1}$$

Initial earnings y_{ij} are given by some major-specific function f_j, which depends on a vector of observable characteristics of individual i, $\mathbf{x}_i$, and an individual- and major-specific ability component, ξ_{ij}, that is unobservable for an econometrician. We specify

$$y_{ij} = f_j(\mathbf{x}_i, \xi_{ij}) = \xi_{ij} \exp(\mathbf{x}_i' \boldsymbol{\beta}_j + \kappa_j), \tag{2}$$

where $\boldsymbol{\beta}_j$ is a parameter vector and κ_j is a major-specific shift parameter. Defining $u_{ij} \equiv \ln \xi_{ij} + \kappa_j$, we can write

$$\ln y_{ij} = \mathbf{x}_i' \boldsymbol{\beta}_j + u_{ij}, \;\; j \in \{A, B\}. \tag{3}$$

(3) gives us a familiar linear form for log earnings of an individual, which in our context captures that earnings may depend on the university major chosen, possibly in interaction with individual ability.

In periods $t \geq 1$, individuals can freely borrow and lend at the time-invariant (world market) interest rate r. For technical reasons, suppose that r exceeds the growth rate of earnings g_i for all i. Individuals draw utility from their consumption stream. Importantly, each individual i also draws utility h_{ij} from studying (or graduating from)

income is sufficiently higher than available resources in period 0, which we implicitly assume, they optimally choose zero savings.

[6] We observe individual earnings one year and five years after graduation from university. As some graduates acquired post-graduate education in-between, we shall not attempt to compute the growth rate of earnings over the life-cycle of a worker based on these observations. Fortunately, as will become apparent, g_i will not affect the university major choice as long as we assume that earnings growth does not depend on field j.

major j. Total intertemporal utility of individual i when choosing field j is given by

$$U_{ij} = \sum_{t=0}^{\infty} \rho^t \ln c_{ijt} + h_{ij}, \tag{4}$$

where $\rho \in (0, 1)$ is the discount rate and c_{ijt} denotes the level of material consumption in t of an individual i which has chosen major j. We assume that h_{ij} depends on observable characteristics, $\mathbf{z}_i$ of individual i and on an unobservable individual and major specific taste component, τ_{ij}. We specify the linear form

$$h_{ij} = \mathbf{z}_i' \boldsymbol{\theta}_j + \tau_{ij}, \tag{5}$$

where $\boldsymbol{\theta}_j$ is a parameter vector.

Our empirical identification strategy, explained in section 4, requires that $\mathbf{z}_i$ contains variables that are not included in $\mathbf{x}_i$. Taste characteristics in $\mathbf{z}_i$ which determine utility from studying a certain major but do not shape earnings differentials across majors may be thought of (i) the distance of the home municipality to the next technical university, given the distance to the next university, which is related to the costs of studying a STEM field, and (ii) the sociocultural environment in the home municipality at the time the major is chosen.

3.2 Consumption Profile

After choosing a major j, individual i solves the following maximization problem that smooths consumption over time:

$$\max_{\{c_{ijt}\}_{t=1}^{\infty}} \sum_{t=1}^{\infty} \rho^t \ln c_{ijt} \text{ s.t. } \sum_{t=1}^{\infty} \frac{c_{ijt}}{(1+r)^t} = \sum_{t=1}^{\infty} \frac{Y_{ijt}}{(1+r)^t}. \tag{6}$$

This leads to the well-known Euler equation

$$c_{ijt+1} = (1+r)\rho c_{ijt}, \tag{7}$$

$t \geq 1$. Using (7) in (4) and observing that $c_{ij0} = y_i^0$, intertemporal utility of individual i conditional on major choice j reads as[7]

$$U_{ij} = \frac{\rho}{1-\rho} \ln c_{ij1} + \ln y_i^0 + \frac{\rho^2(2-\rho)}{(1-\rho)^2} \ln[(1+r)\rho] + h_{ij}. \tag{8}$$

Combining (7) with the intertemporal budget constraint in (6) and using expression (1) for earnings Y_{ijt} we obtain the (optimal) level of consumption of individual i under college major choice j in the first working period ($t = 1$). Observing that $r > g_i$ by assumption, it is given by

$$c_{ij1} = \frac{(1-\rho)(1+r)}{r - g_i} y_{ij}. \tag{9}$$

3.3 Major Choice

Substituting both (5) and (9) for $j \in \{A, B\}$ into (8), we find that the difference in utility between studying a STEM major (alternative A) and a non-STEM field (alternative B) is given by

$$\Delta U_i = \alpha_1[\ln y_{iA} - \ln y_{iB}] + \mathbf{z}_i' \boldsymbol{\alpha}_z + \nu_i, \tag{10}$$

where $\alpha_1 \equiv \frac{\rho}{1-\rho}$, $\boldsymbol{\alpha}_z \equiv \boldsymbol{\theta}_A - \boldsymbol{\theta}_B$ and $\nu_i \equiv \tau_{iA} - \tau_{iB}$.[8] As an implication of the logarithmic form of instantaneous utility from material consumption,[9] the expression for utility difference ΔU_i does neither depend on the growth rate of earnings, g_i, nor on the interest rate, r. Moreover, because income (and consumption) while attending university, y_i^0, is independent of the major choice, it cancels out.

Substituting the expression for $\ln y_{ij}$ in (3) for $j \in \{A, B\}$ into (10), we can thus write

$$\Delta U_i = \mathbf{w}_i' \boldsymbol{\pi} - \varepsilon_i, \tag{11}$$

[7]Use $\sum_{t=1}^{\infty} \rho^t = \rho(1-\rho)^{-1}$ and $\sum_{t=2}^{\infty} t\rho^t = \rho^2(2-\rho)(1-\rho)^{-2}$.

[8]Assuming a finite time horizon T rather than an infinite one is inconsequential for (10) except that α_1 becomes $\alpha_1 = \frac{\rho(1-\rho^T)}{1-\rho}$.

[9]The assumption means that the coefficient of relative risk aversion is unity, consistent with empirical evidence (e.g., Chetty, 2006).

where $\mathbf{w}_i' \equiv (\mathbf{x}_i', \ \mathbf{z}_i')$, $\boldsymbol{\pi}' \equiv \left(\alpha_1(\boldsymbol{\beta}_A - \boldsymbol{\beta}_B)', \ \boldsymbol{\alpha}_z'\right)$ and $-\varepsilon_i \equiv \alpha_1(u_{iA} - u_{iB}) + \nu_i$. Clearly, individual i prefers alternative A (STEM major) to B if $\Delta U_i > 0$, i.e., if $\mathbf{w}_i'\boldsymbol{\pi} > \varepsilon_i$.

Willis and Rosen (1979) derived expressions for ΔU_i which are formally equivalent to (10) and (11), albeit in a rather different set up. Whereas they analyzed the choice of college participation, our framework captures the choice of the university major given that an individual goes to university. Willis and Rosen (1979) did not consider consumption smoothing and utility from attending university. In their theoretical model, family background enters by affecting the individual discount rate. The (log) linear forms in their model analogous to (10) and (11) are implied by a first-order Taylor-approximation.

4 Econometric Model

4.1 Selection Bias and Estimation

Ideally, we would like to estimate the probability that a STEM field is chosen, $\Pr\{\Delta U_i > 0 \,|\, \ln y_{iA} - \ln y_{iB}, \mathbf{z}_i\}$, on basis of (10); that is,

$$\Pr\{\Delta U_i > 0 \,|\, \ln y_{iA} - \ln y_{iB}, \mathbf{z}_i\} = \Pr\{\alpha_1[\ln y_{iA} - \ln y_{iB}] + \mathbf{z}_i'\boldsymbol{\alpha}_z + \nu_i > 0 \,|\, \ln y_{iA} - \ln y_{iB}, \mathbf{z}_i\}. \tag{12}$$

However, we observe wages of an individual only for the major which has actually been chosen. Thus, we have to estimate wage equations (3) by correcting for selection bias and then plug the estimates for $\ln y_{iA}$ and $\ln y_{iB}$ into (12). We estimate the model in three stages.

4.1.1 Stage 1

We assume that the error term ε_i in expression (11) is normally distributed with variance σ_ε^2, i.e. $\varepsilon_i \,|\, \mathbf{w}_i \sim \mathcal{N}(0, \sigma_\varepsilon^2)$. Further, express the relationship between the error terms u_{ij}, $j \in \{A, B\}$, in wage equation (3) and ε_i as:

$$u_{ij} = \gamma_j \varepsilon_i + \zeta_{ij}, \tag{13}$$

with $\mathrm{E}(u_{ij} \,|\, \mathbf{w}_i, \varepsilon_i) = \gamma_j \varepsilon_i$, which implies that $\mathrm{E}(\zeta_{ij} \,|\, \mathbf{w}_i, \varepsilon_i) = 0$. Thus, the parameter γ_j corresponds to $\mathrm{Cov}(u_{ij}, \varepsilon_i)/\sigma_\varepsilon^2$, where $\mathrm{Cov}(\cdot)$ denotes the covariance.

In a first step, we estimate the reduced form choice equation based on (11). We suppose that

$$\Pr\{\Delta U_i > 0 \,|\, \mathbf{w}_i\} = \Pr\{\mathbf{w}_i'\boldsymbol{\pi} > \varepsilon_i \,|\, \mathbf{w}_i\} = \Phi\left(\frac{\mathbf{w}_i'\boldsymbol{\pi}}{\sigma_\varepsilon}\right), \tag{14}$$

where Φ denotes the standard normal c.d.f.; its p.d.f. is denoted by φ.

4.1.2 Stage 2

From (3), (11) and (13), we find the expected log wage income of an individual resulting from alternative A (STEM field) conditional on self-selecting to that field:

$$\begin{aligned} \mathrm{E}(\ln y_{iA} \,|\, \mathbf{w}_i, \Delta U_i > 0) &= \mathrm{E}\left[\, \mathrm{E}(\ln y_{iA} \,|\, \mathbf{w}_i, \varepsilon_i) \,|\, \mathbf{w}_i, \Delta U_i > 0\right] \\ &= \mathbf{x}_i'\boldsymbol{\beta}_A + \mathrm{E}(\gamma_A \varepsilon_i \,|\, \mathbf{w}_i, \Delta U_i > 0) \\ &= \mathbf{x}_i'\boldsymbol{\beta}_A + \gamma_A \mathrm{E}(\varepsilon_i \,|\, \mathbf{w}_i, \mathbf{w}_i'\boldsymbol{\pi} > \varepsilon_i) \\ &= \mathbf{x}_i'\boldsymbol{\beta}_A + \delta_A \lambda_{iA}, \end{aligned} \tag{15}$$

where $\delta_A \equiv -\gamma_A \sigma_\varepsilon$ and λ_{iA} denotes the inverse Mills ratio that is defined as

$$\lambda_{iA} \equiv \frac{\varphi(\mathbf{w}_i'\boldsymbol{\pi}/\sigma_\varepsilon)}{\Phi(\mathbf{w}_i'\boldsymbol{\pi}/\sigma_\varepsilon)}. \tag{16}$$

Analogously, we have

$$\mathrm{E}(\ln y_{iB} \,|\, \mathbf{w}_i, \Delta U_i < 0) = \mathbf{x}_i'\boldsymbol{\beta}_B + \delta_B \lambda_{iB}, \tag{17}$$

where $\delta_B \equiv \gamma_B \sigma_\varepsilon$ and

$$\lambda_{iB} \equiv \frac{\varphi(\mathbf{w}_i'\boldsymbol{\pi}/\sigma_\varepsilon)}{1-\Phi(\mathbf{w}_i'\boldsymbol{\pi}/\sigma_\varepsilon)}. \tag{18}$$

Equations (15) and (17) suggest that, at stage 2, we could estimate wage equations

$$\ln y_{iA} = \mathbf{x}_i'\boldsymbol{\beta}_A + \delta_A \lambda_{iA} + \eta_{iA}, \tag{19}$$

$$\ln y_{iB} = \mathbf{x}_i'\boldsymbol{\beta}_B + \delta_B \lambda_{iB} + \eta_{iB}, \tag{20}$$

with error term $\eta_{ij} \equiv \gamma_j(\varepsilon_i - \sigma_\varepsilon \lambda_{ij}) + \zeta_{ij}$, $j \in \{A, B\}$, in the subsamples for which wages associated with alternatives A and B, respectively, are observed. Recalling $-\gamma_A = \text{Cov}(u_{iA}, -\varepsilon_i)/\sigma_\varepsilon^2$, we have $\delta_A = \text{Cov}(u_{iA}, -\varepsilon_i)/\sigma_\varepsilon$. If the estimate of δ_A is positive (and significant), we can conclude that the unobservable u_{iA}, which affects earnings of individual i when graduating from major A, is positively related to the unobservable $-\varepsilon_i = \alpha_1(u_{iA} - u_{iB}) + \tau_{iA} - \tau_{iB}$ which represents unobserved differences in ability and tastes of i between major A and the alternative major B. A positive estimate for δ_B has the analogous interpretation of a positive relation between u_{iB} and ε_i. In these cases, there is selection bias in the sense that individuals choose their major according to their comparative advantage.

In practice, λ_{iA} and λ_{iB} are unknown. We obtain estimates $\hat{\lambda}_{iA}$ and $\hat{\lambda}_{iB}$ by evaluating the right-hand sides of (16) and (18) using the estimated ratio $\hat{\boldsymbol{\pi}}/\hat{\sigma}_\varepsilon$ from the first stage probit regression (14). As shown by Heckman (1976, 1979), the two-step estimation procedure yields consistent estimates $\hat{\boldsymbol{\beta}}_A$ and $\hat{\boldsymbol{\beta}}_B$ for coefficient vectors $\boldsymbol{\beta}_A$ and $\boldsymbol{\beta}_B$. The conventional OLS standard errors for the estimated coefficients in (19) and (20) are incorrect, however, when $\gamma_j \neq 0$, $j \in \{A, B\}$, because the conditional variances of the error terms, $\text{Var}(\eta_{iA} \,|\, \mathbf{w}_i, \Delta U_i > 0)$, $\text{Var}(\eta_{iB} \,|\, \mathbf{w}_i, \Delta U_i \leq 0)$, are nonconstant and $\hat{\lambda}_{iA}$, $\hat{\lambda}_{iB}$ are generated regressors. Therefore, we bootstrap the full three-step estimation procedure using 499 bootstrap replications. Specifically, we apply the weighted bootstrap suggested by Barbe and Bertail (1995). For each person in our data set we generate 499 weights based on random draws from a gamma distribution with shape and scale parameters equal to one. Thus, the bootstrap weights are non-integer and the probability that a weight exactly equals zero is zero. With a binary dependent variable and a number of discrete regressors, this bootstrap procedure has the advantage that we avoid having to repeat the sampling if, in a given resample, the maximum likelihood estimation fails to converge or certain covariate settings perfectly predict the dependent variable (see also Fitzenberger and Muehler, 2015, for a similar argument).

4.1.3 Stage 3

In the final stage 3 (major choice), we estimate the structural probit equation (12) by replacing $\ln y_{iA} - \ln y_{iB}$ by

$$\ln \hat{y}_{iA} - \ln \hat{y}_{iB} = \mathbf{x}_i'(\hat{\boldsymbol{\beta}}_A - \hat{\boldsymbol{\beta}}_B). \tag{21}$$

Again, we rely on the bootstrap procedure described above to obtain standard errors that are valid when the generated wage difference is included as regressor.

4.2 Identification

Our estimating equations (12), (19) and (20) contain two sets of individual characteristics $\mathbf{x}_i$ and $\mathbf{z}_i$. While $\mathbf{x}_i$ captures regressors that reflect abilities affecting earnings capability, $\mathbf{z}_i$ subsumes regressors that measure socialcultural and economic factors affecting major choice. The vector $\mathbf{x}_i$ and the inverse Mills ratio that is a function of $\mathbf{w}_i' = (\mathbf{x}_i', \mathbf{z}_i')$ enter in the second stage equations (19) and (20). The third stage equation contains $\mathbf{z}_i$ and the wage difference that is a function of $\mathbf{x}_i$ as regressors. To avoid multicollinearity issues in the second and third stage estimations it is important to have distinct variables in $\mathbf{x}_i$ and $\mathbf{z}_i$. In Section 5 we provide further details on the specific variables used.

5 Background and Data

5.1 Institutional Background

Attending a Swiss university requires an upper secondary degree from a general high school (*Gymnasiale Matura*). The share of young people holding an upper secondary degree that entitles them to attend university is rather low in Switzerland in international comparison. In 1999, around the time of our survey data, 18 percent of a cohort held a *Gymnasiale Matura* degree (Bundesamt für Statistik, 2015).[10]

At the time of our study, individuals with a Swiss general high school degree could choose freely among the available tertiary education programs and institutions in Switzerland, i.e. for those students there were no university entrance exams, restrictions in terms of minimum high school grade point average, or other selection procedures.[11] In Switzerland, there are two types of academic tertiary education institutions: universities and so-called universities of applied sciences (*Fachhochschulen*). The latter offer programs that are more practically oriented and occupation-specific compared with those at standard universities. Most of them were founded in the mid-1990s, whereas the universities are typically much older. In the 1990s and early 2000s, around 75 percent of the young people with a Swiss general high school degree enroll at a (standard) university within a year after high school graduation (Bundesamt für Statistik, 2013). There was no distinction between undergraduate and graduate university degrees. Graduating from university meant completing a curriculum comparable to a Master's degree in Switzerland and other countries nowadays, whereas graduating from a university of applied sciences meant completing a shorter curriculum comparable to a Bachelor's degree nowadays.

In the period under study, there were eleven universities in Switzerland. The two technical universities, called *Eidgenössische Technische Hochschulen* (ETH), are the

[10]In addition, in 1999, seven percent of a cohort obtained an upper secondary degree from a vocational high school (*Berufsmatura*). This degree only provides access to a particular field of study at a university of applied sciences.

[11]Only medical schools began, in the year 1998, to select students according to their grade point average at high school and in an entrance exam. These restrictions are not relevant for the cohorts in our data set.

only federal universities in Switzerland. They are located in the cities of Lausanne and Zurich. All other universities are governed at the cantonal (i.e., state) level. The nine cantonal universities are located in the cities of Basel, Berne, Fribourg, Geneva, Lausanne, Lugano, Neuchâtel, St. Gallen, and Zurich. The cantonal universities offer degree programs of comparable quality in non-STEM fields. For STEM fields, however, the technical universities are better endowed, have much bigger departments and offer a wider variety of programs and specializations than the cantonal universities. Thus, a STEM degree from a technical university is considered as more prestigious than one from a cantonal university.[12] In our data set, 62.8 percent of STEM university graduates attended one of the two technical universities.

Drop-out rates are similar across STEM and non-STEM programs and relatively low in international comparison. Of those university students enrolled in a particular program in the year 2001, for instance, 28.7 percent did not graduate from that program after 10 years and the vast majority of them has definitely dropped out of that program (Wolter, Diem, and Messer, 2013). This is very different to the pattern of drop-out rates found by Arcidiacono (2004) and Stinebrickner and Stinebrickner (2014) for the US. Their evidence suggests that an extraordinarily high fraction of students, who intend to or actually start a science major, graduate in another major or drop out from university. A possible explanation for the uniformly low drop-out rates in Switzerland could be the rather low enrolment rates in university education in Switzerland, possibly leading to a more talented and/or better informed selection of university students on average.

Tuition fees in Swiss universities are moderate in international comparison, both in absolute terms and relative to housing costs. They are similar across universities and the same for all majors within a university. With nine university locations in a small country like Switzerland, but only two technical universities located in the high-cost areas Zurich and Lausanne, we hypothesize that the distance from the home municipality to the next technical university, relative to the distance to the next (other) university,

[12]For instance, Nobel Prize winner Albert Einstein studied between 1896 and 1900 at the ETH Zurich where he later also served as a professor. Until today, 21 Nobel prize winners have studied or worked at the ETH Zurich.

is a major determinant of the economic cost to study a STEM major. For instance, high school graduates living at their parents' home in the canton of Ticino or St. Gallen face the trade-off between studying a STEM field at one of the prestigious technical universities in Zurich and Lausanne or studying, say, economics at the University of Lugano or the University of St. Gallen – involving substantially lower living expenses.

5.2 Graduate Survey

Our main data source is the 'Swiss Graduate Survey' of the Federal Statistical Office (*Bundesamt für Statistik*), a unique survey of the population of graduates from tertiary academic education in Switzerland (Bundesamt für Statistik, 2008, 2009, 2012). We consider all respondents who graduated in 2000 and 2002 from one of the nine cantonal or the two federal universities.[13] All graduates of these two cohorts received a questionnaire one year and five years after graduation. Participation in the survey was voluntary. All respondents in the first wave received a follow-up questionnaire five years after graduation. The response rate was about 60 percent in the first wave and 65 percent in the second. We use the probability weights provided by the Federal Statistical Office of to account for potentially selective nonresponse.

The survey contains a large array of individual characteristics including earnings, hours worked, major at university, gender, the level of education of mother and father, as well as the home municipality before entering university. To construct our main dependent variable, we categorize graduates into two groups according to their field of study. STEM majors include physical sciences, biology, mathematics, computing, and engineering. The remaining majors are classified as non-STEM or humanities.

Since our theoretical model implies that expected earnings differences between fields of study may have an important impact on study major choice, the availability of individual earnings several years after graduation is crucial for our estimation strategy. As a consequence, we restrict the analysis sample to those who participate also in the

[13] For homogeneity reasons, we do not consider graduates from other higher education institutions, i.e. universities of applied sciences. The graduates from the cantonal and federal universities represent 70 percent of the total number of graduates in the survey.

second wave because it includes information on earnings five years after graduation. To construct our earnings variable, we consider earnings in the main job including also overtime compensation and bonus payments. We divide total earnings by total hours worked (contractual hours plus overtime) to obtain the hourly wage rate we use in the estimations.

We further focus on Swiss persons working at least 20 percent of the fulltime amount. In order to mitigate potential measurement error, we exclude individuals who report extreme earnings values (445 observations). In order to focus on typical careers, we leave out graduates who took less than eight or more than 18 semesters to complete their degree, and we exclude respondents older than 37 years of age (599 observations). Our final sample includes 4,767 individuals.

5.3 Geographical and Sociocultural Data

For our analysis, an important piece of information in the 'Swiss Graduate Survey' is the home municipality of each graduate at the end of high school. We draw on this variable to characterize a student's sociocultural background at the time of major choice. There are about 2,600 municipalities in Switzerland, which allows us to reconstruct the sociocultural environment at a very detailed regional level.[14]

First, we characterize the majority language and the religious environment (share of Catholics) of a graduate in the home municipality using information from the 'Federal Population Census' in 1990 (Bundesamt für Statistik, 1990). The census is a mandatory survey of the entire resident population that takes place every 10 years. Every household in Switzerland receives a household specific questionnaire and individual specific questionnaires for each person living in the household (Bundesamt für Statistik, 1996). The census collects information on the demographic, economic, social and cultural structure of Switzerland and its development over time. Second, we construct the distances from the center of the home municipality to the next technical university (ETH) and the distance to the next cantonal university with the help of Google

[14] A complete listing of the data sources used is provided in Appendix A.

Maps. Third, we calculate the total vote share which accrued to left-wing parties in the Swiss national election in 1995 based on municipality level election data (Bundesamt für Statistik, 1995). Fourth, we use the results from four nationwide referenda to capture how progressive views were on gender equality and science-related issues. The municipality level data on referenda results are provided by Année Politique Suisse (2013). Some details of these referenda are outlined next.

The referendum on gender equality in 1981 intended to give equal rights to women with respect to professional life, family life, and education. A particular focus of the initiative was to ensure by law equal pay for equal work. Opponents feared that the proposal would interfere in wage negotiations and endanger private autonomy of families. The referendum passed in 17 of the 26 cantons. The overall support for the proposal was 60.3 percent. A nationwide representative poll revealed that opponents of the initiative, in general, disapproved equal rights for men and women.[15]

After the isolation of embryonic stem cells in 1998, advances in stem cell engineering prompted the debate on how to deal with the use of embryonic stem cells legally and ethically. The Swiss government proposed a law allowing scientists to take stem cells only from embryos left over from in vitro fertilization procedures. In 2004, the electorate accepted the law with a majority of 66.4 percent. All cantons voted in favor of the proposal. Polls showed that 40 percent of the opponents said that ethical concerns were the principal reason for voting against the proposal. About 50 percent of adversaries expressed that doubts about the merits of scientific research in general and fears of unwelcome consequences were decisive factors to oppose the law.

In a scientific pilot project set up by the Swiss Government in 1994, drug addicts were entitled to receive heroin from a physician for free. Evaluation of this program suggested positive effects on both the health and the social situation of drug addicts. Subsequently, the Swiss government was seeking to enlarge the set of therapies by a state-controlled distribution of heroin all over Switzerland. Adversaries argued, in particular, that the state would financially and morally support drug addicts by this

[15] For such background information and further discussion of the referenda used in our study, see Linder, Bolliger and Rielle (2010).

law. In 1999, the people approved the proposal by a majority of 54.4 percent. Ten cantons refused the law.

Finally, in 2005, a referendum was held on the introduction of equal rights for homosexual couples in civil law. Registered homosexual partnerships were supposed to get the same rights as married couples except for the right to adopt children and access to in vitro fertilization. 58 percent of voters approved the law. In seven of the 26 cantons the majority refused it. A nationwide poll found that voters based their decision on their fundamental conviction whether homosexual partnerships should be legally and socially recognized.[16]

5.4 Variables Affecting Earnings Capability

According to equation (2) in the theoretical framework, variables in $\mathbf{x}_i$ are those which affect the earnings capability of an individual i early in the professional career (time $t = 1$) given the major choice. They enter the estimated equations (19) and (20) at the second stage. (As usual, we also include a constant term.) We employ a dummy variable which indicates gender (equal to 1 if i is female) to capture potential discrimination of women in the labor market (variable 'female'). Moreover, we control for the age (in logs) of an individual at the time of the survey (five years after graduating from university) to capture work experience (variable 'log age'). Some older graduates may have gained work experience prior or during attending university, the latter possibly prolonging their study duration to the benefit of higher earnings early in the career (as captured by $y_{ij} = f_j(\mathbf{x}_i, \xi_{ij})$ for major j in our model). We also account for the fact whether an individual has participated in a post-graduate education program for a period of at least six months (variable 'postgraduate education'). We expect individuals who have participated in such a program to earn significantly less early in the career than those who have not because, for a given age, they tend to have shorter work experience at

[16]In the period 1980-2005, there were additional referenda on similar topics than the ones included. In 1985 and in 2000 there were two further referenda on gender equality. In the late 1990s, there were four additional referenda on topics related to science issues (genetic engineering, transplantation medicine) and drug policy. Statistically, these additional referenda capture similar variation than the ones we have retained. The included referenda were particularly salient in the public debate at the time.

the time of observation. For instance, the work experience five years after receiving a master degree of an individual which participated in a doctoral program is relatively low (often literally zero). Even if the growth rate of income, g_i, of such an individual i could be higher on average than for individuals without a doctorate but five years of work experience,[17] income y_{ij} for any major j is typically lower. Failing to account for this fact could confound our second-stage estimates (earnings regressions), from which we construct the (log) earnings differences (21). These are denoted by 'log earnings differential' and enter at the third stage of the estimation procedure (structural major choice). Finally, we also include dummy variables indicating whether at least one parent attended tertiary academic education, tertiary vocational education, or no vocational education.[18] In this way we account for a possible intergenerational transmission of cognitive ability.[19] Note, however, that the education of parents may be less important for success in the labor market within the group of university graduates as compared to the whole population.

5.5 Variables Affecting Major Choice

Identification requires that we find convincing exclusion restrictions. That is, we need variables that reflect tastes and economic constraints affecting major choice $\mathbf{z}_i$ but are (partly) distinct from characteristics in $\mathbf{x}_i$ affecting earnings capability of a student i. Moreover, our structural estimation approach dictates that only those variables enter $\mathbf{z}_i$ which are known to an individual i at the time of major choice. We thus employ the female dummy and a cohort dummy (taking the value one if an individual is observed in the second survey of the year 2003 rather than 2001) as the only variables that enter

[17]Recall that g_i does not enter the estimated equations according to our structural model such that we do not have to observe it.

[18]We apply the International Standard Classification of Education (ISCED) by UNESCO which distinguishes tertiary education of type 5A (academic) and type 5B (vocational). Switzerland is, like Germany, well-known for its dual apprenticeship system, associated with lower enrolment rates in tertiary academic education than is typically observed in other advanced countries. We experimented with also including a dummy variable indicating whether at least one parent has secondary vocational education. The variable turned out to be unimportant for any of the results.

[19]As robustness checks, we included the education of the mother and father separately and constructed various indicators of their level of education. We found no important differences in the estimation results compared to the parental education measure we use to reach the reported results.

both stage 2 and stage 3 estimations.

Sociocultural Characteristics and Gender Differences Our first identifying assumption is that variables which capture the sociocultural background of students affect the decision whether to study a STEM field but do not affect the differences of (log) earnings across majors after graduating from university. We include in $\mathbf{z}_i$ the shares of yes-votes in the following nationwide referenda in the home municipality of a college graduate before going to university: on introducing equal rights of men and women in the constitution held in 1981 (variable 'gender equality'), on providing drug addicts with medical prescriptions of heroin to addicts held in 1999 (variable 'heroin program'), on regulating stem cell research held in 2004 (variable 'stem cells'), and on a civil union of homosexual couples held in 2005 (variable 'gay marriage'). As a different kind of political indicator, we employ the support for left wing parties in the election for the National Parliament of 1995 (variable 'left-wing'). We also aim to capture the cultural background by the share of Catholics in a graduate's home municipality (variable 'Catholics'). Although Catholicism and political attitudes may have been related to cognitive skills in the 19th century (e.g. Becker and Woessmann, 2009; Boppart et al., 2013, 2014), both kinds of variables are unlikely to affect the contemporaneous individual earnings potential for a given study field.

A principal component analysis with these variables suggests that they load particularly high on a single principal component, denoted by 'principal factor' (see Tab. 7 in Appendix B). It is therefore reasonable to interpret the sociocultural variables as indicators of progressive attitudes on gender equality and science-related issues. We use the sociocultural characteristics and the summary indicator 'principal factor' separately in our first and third stage estimations. The share of Catholics is supposed to be a measure of "anti-progressive" attitudes (entering with the opposite sign than the others).

In order to examine whether the sociocultural characteristics contribute to explaining gender differences with respect to choosing a STEM field in university, in an extension of our basic major choice probit estimations, we also include interaction effects between sociocultural characteristics and gender. Moreover, we use this specification to check the well-known hypothesis that female students are less motivated by earnings than males. We therefore include an interaction effect at stage 3 between the (constructed) earnings differential across fields as given by (21) and gender.

Geographical Characteristics Our second identifying assumption is that the distances of the home municipality to the next technical and the next other university, respectively, do not affect earnings capability for a given major choice but determine the relative cost to study a STEM field. We take logs to capture that the marginal impact of an additional kilometer on major choice is decreasing with distance. Suppose, for instance, the next technical university (ETH) is 75 km away from the parents' home and the next other university is 25 km away. Then a student may be inclined to choose the university in the region (and not study a STEM field) to save living expenses. However, if the next ETH is 150 km away and the next university is 100 km away, the geographical distances shall not matter much for the major choice. It is the combination of the free choice of those holding an upper secondary education degree which field and where to study and the geographical distribution of technical universities and other universities in Switzerland that provide a unique identification opportunity for the determinants of university major choice.

Majority Language Moreover, in Switzerland, the motivation to study a STEM field may depend on the majority language (German, French, Italian) of an individual's home environment. For instance, the two technical universities in Switzerland offer programs in German, French, and English but not in Italian. Further, regional differences in institutions and industry structure may be affected by trade relations of Swiss regions and neighboring countries with a common language. Of course, language may also be perceived as a cultural characteristic. We include dummy variables for French and Italian as majority language, i.e., German as majority language is the left-out category.[20]

[20]We subsume the very few observations from Rhaeto-Romansh speaking municipalities to the category Italian speaking. Inhabitants of these municipalities speak Italian at least as their second

5.6 Economic Environment

One may hypothesize that the economic environment may shape taste or capability differences of an individual across study fields. We thus perform a sensitivity analysis, where we include the employment rate of the home municipality, the industry structure (employment shares in agriculture, manufacturing, construction, and business services), and the municipality size as control variables at the first stage. We document in Appendix B that these factors are insignificant and therefore we focus in the main text on the estimation results without those controls.

5.7 Summary Statistics

Tab. 1 provides summary statistics of the variables used in the empirical analysis. Five years after graduation, the average age of the respondents is 31 years. Gross hourly wages in the main job are CHF 34.52 for STEM graduates and CHF 36.66 for non-STEM graduates, with men on average earning almost eleven percent more than women. 28 percent of the graduates studied a STEM field, with 38 percent among men and 15.1 percent among women. Both of these figures are very close the OECD average (see Fig. 1). About 53 percent of the respondents participated in post-graduate education and about two-fifths of the graduates report having at least one parent with tertiary academic education. The average distance to the next university is about 28 km, whereas the average distance to the next technical university (ETH) is 71 km.

The summary statistics of the variables capturing the economic environment employed in the sensitivity analysis are relegated to Appendix B (Tab. 8).

6 Estimation Results

We present two sets of results. First, we show the results of estimations without any interaction effects between gender and sociocultural characteristics as well as earnings differences across majors. Second, we include these interaction effects to learn about

language, typically being bilingual.

Table 1: Descriptive Statistics of Core Variables

	Total (1)	Men (2)	Women (3)
Individual level variables			
STEM major (1=yes, 0=no)	0.280 (0.449)	0.380 (0.485)	0.151 (0.358)
Female (1=yes, 0=no)	0.438 (0.496)	0.000 (0.000)	1.000 (0.000)
Second cohort (1=yes, 0=no)	0.438 (0.496)	0.437 (0.496)	0.439 (0.496)
Age	31.05 (1.86)	31.15 (1.78)	30.92 (1.95)
Parent has tertiary academic education (1=yes, 0=no)	0.382 (0.486)	0.368 (0.482)	0.402 (0.490)
Parent has tertiary vocational education (1=yes, 0=no)	0.381 (0.486)	0.388 (0.487)	0.373 (0.484)
Parent has no vocational education (1=yes, 0=no)	0.265 (0.441)	0.268 (0.443)	0.260 (0.439)
Postgraduate education (1=yes, 0=no)	0.534 (0.499)	0.539 (0.499)	0.528 (0.499)
Gross hourly wage with STEM major	34.52 (14.82)	35.34 (13.96)	31.86 (17.05)
Gross hourly wage with non-STEM major	36.66 (13.35)	38.62 (15.31)	34.84 (10.90)
Municipality level variables			
Distance to next university (km)	27.85 (30.39)	28.68 (30.55)	26.79 (30.15)
Distance to next ETH (km)	70.55 (49.60)	70.70 (48.92)	70.35 (50.47)
Share in favor of gender equality	0.635 (0.129)	0.629 (0.130)	0.642 (0.127)
Share in favor of heroin program	0.545 (0.103)	0.547 (0.102)	0.544 (0.104)
Share in favor of stem cell engineering	0.695 (0.102)	0.689 (0.100)	0.703 (0.103)
Share in favor of gay marriage	0.595 (0.085)	0.594 (0.086)	0.596 (0.085)
Share of left-wing parties	0.327 (0.131)	0.322 (0.131)	0.334 (0.132)
Share of Catholics	0.426 (0.291)	0.430 (0.291)	0.420 (0.291)
Majority French (1=yes, 0=no)	0.341 (0.474)	0.312 (0.463)	0.378 (0.485)
Majority Italian (1=yes, 0=no)	0.058 (0.233)	0.053 (0.224)	0.064 (0.245)
Observations	4,767	2,572	2,195

Source: Federal Statistical Office of Switzerland, Année Politique Suisse, own calculations. Notes: The table shows the means and standard deviations (in parentheses) of the variables.

gender differences.

6.1 Results from Pooled Estimations

6.1.1 First Stage: Reduced Form Major Choice

We start with the results on the reduced form Probit estimations (14) of stage 1, presented in Tab. 2. Columns (1)-(7) of Tab. 2 refer to the different "progressivism" indicators included.

As expected from the summary statistics, women are significantly less likely to study a STEM field. Moreover, the larger the (log) distance to the next technical university (ETH), the higher the probability to study a STEM field; coefficients are significantly different from zero at least at the five percent level. The (log) distance to the next university enters positively and often significantly, suggesting that the proximity to the next ETH *relative* to the proximity to the next university positively affects the likelihood to choose a STEM major.[21] As such geographic characteristics should not matter for earnings *per se* and hence can be left out at stage 2 estimations, these results well support our identification strategy.

Columns (1)-(7) of Tab. 2 differ in the "progressivism" indicator we control for. Its effects are shown in the first row. Not all of the coefficients are significantly different from zero, but overall they provide a consistent picture. Individuals from more conservative environments are more likely to choose a STEM field. For instance, the higher the vote share for left-wing parties (column (5)) in a municipality and for supporting the referenda on extending gender equality (column (1)) as well as allowing stem cell research (column (3)), the lower the probability that a student chooses a STEM major (with significance at the one percent level). The point estimates of the other coefficients point to the same conclusion, i.e., a negative sign for supporting heroin prescriptions to addicts (column (2)) and marriage of homosexuals (column (5)). The share of Catholics enters with a positive sign (column (6)). Instead of using these

[21] This is confirmed when we include the log of the ratio of the two distance measures rather than including the measures separately (not reported). We chose to stick to the latter specification to allow for differential effects.

Table 2: First Stage Probit Estimates for Probability of Graduating in a STEM Major

	Gender equality (1)	Heroin program (2)	Stem cells (3)	Gay marriage (4)	Left-wing (5)	Catholics (6)	Principal factor (7)
	Coefficients and standard errors						
Progressivism	-0.733	-0.346	-0.922	-0.460	-0.540	0.201	-0.056
	(0.212)***	(0.278)	(0.288)***	(0.320)	(0.197)***	(0.105)*	(0.017)***
Female	-0.735	-0.734	-0.733	-0.733	-0.731	-0.733	-0.732
	(0.043)***	(0.043)***	(0.043)***	(0.043)***	(0.043)***	(0.043)***	(0.043)***
Cohort two	0.051	0.048	0.050	0.048	0.048	0.048	0.050
	(0.039)	(0.038)	(0.038)	(0.038)	(0.038)	(0.038)	(0.038)
Majority French	-0.324	-0.437	-0.280	-0.414	-0.367	-0.418	-0.394
	(0.054)***	(0.065)***	(0.061)***	(0.054)***	(0.052)***	(0.053)***	(0.051)***
Majority Italian	-0.050	-0.119	-0.039	-0.150	-0.153	-0.176	-0.168
	(0.098)	(0.102)	(0.099)	(0.109)	(0.100)	(0.110)	(0.102)*
Log distance to next univ.	0.029	0.049	0.044	0.048	0.038	0.040	0.022
	(0.020)	(0.019)**	(0.018)**	(0.019)**	(0.019)**	(0.021)*	(0.021)
Log distance to ETH	-0.043	-0.046	-0.057	-0.051	-0.046	-0.052	-0.051
	(0.019)**	(0.019)**	(0.019)***	(0.019)***	(0.019)**	(0.019)***	(0.019)***
Parent tert. acad. educ.	-0.089	-0.097	-0.093	-0.096	-0.099	-0.098	-0.089
	(0.043)**	(0.043)**	(0.043)**	(0.044)**	(0.043)**	(0.043)**	(0.043)**
Parent tert. voc. educ.	0.056	0.061	0.065	0.062	0.062	0.063	0.061
	(0.045)	(0.045)	(0.045)	(0.045)	(0.045)	(0.045)	(0.045)
Parent no voc. educ.	-0.119	-0.114	-0.122	-0.118	-0.119	-0.121	-0.122
	(0.051)**	(0.050)**	(0.051)**	(0.051)**	(0.051)**	(0.051)**	(0.051)**
Log age	-3.119	-3.110	-3.132	-3.113	-3.147	-3.128	-3.132
	(0.405)***	(0.405)***	(0.405)***	(0.404)***	(0.404)***	(0.405)***	(0.404)***
Postgraduate education	-0.193	-0.192	-0.192	-0.191	-0.192	-0.190	-0.192
	(0.040)***	(0.040)***	(0.040)***	(0.040)***	(0.040)***	(0.040)***	(0.040)***
Constant	11.180	10.877	11.400	10.987	10.997	10.704	10.907
	(1.401)***	(1.402)***	(1.423)***	(1.431)***	(1.410)***	(1.406)***	(1.404)***
	Model statistics						
Observations	4,767	4,767	4,767	4,767	4,767	4,767	4,767
Pseudo R^2	0.09	0.09	0.09	0.09	0.09	0.09	0.09

Source: Swiss Federal Statistical Office, Année Politique Suisse, own calculations. Notes: The dependent variable is a dummy for graduation in a STEM field. Progressivism refers to the different indicators of progressivism indicated by the column headers. Bootstrapped standard errors of the coefficients are shown in parentheses. *, ** and *** denote significance at the 10%-, 5%- and 1%-level, respectively.

six sociocultural indicators separately, column (7) uses the first principal component extracted from a principal component analysis on these indicators. As argued above, it may well be interpreted as measure of "progressivism" of the students' sociocultural home environment. Consistent with the results from columns (1)-(6), column (7) shows that a higher degree of progressivism reduces the probability to study a STEM field. The coefficient is significantly different from zero at the one percent level.

We also estimated a richer first stage model that includes additional variables capturing the economic environment at the time of major choice (see Tab. 9 in Appendix B). We then conducted joint significance tests on the different sets of regressors: cost determinants, earnings determinants, socio-cultural background, and economic environment. The results shown in Tab. 10 suggest that the variables capturing the economic environment are not statistically significant while all the others are. We therefore report results from estimations that exclude the variables measuring the economic environment as our preferred specification.

6.1.2 Second Stage: Earnings

Results of the earnings regressions at stage 2 are given in Tab. 3 and Tab. 4. Tab. 3 relates to STEM fields and Tab. 4 to Humanities. The columns correspond to those of the first stage, differing in the progressivism indicator used. This is why the estimates for the correction terms $\hat{\lambda}_{iA}$ and $\hat{\lambda}_{iB}$ (constructed from stage 1 estimates to account for selection bias; see (19) and (20)) are different across the columns within Tab. 3 and Tab. 4, respectively. In the tables, correction terms are denoted by λ_A and λ_B for STEM fields and Humanities respectively. We find that their coefficients are always positive and significant at the one percent level. As expected from the proposed Roy (1951) model, they suggest that individuals self-select according to their comparative advantage. If anything, females have slightly higher hourly wages than males when graduating from a STEM field (Tab. 3). However, the coefficient on the female dummy in Tab. 4 is insignificant. By contrast, inter alia correcting for self-selection, females have 8-10 percent higher hourly wages than among non-STEM university graduates.

As expected, older and more experienced graduates earn more. The coefficient

Table 3: Second Stage Estimates of the Earnings Equation for STEM Graduates Corrected for Self-Selection

	Gender equality (1)	Heroin program (2)	Stem cells (3)	Gay marriage (4)	Left-wing (5)	Catholics (6)	Principal factor (7)
	Coefficients and standard errors						
Female	0.041	0.032	0.030	0.037	0.014	0.018	0.031
	(0.056)	(0.059)	(0.056)	(0.060)	(0.058)	(0.056)	(0.057)
Cohort two	-0.024	-0.024	-0.023	-0.024	-0.023	-0.023	-0.024
	(0.022)	(0.023)	(0.022)	(0.023)	(0.022)	(0.022)	(0.022)
Parent tert. acad. educ.	-0.031	-0.033	-0.034	-0.032	-0.036	-0.035	-0.033
	(0.024)	(0.024)	(0.024)	(0.025)	(0.024)	(0.024)	(0.024)
Parent tert. voc. educ.	-0.002	-0.001	-0.001	-0.002	0.001	0.000	-0.001
	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)
Parent no voc. educ.	0.029	0.028	0.027	0.029	0.025	0.026	0.027
	(0.029)	(0.029)	(0.029)	(0.029)	(0.029)	(0.029)	(0.029)
Log age	0.561	0.534	0.539	0.549	0.493	0.501	0.537
	(0.274)**	(0.271)**	(0.269)**	(0.274)**	(0.269)*	(0.265)*	(0.269)**
Postgraduate education	-0.195	-0.198	-0.198	-0.197	-0.202	-0.202	-0.198
	(0.027)***	(0.027)***	(0.027)***	(0.028)***	(0.027)***	(0.027)***	(0.027)***
λ_A	0.279	0.263	0.258	0.272	0.230	0.238	0.261
	(0.083)***	(0.090)***	(0.082)***	(0.091)***	(0.087)***	(0.086)***	(0.084)***
Constant	1.943	2.024	1.998	1.978	2.133	2.113	2.009
	(0.915)**	(0.903)**	(0.900)**	(0.913)**	(0.896)**	(0.885)**	(0.901)**
	Model statistics						
Observations	1,438	1,438	1,438	1,438	1,438	1,438	1,438
R^2	0.12	0.11	0.12	0.12	0.12	0.11	0.11

Source: Swiss Federal Statistical Office, Année Politique Suisse, own calculations. Notes: The dependent variable is the log of monthly full-time equivalent earnings. The different specifications differ in the progressivism indicator included at the first stage. Bootstrapped standard errors of the coefficients are shown in parentheses. *, ** and *** denote significance at the 10%-, 5%- and 1%-level, respectively.

Table 4: Second Stage Estimates of the Earnings Equation for Non-STEM Graduates Corrected for Self-Selection

	Gender equality (1)	Heroin program (2)	Stem cells (3)	Gay marriage (4)	Left-wing (5)	Catholics (6)	Principal factor (7)
	Coefficients and standard errors						
Female	0.084	0.104	0.078	0.101	0.089	0.097	0.080
	(0.034)**	(0.036)***	(0.035)**	(0.036)***	(0.034)***	(0.035)***	(0.034)**
Cohort two	0.009	0.008	0.010	0.008	0.009	0.009	0.010
	(0.015)	(0.016)	(0.015)	(0.016)	(0.015)	(0.016)	(0.015)
Parent tert. acad. educ.	-0.005	-0.002	-0.006	-0.002	-0.004	-0.003	-0.006
	(0.017)	(0.018)	(0.017)	(0.018)	(0.017)	(0.017)	(0.017)
Parent tert. voc. educ.	-0.006	-0.008	-0.005	-0.008	-0.007	-0.008	-0.005
	(0.017)	(0.018)	(0.017)	(0.018)	(0.017)	(0.018)	(0.017)
Parent no voc. educ.	0.025	0.028	0.024	0.028	0.026	0.027	0.024
	(0.020)	(0.021)	(0.020)	(0.020)	(0.020)	(0.020)	(0.019)
Log age	0.816	0.869	0.800	0.861	0.832	0.851	0.808
	(0.141)***	(0.149)***	(0.141)***	(0.146)***	(0.141)***	(0.144)***	(0.140)***
Postgraduate education	-0.039	-0.034	-0.041	-0.035	-0.037	-0.036	-0.040
	(0.016)**	(0.017)**	(0.016)**	(0.016)**	(0.016)**	(0.016)**	(0.016)**
λ_B	0.516	0.573	0.498	0.566	0.531	0.551	0.505
	(0.089)***	(0.096)***	(0.092)***	(0.096)***	(0.092)***	(0.091)***	(0.089)***
Constant	0.492	0.271	0.561	0.306	0.427	0.351	0.528
	(0.518)	(0.549)	(0.520)	(0.539)	(0.519)	(0.529)	(0.515)
	Model statistics						
Observations	3,329	3,329	3,329	3,329	3,329	3,329	3,329
R^2	0.06	0.06	0.06	0.06	0.06	0.06	0.06

Source: Swiss Federal Statistical Office, Année Politique Suisse, own calculations. Notes: The dependent variable is the log of monthly full-time equivalent earnings. The different specifications differ in the progressivism indicator included at the first stage. Bootstrapped standard errors of the coefficients are shown in parentheses. *, ** and *** denote significance at the 10%-, 5%- and 1%-level, respectively.

on log age is somewhat higher for non-STEM graduates and highly significant for non-STEM graduates. Also as expected, individuals with post-graduate education earn significantly less five years after graduation. For people who have obtained post-graduate education, earnings are about 20 percent lower for STEM field graduates and four percent lower for non-STEM field graduates. Interestingly, earnings do not seem to be affected much by the education level of parents. This is not implausible. The education of parents would certainly matter for earnings in a sample with both graduates and non-graduates but there is not much reason for such an effect when restricting focus on those who attended university.

6.1.3 Third Stage: Structural Major Choice

Results for stage 3, presented in Tab. 5, basically confirm those of stage 1. The only difference to Tab. 2 is that at stage 3 we employ our measure of constructed differences in (log) earnings across fields (21) rather than controlling for those variables which affect earnings at stage 2. The estimated coefficients are significantly different from zero at the five percent level and suggest that an increase in the log earnings differential positively affects the probability to choose a STEM field. Moreover, as expected, the coefficient on the female dummy is negative and highly significant. The distance measures and sociocultural variables basically keep their significance levels from the stage 1 results and also the sizes of the coefficients are similar in magnitude to Tab. 2.

Table 5: Third Stage Probit Estimates for Probability of Graduating in a STEM Major

	Gender equality (1)	Heroin program (2)	Stem cells (3)	Gay marriage (4)	Left-wing (5)	Catholics (6)	Principal factor (7)
	Coefficients and standard errors						
Progressivism	-0.785	-0.436	-0.902	-0.493	-0.533	0.195	-0.057
	(0.219)***	(0.294)	(0.292)***	(0.332)	(0.213)**	(0.110)*	(0.017)***
Female	-0.693	-0.691	-0.692	-0.691	-0.690	-0.690	-0.690
	(0.054)***	(0.053)***	(0.053)***	(0.053)***	(0.053)***	(0.053)***	(0.054)***

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Table 5: Third Stage Probit Estimates <continued>

	Gender equality (1)	Heroin program (2)	Stem cells (3)	Gay marriage (4)	Left-wing (5)	Catholics (6)	Principal factor (7)
Cohort two	0.089	0.084	0.087	0.083	0.084	0.083	0.089
	(0.052)*	(0.052)	(0.052)*	(0.052)	(0.052)	(0.052)	(0.052)*
Majority	-0.215	-0.359	-0.179	-0.321	-0.276	-0.328	-0.293
French	(0.057)***	(0.071)***	(0.064)***	(0.059)***	(0.058)***	(0.059)***	(0.056)***
Majority	0.040	-0.038	0.050	-0.065	-0.062	-0.084	-0.082
Italian	(0.102)	(0.111)	(0.103)	(0.116)	(0.109)	(0.118)	(0.107)
Log distance	0.034	0.057	0.054	0.057	0.049	0.052	0.030
to next univ.	(0.020)*	(0.020)***	(0.018)***	(0.020)***	(0.019)**	(0.021)**	(0.021)
Log distance	-0.043	-0.049	-0.059	-0.054	-0.049	-0.055	-0.053
to ETH	(0.019)**	(0.020)**	(0.019)***	(0.020)***	(0.020)**	(0.020)***	(0.019)***
Log earnings	1.074	1.032	1.039	1.021	1.015	1.012	1.066
difference	(0.492)**	(0.492)**	(0.499)**	(0.494)**	(0.503)**	(0.497)**	(0.500)**
Constant	0.429	0.182	0.550	0.243	0.107	-0.116	0.081
	(0.181)**	(0.221)	(0.247)**	(0.268)	(0.144)	(0.104)	(0.119)
Average partial effects and standard errors							
Progressivism	-0.038	-0.017	-0.037	-0.017	-0.028	0.029	-0.041
	(0.011)***	(0.011)	(0.012)***	(0.011)	(0.011)**	(0.016)*	(0.012)***
Female	-0.215	-0.215	-0.215	-0.215	-0.214	-0.214	-0.214
	(0.016)***	(0.016)***	(0.016)***	(0.016)***	(0.016)***	(0.016)***	(0.016)***
Cohort two	0.028	0.026	0.027	0.026	0.026	0.026	0.028
	(0.016)*	(0.016)	(0.016)*	(0.016)	(0.016)	(0.016)	(0.016)*
Majority	-0.066	-0.108	-0.055	-0.097	-0.084	-0.099	-0.089
French	(0.017)***	(0.020)***	(0.019)***	(0.017)***	(0.017)***	(0.017)***	(0.016)***
Majority	0.013	-0.012	0.016	-0.020	-0.019	-0.026	-0.025
Italian	(0.032)	(0.034)	(0.033)	(0.035)	(0.033)	(0.035)	(0.032)
Log distance	0.022	0.036	0.034	0.036	0.031	0.033	0.019
to next univ.	(0.013)*	(0.013)***	(0.011)***	(0.013)***	(0.012)**	(0.013)**	(0.013)
Log distance	-0.015	-0.017	-0.021	-0.019	-0.017	-0.019	-0.019
to ETH	(0.007)**	(0.007)**	(0.007)***	(0.007)***	(0.007)**	(0.007)***	(0.007)***
Log earnings	0.050	0.048	0.048	0.047	0.048	0.048	0.050
difference	(0.023)**	(0.023)**	(0.023)**	(0.023)**	(0.024)**	(0.023)**	(0.023)**
Model statistics							
Observations	4,767	4,767	4,767	4,767	4,767	4,767	4,767
Pseudo R^2	0.07	0.07	0.07	0.07	0.07	0.07	0.07

Source: Federal Statistical Office of Switzerland, Année Politique Suisse, own calculations. Notes: The dependent variable is a dummy for graduation in a STEM field. Progressivism refers to the different indicators of progressivism indicated by the column headers. The panel labeled "Average partial effects" shows the average partial effect of the corresponding regressor on the response probability. For continuous regressors, the regressor change is from the 25th to the 75th percentile. For dummy regressors, it is from zero to one. Bootstrapped standard errors are shown in parentheses. *, ** and *** denote significance at the 10%-, 5%- and 1%-level, respectively.

We are interested in the quantitative impact of the factors which affect major choice. For this, we first calculate for each individual the effect of a change in a variable on the probability of studying a STEM field by using the point estimates at stage 3; secondly, we average the effects over all individuals.

We find that women are expected to have a 21-22 percentage points lower fraction of STEM field graduates than men. This reflects the widely-discussed substantial gender differences in university major choice we see in most OECD countries, including Switzerland, as also reflected in Tab. 1. (We further explore the gender effect in the next subsection.) Moreover, students with a Francophone background are significantly less likely to choose a STEM field than students with a home municipality where German or Italian is the majority language. The effect on the fraction of STEM field graduates varies from six to ten percentage points, depending on the specification. A change in the log earnings differential from the 25th to the 75th percentile increases the fraction of STEM major graduates by five percentage points. An 25th to 75th percentile increase in the log distance to the next technical university (ETH), which is equal to an increase from 30.5 km to 98.3 km, reduces the probability of choosing a STEM major by about two percentage points. The (positive) impact of a larger distance to the next university, for a given distance to the next ETH, is typically somewhat higher in magnitude.

The impact of the sociocultural background of a student as measured by referenda results on gender equality and science-related issues (conservatism versus progressivism) is typically non-negligible. If the support for liberalizing stem cell research rises from 63.4 percent (25th percentile) to 76 percent (75th percentile), then the fraction of STEM field graduates falls by almost four percentage points (column (3)). Compared to the mean fraction of STEM field graduates of 28 percent, this is a sizable effect. A similar, negative quantitative effect arises if the vote share at the municipality level in favor of gender equality rises from 56 to 71.6 percent (column (1)). An increase from the 25th to 75th percentile in vote share for left-wing parties reduces the percentage of those choosing a STEM field by 2.9 points (column (5)). Somewhat smaller but still negative effects come from similar increases of the vote share in support for heroin distribution to addicts (column (2)) and gay marriage (column (4)). According to the insignificant point estimates, the reduction in the expected fraction of those choosing a STEM major is 1.7 percentage points in both cases. Raising the share of Catholics in a municipality from 29.9 to 65.1 percent raises the fraction on STEM graduates on average by 2.9 percentage points (column (6)). Finally, the impact of the summary indicator of progressivism (column (7)) is 4.1 percentage points and highly significant.

6.2 Results with Interactions Across Gender

The results presented in Tab. 2-5 do not allow for differential effects of sociocultural characteristics and pecuniary incentives for study major choice between men and women. In this subsection, we include interaction effects with gender. For the sake of brevity we only discuss the results in the structural choice equation, further estimation results can be found in Appendix B.

According to Tab. 6, the quantitative effects of distance variables and majority language are similar to those presented in Tab. 5 for both men and women. More interestingly, Tab. 6 provides a consistent picture how sociocultural variables determine the major choice conditional on gender. While the vote shares for left-wing parties and in support of progressive views on gender equality and science-related issues affect the probability to study a STEM major significantly negatively among men, they have no significant effects on the major choice of women. Thus, the results suggest that the sociocultural background matters considerably for males but not for females. This is confirmed by column (7). The effect of first principal component (our measure of progressive values on gender equality and science-related issues) again suggests a negative effect on the probability to study a STEM field for men but not for women. The coefficient on the first principal component is negative and significantly different from zero at the one percent level for men whereas it is close to zero and insignificant for women (bottom panel of column (7)).

Table 6: Third Stage Probit Estimates for Probability of Graduating in a STEM Major with Gender Interactions

	Gender equality (1)	Heroin program (2)	Stem cells (3)	Gay marriage (4)	Left-wing (5)	Catholics (6)	Principal factor (7)
Average partial effects for men							
Progressivism	-0.060	-0.027	-0.072	-0.035	-0.053	0.036	-0.068
	(0.019)***	(0.020)	(0.021)***	(0.020)*	(0.020)***	(0.027)	(0.022)***
Majority	-0.067	-0.141	-0.036	-0.122	-0.095	-0.122	-0.101
French	(0.032)**	(0.038)***	(0.034)	(0.033)***	(0.032)***	(0.034)***	(0.031)***
Majority	0.004	-0.040	0.011	-0.059	-0.054	-0.053	-0.057
Italian	(0.057)	(0.061)	(0.057)	(0.061)	(0.058)	(0.063)	(0.055)
Log distance	0.041	0.066	0.054	0.059	0.051	0.065	0.032
to next univ.	(0.022)*	(0.024)***	(0.019)***	(0.023)**	(0.022)**	(0.024)***	(0.023)

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Table 6: Third Stage Probit Estimates <continued>

	Gender equality (1)	Heroin program (2)	Stem cells (3)	Gay marriage (4)	Left-wing (5)	Catholics (6)	Principal factor (7)
Log distance to ETH	-0.015 (0.012)	-0.018 (0.013)	-0.024 (0.012)**	-0.021 (0.012)*	-0.018 (0.012)	-0.021 (0.013)*	-0.020 (0.012)*
Log earnings difference	0.102 (0.042)**	0.105 (0.043)**	0.101 (0.043)**	0.104 (0.043)**	0.103 (0.043)**	0.103 (0.043)**	0.103 (0.042)**
Average partial effects for women							
Progressivism	-0.018 (0.012)	-0.008 (0.013)	-0.005 (0.014)	0.003 (0.013)	-0.005 (0.012)	0.022 (0.018)	-0.012 (0.014)
Majority French	-0.067 (0.017)***	-0.085 (0.021)***	-0.073 (0.021)***	-0.076 (0.017)***	-0.076 (0.017)***	-0.084 (0.017)***	-0.077 (0.016)***
Majority Italian	0.010 (0.034)	0 (0.036)	0.008 (0.034)	0.010 (0.041)	0.003 (0.035)	-0.015 (0.037)	-0.003 (0.035)
Log distance to next univ.	0.003 (0.013)	0.010 (0.014)	0.013 (0.013)	0.015 (0.014)	0.012 (0.014)	0.004 (0.015)	0.006 (0.015)
Log distance to ETH	-0.015 (0.007)**	-0.015 (0.007)**	-0.016 (0.007)**	-0.015 (0.007)**	-0.016 (0.007)**	-0.017 (0.007)**	-0.016 (0.007)**
Log earnings difference	0.015 (0.017)	0.014 (0.017)	0.014 (0.017)	0.014 (0.018)	0.014 (0.018)	0.014 (0.018)	0.015 (0.017)
Model statistics							
Observations	4,767	4,767	4,767	4,767	4,767	4,767	4,767
Pseudo R^2	0.08	0.08	0.08	0.08	0.08	0.08	0.08

Source: Federal Statistical Office of Switzerland, Année Politique Suisse, own calculations. Notes: The dependent variable is a dummy for graduation in a STEM field. Progressivism refers to the different indicators of progressivism indicated by the column headers. The table shows the average partial effect of the corresponding regressor on the response probability. For continuous regressors, the regressor change is from the 25th to the 75th percentile. For dummy regressors, it is from zero to one. Bootstrapped standard errors of the average partial effects are shown in parentheses. *, ** and *** denote significance at the 10%-, 5%- and 1%-level, respectively.

Quantitatively, for men, the impact of a 25th to 75th percentile increase in the vote share in favor of progressive changes in context-specific political attitudes reduces the fraction of STEM field graduates significantly by 2.7-7.2 percentage points, depending on the referendum. A similar increase in the fraction of Catholics increases this fraction by 3.6 percentage points, albeit in contrast to Tab. 5 the point estimate is not significantly different from zero. The corresponding impact of an increase in the vote share accruing to left-wing parties is 5.3 percentage points and highly significant. By contrast, these variables typically have negligible and insignificant effects for women.

The effect of pecuniary incentives to study a STEM field is different for men and women, too. For men, the average increase in the fraction of STEM major graduates from an increase in the log earnings differential from the 25th to the 75th percentile is a sizeable and highly significant 10 percentage points. However, the average partial effect of the earnings differential (STEM versus non-STEM) for women is 1.4-1.5 percentage points. This effect is not even significantly different from zero. It is thus safe to conclude that pecuniary returns to graduating in a STEM field matter considerably less for women than for men. This is consistent with stage 2 results in Tab. 3 and Tab. 4 suggesting that females earn more than males once we correct for self-selection. However, men earn more than women according to the summary statistics in Tab. 1. That is, men also self-select themselves according to their comparative advantage to earn income, whereas women do not. The estimated values of terms λ_A and λ_B correcting for self-selection are negatively correlated with the female dummy (not reported).

For men, the effect of the change in the log earnings differential is larger than the corresponding change in the principal factor measuring progressivism. The latter reduces the fraction of STEM field graduates by 6.8 percentage points. Thus, we may conclude that for men the effect of the sociocultural background is about two-thirds of the effect of (log) earnings differences for university major choice.

7 Conclusion

We have examined the role of the sociocultural background of students as measured by religious and political attitudes at the municipality level towards gender equality and science-related issues for choosing a STEM field in university. The motivation to focus on the formation of STEM skills was rooted in their salient role for the process of long run economic growth. We exploited regional variation within Switzerland at the municipal level. The unique opportunity for our research mainly comes from two institutional features in Switzerland, (i) the frequently held national referenda in the Swiss direct democratic system and (ii) the fact that at the time of our study all inhabitants with a upper secondary education degree where free which field and at which university to study at very moderate tuition fees. We based the empirical identification on a structural Roy (1951) model which accounts for differences in costs (distance to the next technical university) and earnings across majors as well as for selection bias.

Our findings suggest that male students from more conservative municipalities are more likely to study a STEM field, whereas the sociocultural background plays little role for the major choice of females. Insofar as the sociological background matters in a quite sizable way for men but not for women the evidence can contribute to understand the widely discussed gender gap in STEM major choice. Consistent with previous studies, we also find that female students are considerably less motivated by earnings than men. Overall, for men the effect of the sociocultural background is about two-thirds the effect of (log) earnings differences associated with different fields of study.

Why men from more conservative environments seem to be more motivated to study STEM fields than men from progressive environments certainly deserves further research. One possibility could be that social sciences are generally considered to be oriented to left-wing political attitudes. Differentiating among the non-STEM fields seems welcome to dig deeper in this phenomenon. As this would probably require modelling of major choice among more than two alternatives, identification will be an important challenge which is beyond the scope of the current paper. The differential impact of the sociocultural environment on males and females certainly deserves further attention in future research as well.

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Appendix

A List of Data Sources

- The 'Swiss Graduate Survey' (*Absolventenstudie*) of the Swiss Federal Statistical Office (*Bundesamt für Statistik*) is a biennial survey of the population of students who graduate from tertiary academic education in Switzerland (Bundesamt für Statistik, 2008, 2009, 2012). We use data on the cohorts who graduated in 2000 and 2002 and completed the questionnaires one year and five years after graduation.

- The 'Swiss Historical Municipality Register' (*Historisiertes Gemeindeverzeichnis der Schweiz*) records all municipality changes since 1960 (Bundesamt für Statistik, 2014). We use it to harmonize the municipality codes across data sources to the classification valid on December 31, 2010. We obtain additional information on geographical classifications and region types from Bundesamt für Statistik (2010, 2011).

- The 'Federal Population Census' (*Eidgenössische Volkszählung*) of the year 1990 provides population counts at the municipality level on several aspects of economic and social life (Bundesamt für Statistik, 1990, 1996). We use the census to construct the share of Catholics, indicators for the majority language, the employment rate, and industry shares of a municipality.

- We use municipality level information on the results of the 'Federal Elections' (*Nationalratswahlen*) of the year 1995 (Bundesamt für Statistik, 1995) to calculate the share of left-wing parties in each municipality. We classify the following parties as left wing: SP, PdA, Sol., FGA, and GPS.

- The municipality level data on the results of the nationwide referenda is provided by Année Politique Suisse (2013). We use it to compute the share of yes-votes in four referenda on gender equality and science-related issues.

- With the help of Google Maps, we compiled a data base recording the distances between the municipalities that existed in 2010 and the nine locations of the cantonal and federal universities.

B Additional Empirical Results

Table 7: Principal Component Analysis of the Six Variables for the Sociocultural Environment

Component	Eigenvalue	Difference	Proportion	Cumulative
1	2.598	1.573	0.433	0.433
2	1.025	0.017	0.171	0.604
3	1.008	0.373	0.168	0.772
4	0.635	0.154	0.106	0.878
5	0.480	0.226	0.080	0.958
6	0.254		0.042	1.000

Source: Federal Statistical Office of Switzerland, Année Politique Suisse, own calculations. Notes: The six variables are the share of yes votes in four national referenda on gender equality and science related issues, the share of left-wing parties in the federal elections, the share of Catholics. The number of observations is 2,573 municipalities.

Table 8: Descriptive Statistics of Economic Environment

	Total (1)	Men (2)	Women (3)
Employment rate	0.624 (0.045)	0.625 (0.045)	0.622 (0.046)
Share of agriculture	0.017 (0.025)	0.017 (0.024)	0.017 (0.026)
Share of manufacturing	0.100 (0.046)	0.103 (0.046)	0.097 (0.044)
Share of construction	0.044 (0.014)	0.044 (0.014)	0.044 (0.015)
Share of business services	0.078 (0.029)	0.077 (0.028)	0.079 (0.028)
100,000 and more inhabitants	0.142 (0.349)	0.135 (0.342)	0.151 (0.358)
Between 50,000 and 99,999	0.038 (0.190)	0.039 (0.194)	0.036 (0.185)
Between 20,000 and 49,999	0.096 (0.295)	0.094 (0.292)	0.099 (0.298)
Between 10,000 and 19,999	0.179 (0.383)	0.182 (0.386)	0.176 (0.381)
Between 5,000 and 9,999	0.175 (0.380)	0.180 (0.384)	0.168 (0.374)
Between 2,000 and 4,999	0.214 (0.410)	0.219 (0.414)	0.208 (0.406)
Between 1,000 and 1,999	0.085 (0.280)	0.085 (0.279)	0.085 (0.280)
Less than 1,000 inhabitants	0.071 (0.256)	0.066 (0.248)	0.077 (0.266)
Observations	4,767	2,572	2,195

Source: Federal Statistical Office of Switzerland, own calculations. Notes: The table shows the means and standard deviations (in parentheses) of the variables.

Table 9: First Stage Probit Estimates for Probability of Graduating in a STEM Major including Economic Environment Controls

	Gender equality (1)	Heroin program (2)	Stem cells (3)	Gay marriage (4)	Left-wing (5)	Catholics (6)	Principal factor (7)
	Coefficients and standard errors						
Progressivism	-0.721	0.202	-0.956	-0.074	-0.571	0.230	-0.053
	(0.254)***	(0.377)	(0.349)***	(0.399)	(0.234)**	(0.114)**	(0.021)**
Female	-0.733	-0.732	-0.731	-0.732	-0.728	-0.730	-0.729
	(0.043)***	(0.043)***	(0.043)***	(0.043)***	(0.044)***	(0.044)***	(0.043)***
Cohort two	0.052	0.049	0.052	0.049	0.052	0.051	0.052
	(0.039)	(0.038)	(0.038)	(0.038)	(0.038)	(0.038)	(0.038)
Employment rate	0.430	0.118	0.362	0.159	0.367	0.215	0.428
	(0.664)	(0.665)	(0.668)	(0.672)	(0.675)	(0.667)	(0.671)
Share agriculture	-1.151	-0.211	-0.645	-0.384	-1.120	-0.471	-1.154
	(1.226)	(1.171)	(1.172)	(1.232)	(1.232)	(1.165)	(1.247)
Share manufacturing	-0.356	-0.275	-0.303	-0.312	-0.224	-0.399	-0.375
	(0.676)	(0.674)	(0.676)	(0.678)	(0.676)	(0.684)	(0.678)
Share construction	-2.258	-0.325	-1.722	-0.671	-1.266	-1.511	-2.081
	(1.754)	(1.736)	(1.738)	(1.750)	(1.709)	(1.731)	(1.797)
Share business services	-2.583	-3.460	-2.176	-3.143	-3.325	-3.376	-2.572
	(1.365)*	(1.470)**	(1.395)	(1.373)**	(1.359)**	(1.370)**	(1.369)*
50,000 to 99,999	0.136	0.204	0.186	0.190	0.122	0.171	0.141
	(0.137)	(0.138)	(0.136)	(0.136)	(0.136)	(0.136)	(0.136)
20,000 to 49,999	0.102	0.117	0.127	0.108	0.053	0.040	0.070
	(0.119)	(0.121)	(0.119)	(0.119)	(0.119)	(0.123)	(0.120)
10,000 to 19,999	0.137	0.160	0.193	0.149	0.077	0.086	0.108
	(0.114)	(0.116)	(0.114)*	(0.113)	(0.115)	(0.115)	(0.114)
5,000 to 9,999	0.133	0.172	0.201	0.159	0.062	0.090	0.102
	(0.117)	(0.119)	(0.117)*	(0.116)	(0.121)	(0.119)	(0.118)
2,000 to 4,999	0.052	0.107	0.139	0.091	-0.014	0.035	0.029
	(0.120)	(0.122)	(0.120)	(0.118)	(0.123)	(0.120)	(0.121)
1,000 to 1,999	0.257	0.303	0.343	0.290	0.189	0.232	0.235
	(0.133)*	(0.134)**	(0.134)**	(0.132)**	(0.136)	(0.135)*	(0.134)*
Less than 1,000 inhab.	0.132	0.143	0.213	0.134	0.051	0.103	0.110
	(0.143)	(0.144)	(0.145)	(0.143)	(0.144)	(0.143)	(0.143)
Majority French	-0.337	-0.380	-0.295	-0.412	-0.372	-0.439	-0.403
	(0.062)***	(0.076)***	(0.071)***	(0.061)***	(0.058)***	(0.059)***	(0.057)***
Majority Italian	0.007	-0.013	-0.005	-0.048	-0.073	-0.131	-0.110
	(0.117)	(0.123)	(0.118)	(0.131)	(0.116)	(0.127)	(0.120)

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Table 9: First Stage Probit Estimates including Economic Environment Controls <continued>

	Gender equality (1)	Heroin program (2)	Stem cells (3)	Gay marriage (4)	Left-wing (5)	Catholics (6)	Principal factor (7)
Log distance to next uni.	0.009	0.026	0.009	0.023	0.019	0.013	0.009
	(0.025)	(0.024)	(0.025)	(0.025)	(0.024)	(0.026)	(0.025)
Log distance to ETH	-0.070	-0.086	-0.084	-0.083	-0.078	-0.087	-0.077
	(0.024)***	(0.024)***	(0.023)***	(0.023)***	(0.023)***	(0.023)***	(0.023)***
Parent tert. acad. educ.	-0.087	-0.093	-0.089	-0.092	-0.090	-0.088	-0.087
	(0.043)**	(0.043)**	(0.043)**	(0.044)**	(0.043)**	(0.043)**	(0.043)**
Parent tert. voc. educ.	0.058	0.063	0.065	0.062	0.064	0.064	0.062
	(0.045)	(0.045)	(0.045)	(0.045)	(0.045)	(0.045)	(0.045)
Parent no voc. educ.	-0.119	-0.117	-0.122	-0.117	-0.122	-0.124	-0.123
	(0.051)**	(0.051)**	(0.051)**	(0.051)**	(0.051)**	(0.051)**	(0.051)**
Log age	-3.133	-3.125	-3.132	-3.122	-3.169	-3.139	-3.143
	(0.404)***	(0.403)***	(0.404)***	(0.404)***	(0.405)***	(0.404)***	(0.404)***
Postgraduate education	-0.193	-0.192	-0.193	-0.192	-0.193	-0.191	-0.193
	(0.040)***	(0.040)***	(0.040)***	(0.040)***	(0.040)***	(0.040)***	(0.040)***
Constant	11.352	10.912	11.510	11.049	11.320	11.099	11.068
	(1.432)***	(1.432)***	(1.451)***	(1.467)***	(1.439)***	(1.431)***	(1.429)***
Model statistics							
Observations	4,767	4,767	4,767	4,767	4,767	4,767	4,767
Pseudo R^2	0.09	0.09	0.09	0.09	0.09	0.09	0.09

Source: Swiss Federal Statistical Office, Année Politique Suisse, own calculations. Notes: The dependent variable is a dummy for graduation in a STEM field. Progressivism refers to the different indicators of progressivism indicated by the column headers. Bootstrapped standard errors of the coefficients are shown in parentheses. *, ** and *** denote significance at the 10%-, 5%- and 1%-level, respectively.

Table 10: Wald Tests of Joint Significance (First Stage Probit Estimation including Economic Environment Controls)

	Gender equality (1)	Heroin program (2)	Stem cells (3)	Gay marriage (4)	Left-wing (5)	Catholics (6)	Principal factor (7)
				Cost determinants			
χ^2-statistic	8.877	13.815	13.438	13.857	11.967	14.609	11.195
df	2	2	2	2	2	2	2
p-value	0.012	0.001	0.001	0.001	0.003	0.001	0.004
				Earnings determinants			
χ^2-statistic	87.613	87.839	88.157	87.603	89.280	88.569	88.532
df	5	5	5	5	5	5	5
p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000
				Sociocultural background			
χ^2-statistic	60.578	53.457	61.664	53.203	58.012	56.368	58.865
df	3	3	3	3	3	3	3
p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000
				Economic environment			
χ^2-statistic	12.071	15.236	13.015	14.758	15.299	17.088	11.629
df	12	12	12	12	12	12	12
p-value	0.440	0.229	0.368	0.255	0.225	0.146	0.476
				Remaining variables			
χ^2-statistic	287.695	285.143	284.743	285.467	281.466	282.867	283.772
df	2	2	2	2	2	2	2
p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Source: Swiss Federal Statistical Office, Année Politique Suisse, own calculations. Notes: The panel labeled 'Cost determinants' refers to a joint test of the log distances to the next university and the next technical university (ETH). The panel 'Earnings determinants' includes the variables log age, dummies for parental education, and postgraduate training. The panel 'Sociocultural background' includes dummies for the majority language and the progressivism variable. The panel 'Economic environment' includes the variables shown in Tab. 8. The remaining variables in the last panel are a female dummy and a dummy for the second cohort.

Table 11: First Stage Probit Estimates for Probability of Graduating in a STEM Major with Gender Interactions

	Gender equality (1)	Heroin program (2)	Stem cells (3)	Gay marriage (4)	Left-wing (5)	Catholics (6)	Principal factor (7)
	Coefficients and standard errors						
Progressivism	-0.835	-0.411	-1.315	-0.729	-0.712	0.186	-0.071
	(0.274)***	(0.354)	(0.365)***	(0.416)*	(0.255)***	(0.127)	(0.022)***
Female	0.050	0.047	0.049	0.046	0.048	0.047	0.049
	(0.039)	(0.039)	(0.039)	(0.039)	(0.039)	(0.038)	(0.038)
Cohort two	-6.448	-6.399	-7.209	-6.968	-6.619	-6.272	-6.450
	(2.788)**	(2.791)**	(2.845)**	(2.843)**	(2.815)**	(2.789)**	(2.793)**
Majority French	-0.260	-0.393	-0.182	-0.376	-0.308	-0.362	-0.341
	(0.069)***	(0.083)***	(0.078)**	(0.069)***	(0.065)***	(0.067)***	(0.064)***
Majority Italian	-0.069	-0.155	-0.051	-0.213	-0.201	-0.200	-0.213
	(0.131)	(0.135)	(0.131)	(0.145)	(0.134)	(0.144)	(0.136)
Log distance to next univ.	0.041	0.063	0.053	0.056	0.046	0.058	0.028
	(0.025)	(0.025)**	(0.023)**	(0.025)**	(0.025)*	(0.026)**	(0.027)
Log distance to ETH	-0.032	-0.036	-0.052	-0.044	-0.035	-0.041	-0.042
	(0.026)	(0.025)	(0.026)**	(0.026)*	(0.026)	(0.025)	(0.025)*
Parent tert. acad. educ.	-0.106	-0.116	-0.109	-0.111	-0.115	-0.117	-0.105
	(0.056)*	(0.056)**	(0.055)**	(0.056)**	(0.056)**	(0.055)**	(0.056)*
Parent tert. voc. educ.	0.109	0.113	0.118	0.115	0.114	0.114	0.113
	(0.057)*	(0.057)**	(0.057)**	(0.057)**	(0.057)**	(0.057)**	(0.057)**
Parent no voc. educ.	-0.156	-0.150	-0.165	-0.156	-0.156	-0.157	-0.163
	(0.062)**	(0.063)**	(0.062)***	(0.063)**	(0.063)**	(0.063)**	(0.062)***
Log age	-3.700	-3.696	-3.717	-3.703	-3.742	-3.717	-3.715
	(0.531)***	(0.531)***	(0.531)***	(0.530)***	(0.529)***	(0.530)***	(0.530)***
Postgrad. education	-0.260	-0.261	-0.260	-0.259	-0.259	-0.258	-0.258
	(0.054)***	(0.054)***	(0.054)***	(0.054)***	(0.054)***	(0.054)***	(0.054)***
Female × progressivism	0.296	0.177	1.165	0.886	0.539	0.027	0.046
	(0.429)	(0.590)	(0.618)*	(0.712)	(0.420)	(0.206)	(0.037)
Female × majority French	-0.156	-0.101	-0.260	-0.074	-0.146	-0.132	-0.123
	(0.108)	(0.137)	(0.128)**	(0.114)	(0.105)	(0.109)	(0.105)
Female × majority Italian	0.032	0.076	0.004	0.182	0.122	0.047	0.117
	(0.197)	(0.208)	(0.199)	(0.229)	(0.204)	(0.222)	(0.208)
Female × log distance to next univ.	-0.035	-0.042	-0.025	-0.022	-0.024	-0.050	-0.015
	(0.039)	(0.041)	(0.037)	(0.041)	(0.040)	(0.043)	(0.045)

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Table 11: Third Stage Probit Estimates with Gender Interactions <continued>

	Gender equality (1)	Heroin program (2)	Stem cells (3)	Gay marriage (4)	Left-wing (5)	Catholics (6)	Principal factor (7)
Female × log distance to ETH	-0.026	-0.025	-0.011	-0.016	-0.026	-0.026	-0.021
	(0.040)	(0.040)	(0.040)	(0.040)	(0.040)	(0.039)	(0.039)
Female × parent ter. acad. educ.	0.042	0.046	0.037	0.035	0.041	0.048	0.037
	(0.090)	(0.091)	(0.090)	(0.090)	(0.090)	(0.090)	(0.090)
Female × parent tert. voc. educ.	-0.144	-0.142	-0.145	-0.142	-0.142	-0.138	-0.142
	(0.091)	(0.091)	(0.091)	(0.091)	(0.091)	(0.091)	(0.091)
Female × parent no voc. educ.	0.105	0.101	0.114	0.105	0.105	0.103	0.112
	(0.108)	(0.109)	(0.108)	(0.108)	(0.108)	(0.108)	(0.108)
Female × log age	1.655	1.665	1.684	1.677	1.698	1.663	1.669
	(0.805)**	(0.806)**	(0.807)**	(0.808)**	(0.808)**	(0.805)**	(0.805)**
Female × postgrad. education	0.192	0.195	0.194	0.195	0.192	0.192	0.190
	(0.087)**	(0.087)**	(0.086)**	(0.087)**	(0.087)**	(0.087)**	(0.087)**
Constant	13.177	12.869	13.636	13.147	13.046	12.662	12.895
	(1.846)***	(1.846)***	(1.864)***	(1.878)***	(1.849)***	(1.845)***	(1.843)***
Model statistics							
Observations	4,767	4,767	4,767	4,767	4,767	4,767	4,767
Pseudo R^2	0.09	0.09	0.09	0.09	0.09	0.09	0.09

Source: Federal Statistical Office of Switzerland, Année Politique Suisse, own calculations. Notes: The dependent variable is a dummy for graduation in a STEM field. Progressivism refers to the different indicators of progressivism indicated by the column headers. Bootstrapped standard errors of the coefficients are shown in parentheses. *, ** and *** denote significance at the 10%-, 5%- and 1%-level, respectively.

Table 12: Third Stage Probit Estimates for Probability of Graduating in a STEM Major with Gender Interactions

	Gender equality (1)	Heroin program (2)	Stem cells (3)	Gay marriage (4)	Left-wing (5)	Catholics (6)	Principal factor (7)
Coefficients and standard errors							
Progressivism	-1.032 (0.325)***	-0.577 (0.430)	-1.464 (0.431)***	-0.832 (0.488)*	-0.833 (0.316)***	0.203 (0.155)	-0.079 (0.025)***
Female	0.100 (0.056)*	0.097 (0.057)*	0.097 (0.055)*	0.096 (0.056)*	0.096 (0.055)*	0.095 (0.055)*	0.099 (0.055)*
Cohort two	-0.979 (0.387)**	-0.832 (0.466)*	-1.585 (0.533)***	-1.299 (0.582)**	-0.912 (0.286)***	-0.610 (0.207)***	-0.808 (0.244)***
Majority French	-0.182 (0.088)**	-0.387 (0.111)***	-0.098 (0.094)	-0.335 (0.093)***	-0.259 (0.090)***	-0.334 (0.096)***	-0.277 (0.086)***
Majority Italian	0.010 (0.155)	-0.110 (0.172)	0.028 (0.153)	-0.163 (0.174)	-0.150 (0.166)	-0.147 (0.180)	-0.158 (0.158)
Log distance to next univ.	0.054 (0.029)*	0.087 (0.031)***	0.071 (0.026)***	0.078 (0.031)**	0.067 (0.029)**	0.086 (0.031)***	0.042 (0.031)
Log distance to ETH	-0.036 (0.029)	-0.044 (0.030)	-0.058 (0.029)**	-0.051 (0.029)*	-0.042 (0.030)	-0.050 (0.030)*	-0.047 (0.028)*
Log earnings difference	1.816 (0.764)**	1.819 (0.761)**	1.774 (0.766)**	1.802 (0.767)**	1.787 (0.760)**	1.777 (0.758)**	1.826 (0.765)**
Female × progressivism	0.526 (0.458)	0.315 (0.625)	1.314 (0.642)**	0.930 (0.749)	0.707 (0.460)	0 (0.225)	0.056 (0.039)
Female × majority French	-0.120 (0.117)	0 (0.153)	-0.232 (0.138)*	-0.010 (0.127)	-0.087 (0.119)	-0.052 (0.128)	-0.074 (0.117)
Female × majority Italian	0.034 (0.212)	0.111 (0.231)	0.007 (0.212)	0.206 (0.246)	0.161 (0.226)	0.082 (0.247)	0.147 (0.222)
Female × log distance to next univ.	-0.048 (0.040)	-0.066 (0.044)	-0.044 (0.038)	-0.045 (0.044)	-0.042 (0.042)	-0.076 (0.046)*	-0.028 (0.047)
Female × log distance to ETH	-0.021 (0.042)	-0.016 (0.043)	-0.004 (0.041)	-0.009 (0.042)	-0.019 (0.043)	-0.017 (0.043)	-0.015 (0.041)
Female × log earn. difference	-1.386 (0.849)	-1.422 (0.844)*	-1.373 (0.851)	-1.422 (0.850)*	-1.399 (0.847)*	-1.397 (0.843)*	-1.413 (0.849)*

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Table 12: Third Stage Probit Estimates with Gender Interactions <continued>

	Gender equality (1)	Heroin program (2)	Stem cells (3)	Gay marriage (4)	Left-wing (5)	Catholics (6)	Principal factor (7)
Constant	0.584	0.266	0.949	0.480	0.220	-0.131	0.144
	(0.274)**	(0.323)	(0.370)**	(0.389)	(0.206)	(0.157)	(0.174)
				Model statistics			
Observations	4,767	4,767	4,767	4,767	4,767	4,767	4,767
Pseudo R^2	0.08	0.07	0.08	0.07	0.08	0.07	0.08

Source: Federal Statistical Office of Switzerland, Année Politique Suisse, own calculations. Notes: The dependent variable is a dummy for graduation in a STEM field. Progressivism refers to the different indicators of progressivism indicated by the column headers. Bootstrapped standard errors of the coefficients are shown in parentheses. *, ** and *** denote significance at the 10%-, 5%- and 1%-level, respectively.