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**It's all about maths! Skill requirements and the gender gap in occupational choice**

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# **It's all about maths! Skill requirements and the gender gap in occupational choice**

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## **Abstract**

Although occupational choice research clearly shows the under-representation of women in mathematics- and science-related fields (STEM), the existing research mostly focuses on i) high-ability (university) students (rather than a wider spectrum of students) and ii) the choice between STEM or non-STEM fields (not specifically between mathematics and science). This study, in turn, investigates the gender gap in occupational choice by using data on the career choices of a wide spectrum of young Swiss students, who choose their work apprenticeships at age 15/16. Specifically, this study investigates whether students' gender is associated with differences in occupational requirements (mathematics, science, language) conditional on individual occupation preferences, skills, personality traits and socio-economic characteristics. The novel dataset links a representative student survey, administrative data on education trajectories and data on occupational skill requirements. While the results suggest only a very small gender gap in favour of men in occupations with higher science requirements (higher “science intensity”), the results suggest a statistically and economically significant gender gap in favour of men in occupations with higher mathematics requirements (higher “mathematics intensity”) equivalent to a 12% wage reduction for women over the working life. The results suggest that the mathematics intensity of an occupation is associated with gender segregation both within STEM and non-STEM occupations.

Keywords: occupational choice; gender gap; STEM; skill requirements

JEL Classifications: J24, J16

## 1. Introduction

To overcome the under-representation of women in science, technology, engineering and mathematics (STEM) occupations, politicians introduce labour market quotas, firms finance coding programmes for girls, and diverse institutions organise extracurricular programmes attempting to increase young women's interest in and knowledge of STEM occupations. Yet strong gender stereotyping of most professions persists across countries (Blau and Kahn 2017). Importantly, the gender gap in occupational choice manifests in labour market outcomes, particularly wages (e.g. Olivetti and Petrongolo 2016; Blau and Kahn 2017).

Despite the proliferation of literature explaining gender segregation (e.g. occupational preferences, skills, personality traits and other personal characteristics) (e.g. Buser, Niederle, and Oosterbeek 2014; Card and Payne 2021; e.g. Kuhn and Wolter 2022; Breda et al. 2023), how these explanations additively drive gender segregation remains understudied. Moreover, economists, by focusing on a STEM vs non-STEM classification, seldom analyse whether certain occupational skill requirements explain gender segregation. Furthermore, because the gender gap literature usually focuses on students' university fields of study (e.g. Porter and Serra 2020) – i.e. on occupations at the upper end of the academic performance spectrum – evidence on the occupational choices of students from a much wider spectrum of academic performance remains missing.

This paper examines the gender gap in occupational choice by using data on the career choices of young Swiss lower-secondary students. Specifically, this paper investigates whether the students' gender is associated with differences in occupational skill requirements (mathematics, science, language) conditional on individual occupational preferences, skills, personality traits and a set of socio-economic characteristics. By having to choose their work apprenticeships for occupational training and education at age 15/16, these students make specific choices about acquiring occupation-specific competencies with labour market-relevant consequences at a very young age. As about two-thirds of all Swiss young people from the entire ability distribution choose an apprenticeship for their upper secondary education (SERI 2022), the sample in this study consists of students from a wide spectrum of academic performance.

The data set on career choices comprises a representative student survey from 2019, administrative data on education trajectories from 2019-2020 and data on occupational skill requirements. This novel dataset provides extensive information on individuals' preferences, aspirations, personality traits, and socio-economic background; education trajectory before entering vocational education and training (VET) and chosen apprenticeship occupation. Data on skill requirements for approximately 150 occupations cover the occupational skill requirements in mathematics, science, school language and foreign language.

The findings suggest that the occupational choices of women and men differ according to the occupational skill requirements in mathematics and language. While men choose occupations with higher mathematics requirements (higher “mathematics intensity”) than women do, women choose occupations with higher language requirements (higher “language intensity”) than men do. On average, the gender gap in occupations with higher mathematics intensity corresponds to approximately a 12% wage decrease over the entire working life. Surprisingly, however, the results suggest a very small gender gap in favour of men for occupations with higher science requirements (higher “science intensity”). Thus, the results suggest that gender segregation within STEM and non-STEM occupations is mainly associated with the mathematics intensity, not the science intensity, of an occupation.

This paper complements the recent literature on gender gaps in occupational choice by providing new suggestive evidence. First, it examines the gender gap in terms of occupational requirements, rather than in terms of a simple categorisation of occupations into STEM vs non-STEM. Second, it focuses on gender gaps in occupational choice among Swiss students from a wide spectrum of academic performance rather than high-ability (university) students. Third, this paper investigates high-stakes decisions made by very young people.

The structure of the paper is as follows. After discussing the relevant empirical literature in Section 2, Section 3 briefly describes the Swiss education system, with a focus on VET. Section 4 presents and discusses the data sources, Section 5 presents the empirical approach, and Section 6 presents the empirical results. After providing the

results of an additional student survey – results that help explain the findings – Section 7 summarises and interprets the results and discusses implications for future research.

## **2. Explanations For Gendered Occupational Choice**

This section discusses studies offering four different explanations for the gender gap in occupational choice: ability, preferences, personality traits and self-assessment of skills.

First, a number of empirical studies focusing on gender differences in ability (e.g. Guiso et al. 2008; Machin and Pekkarinen 2008; Borgonovi, Choi, and Paccagnella 2021) find that gender differences in mathematics test scores have been declining (e.g. Goldin, Katz, and Kuziemko 2006). While women slightly underperform men in mathematics, performance differences vary considerably across countries (e.g. Guiso et al. 2008; Else-Quest, Hyde, and Linn 2010; Fryer Jr and Levitt 2010), the ability distribution (e.g. Machin and Pekkarinen 2008; Ellison and Swanson 2010; Borgonovi, Choi, and Paccagnella 2021) and the life cycle (e.g. Borgonovi, Choi, and Paccagnella 2021).

While women's overall mathematics ability is insufficient for explaining the extensive gender gap, women's comparative advantage in languages partially rationalises their choice of more language-intensive occupations (e.g. Breda and Napp 2019; Goulas, Griselda, and Megalokonomou 2022). In line with these findings, the descriptive statistics (Table A1 in the Appendix) suggest small differences in school grades in mathematics, language and science. Nonetheless, the results suggest clear gender differences in occupational choice.

Second, gender differences in self-perception or self-confidence are associated with gendered occupational choices. Several studies find that women exhibit lower confidence in gender-incongruent areas (e.g. Coffman 2014; Exley and Kessler 2022; Murciano-Goroff 2022) and in mathematics skills (e.g. Cappelletti et al. 2022; Exley and Kessler 2022). Ellis, Fosdick, and Rasmussen (2016) show that lower mathematics confidence is associated with a lower likelihood of choosing a science major at university. Thus, not women's mathematics ability per se but rather their lower confidence in their mathematics abilities could lead to women's under-representation in STEM occupations. Women's underestimation of their mathematics abilities can result from teachers' traditional

mathematics and gender stereotypes<sup>1</sup> (e.g. Lavy 2008; Falch and Naper 2013; Protivinsky and München 2018; Terrier 2020)<sup>2</sup>, societal stereotypes (e.g. Bordalo et al. 2019) or lower parental expectations for daughters relative to sons (e.g. Eccles and Wang 2016). The self-assessment strand of the research lies outside the scope of this paper.

Third, preferences for occupational characteristics are associated with gendered occupational choices (e.g. Kuhn and Wolter 2022). Holland's (1973) theory of career choice suggests that people choose occupations according to their skills, their preference for enjoyable work and their values. Several economic papers support his hypothesis. Kuhn and Wolter (2022) show that while women prefer to work with people, men prefer to work with things. In turn, Brenøe and Zölitz (2020) and Brenøe (2022) suggest that both high school gender composition and sibling sex composition affect students' occupational choice.

Furthermore, a number of studies theorise that people may choose gendered occupations because deviating from a person's gender identity would cause discomfort (e.g. Akerlof and Kranton 2000), while empirical papers suggest that their opposing prevalent gender identity norms would have the same effect (e.g. Bertrand, Kamenica, and Pan 2015).<sup>3</sup> The paper includes a measure of work preference that encompasses the broad spectrum of different interests between women and men, as well as the variety of characteristics of the different occupations.

Fourth, evidence on personality traits, particularly in relation to STEM occupations, suggests that because women have a much less pronounced tendency to enter competition, they avoid competitive fields of study and work such as STEM (e.g. Buser, Niederle, and Oosterbeek 2014; Buser, Peter, and Wolter 2017). While the data from this study do not provide a measure of competitiveness per se, the data provide a measure of students' passion for and perseverance in their long-term goals (GRIT) (Duckworth et al. 2007; Duckworth and Quinn 2009).

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<sup>1</sup> By 'traditional mathematics stereotypes' we mean the preconception that men have higher mathematics ability than women.

<sup>2</sup> However, as Quinn (2020) points out the results on teacher bias show no clear pattern. For instance some papers suggest that teachers favour males in math (e.g. Lavy and Sand 2015), while others find no bias (e.g. Hinnerich, Höglin, and Johannesson 2011).

<sup>3</sup> Studies showing that role models of one's own gender can bring people into gender atypical professions underline the importance of social norms and social identity associated with professions (e.g. Porter and Serra 2020; Del Carpio and Guadalupe 2022; Breda et al. 2023).

### **3. The Swiss education system**

In Switzerland, compulsory schooling lasts eleven years (K+9), including lower secondary school, where students attend school tracks that differ by academic requirement levels (basic or advanced). After finishing compulsory schooling, almost 95 percent of all students transfer to upper-secondary education (either directly or after a non-certifying intermediate education). Two-thirds of students transferring to upper-secondary education choose the vocational education and training (VET) track and one-third choose to continue with a general education that prepares students for instance to attend academic universities (baccalaureate schools). Of those students choosing VET, almost ninety percent choose dual VET, which includes apprenticeship (SERI 2022).

The apprenticeship system has several distinct features: As the training firm selects and hires the apprentices, apprenticeships are firm-based. Education and training take place both in school and at the workplace. All apprenticeships are nationally regulated and completed through taking standardised examinations leading to a nationally recognised qualification. This qualification should guarantee the mobility of apprentices in the labour market, i.e. across firms.

Students can choose from about 240 different occupations, apprenticeships that differ both in their aggregate and skill-specific (mathematics, science, school language, foreign language) requirements and training period. Most apprenticeships with high aggregate skill intensity are three- or four-year programmes; apprenticeships with low aggregate skill intensity are two-year programmes.

The vocational education system provides matching career possibilities for students from a wide spectrum of academic performance. Because apprenticeships differ substantially in occupational skill requirement intensity, students from this wide spectrum find one that fits. For high-performing students, professions with high requirements are attractive for professional reasons and the possibility of further education. Such professions allow students to obtain a vocational baccalaureate enabling them to study at a university of applied sciences.

To identify possible differences in career choices between women and men, this paper exploits the unique VET education in Switzerland by using skill-specific differences in occupational requirements.

#### **4. Data and data sources**

For the core analysis, the paper uses a dataset comprising three different sources. First, it uses a 2019 representative student survey covering students in the final year of compulsory education across the country. This survey provides information on students' vocational and training-related preferences. Second, it uses the 2019 student survey data with administrative data from the Federal Statistical Office, data covering the education trajectories from 2019-2020 of the universe of students in Switzerland. Administrative data alone is insufficient for the analysis primarily because the data contains neither information on academic performance nor information on vocational and training-related preferences and motives. Third, the paper uses occupational skill requirements (mathematics, science, school language, foreign language) to analyse the gender gap in terms of occupational requirements.

##### ***4.1 Survey***

The survey gathers information on students' transition from the final year of compulsory schooling (year 9) to upper secondary schooling (vocational track or general education). Therefore, the survey targets students at the end of compulsory school.<sup>4</sup> The State Secretariat for Education, Research and Innovation (SERI) initiated the survey and mandated a national survey institute (GfS) to survey students twice a year (April and August; the school year ends in June). The Federal Statistical Office provided the sampling of the students. At almost 70% the response rate is remarkably high.

The 2019 student survey contains a rich set of information on students' academic performance, occupational preferences and personality traits. First, the baseline questionnaire covers personal information, including age, gender, nationality, migration background, place of residence, family characteristics, and school grades in mathematics, school language, and English. Whereas standardised achievement tests ensure the comparability of test results across classes and schools, school grades constitute the relevant competency information in the apprenticeship search, and employers use them as information about applicants' abilities.

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<sup>4</sup> <https://cockpit.gfsbern.ch/de/cockpit/nahtstellenbarometer-2019/>

Second, students were asked questions covering individual preferences for choosing a particular type of education or occupation. Ten questions, on preferences and motives, cover as many empirically established explanations for gendered career preferences as possible. Respondents ranked the following career preferences from 1 (lowest importance) to 10 (highest importance), assigning each rank only once.<sup>5</sup> The 10 possibilities are having social contacts, the possibility of accessing higher education, good prospects for continuous education, social status of the occupation, job security, creativity, work and family life balance, helping people, salary prospects and good career prospects.

Third, the survey provides a measure of students' GRIT (Duckworth et al. 2007; Duckworth and Quinn 2009), a personality measure eliciting students' passion for and perseverance in long-term goals.

#### ***4.2 Administrative data***

Linking the student survey data with administrative records via the national social security number, which is possible under certain conditions, enriches the survey data. Two major advantages for research arise from the linkage of the SERI survey data with administrative data. First, linking cross-sectional survey data to longitudinal administrative data enriches the available information on students' educational pathways over time, rather than just at the time of the survey. Without this data linkage, producing the data at hand would require great effort through multiple interviews. Even had such effort been possible, sample attrition will cause non-complete records of answers for survey respondents across years.

Second, the linkage of student survey data and administrative data improves the final data set both qualitatively and quantitatively by validating several responses from the survey. Because survey data is subject to many potential biases, such as recall bias, retrospective rationalisation or social desirability of the response, certain information is almost always more trustworthy in administrative data. Indeed, in this paper, the data quality of the administrative data on educational careers before and after the time of the

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<sup>5</sup> For a more intuitive interpretation, the analysis uses a conversion of the original scale.

survey is high and thus preferable to the survey answers. Furthermore, the linkage of survey and administrative data enriches the dataset with student information not captured earlier.

### *4.3 Occupational skill requirements*

Data on skill requirements for approximately 150 occupations cover requirements in four domains: mathematics, school language, science and foreign language. These requirements are measured on a scale from 1 to 100, where 1 is the least demanding and 100 most demanding. The skill intensity in each category is defined by subtopics. For example, in mathematics subtopics are algebra, geometry, units of measurement, calculus and statistics. The analyses, however, use the composite indices for the four domains. The classification of apprenticeships was carried out by experts in the Conference of Cantonal Ministers of Education (EDK) and the Swiss Trade Association (sgv). The work was co-financed by the State Secretariat for Education, Research and Innovation.<sup>6</sup>

Skill requirements do not exist for all 240 occupations of the Swiss VET system. Thus, as the data does not cover all the occupations that the survey respondents chose, about 7% of observations in the final analyses are lost.

However, the advantage of the data on occupational skill requirements is twofold: First, the data allows an analysis of the gender gap in terms of occupational requirements rather than a simple categorisation of occupations into STEM vs non-STEM. As the analyses will show, the requirement intensity is associated with the gender gap within STEM occupations. Second, rather than having to operationalise students' decision as a 0/1 decision for or against STEM occupations, the paper investigates students' preference for occupations with higher mathematics intensity on a continuous scale.

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<sup>6</sup> [www.anforderungsprofile.ch](http://www.anforderungsprofile.ch). The author thanks Dr. Walter Götze for providing Stefan C. Wolter and his research team with the raw data describing the cognitive requirements of the various occupations.

#### 4.4 Sample

As this paper focuses on students' vocational choice, the sample of interest includes students who, at the time of the survey, were in 9<sup>th</sup> grade and continued with an apprenticeship after completing compulsory schooling. 1417 students completed the survey in 9<sup>th</sup> grade. Of these 1417, 645 students (45%) started an apprenticeship immediately after completing compulsory schooling. An equal share of students chose a general education (baccalaureate school). The remaining students took an additional year of schooling to prepare for higher education (intermediate education) or took a break. In this survey sample, the share of students choosing general education is much higher than that of students in the entire Swiss population. The discrepancy is primarily driven by a large proportion of students who first attempt general education and students in the French- and Italian-speaking parts of Switzerland, who only start and complete an apprenticeship after dropping out of general education (Cattaneo and Wolter 2022).

Finally, 45 students chose an occupation for which no occupational skill requirements exist; thereby, the analytical sample comprises 600 observations. The dataset has missing values for some background questions, including grades. To avoid dropping further student observations, I impute missing values for mathematics (4 observations), language (6 observations) and foreign language (9 observations) grades by using mean grades by gender.<sup>7</sup>

### 5. Empirical Approach

To investigate the gender gap in occupational choice, I estimate the following ordinary least squares (OLS) model for students who continue with an apprenticeship after completing compulsory schooling:

$$\text{Skill requirement}_{ij} = \beta_0 + \beta_1 \text{female}_i + \gamma X_i + \varepsilon_i \quad (1)$$

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<sup>7</sup> Following Hanushek, Link, and Woessmann (2013), I ensure that the imputed data is not driving the results by including an indicator for the school grades variables with missing data. Results are available upon request.

Where  $Skill\ requirement_{ij}$  is the skill requirement of skill  $j$  of individual  $i$ 's occupation. Skill requirement  $j$  is school language, science, mathematics or foreign language, and requirements range from 1 to 100.  $female_i$  is a dummy variable taking the value 1 if the respondent is female and 0 if the respondent is male. The coefficient of interest  $\beta_1$  measures the effect of being female on the skill intensity conditional on covariates  $X_i$ , which includes motivations, grades, educational track, family background and information on the cantonal education system. Standard errors  $\varepsilon_i$  are clustered at the cantonal level.

Since  $X_i$  does not include any possible explanation for the gender gap in occupational choice, other unobserved factors could certainly explain the remaining gap. However, the estimated gender gap is an interesting measure in terms of education and labour market policy, as it describes the magnitude of the difference that cannot be explained by school performance, origin and, above all, by different preferences and career choice motives between women and men. Therefore, to close that gap, interventions would have to target factors that lie outside the spectrum of those observed in this paper.

The main analyses show the results for the two skills domains relevant for STEM occupations: mathematics and science. Additional analyses include the regression results for school language and foreign languages (see Appendix), as well as results for average skill requirements of all four skills domains (see Appendix).

## **6. Results**

This section first summarises the descriptive statistics, then presents the main regression results.

### ***6.1 Descriptive statistics***

As the table of descriptive statistics for students who choose an apprenticeship after finishing compulsory schooling is long, it appears as Table A1 in the Appendix. Men and women show considerable differences in occupational skill requirements. Women choose on average occupations with higher language intensity, both school and foreign languages, while men choose on average occupations with both higher mathematics intensity and higher science intensity. The results suggest that while women slightly

outperform men in school language and foreign language, gender differences in mathematics grades are small and insignificant.<sup>8</sup>

Moreover, in line with empirical studies on gendered preferences for occupational characteristics (e.g. Kuhn and Wolter 2022), the average ranking of work- and education-related preferences differ by gender. Female students assign on average a higher rank to 'helping people' and 'social contact' than male students and a lower rank to 'social status', 'good income' and 'career prospects'. 'Social status' has the lowest rank for both genders. Women starting an apprenticeship immediately after compulsory schooling have statistically significant higher GRIT, i.e. passion for and perseverance in long-term goals, than their male peers.<sup>9</sup>

## ***6.2 Main results***

To analyse whether gender segregation is a matter of science or mathematics requirements or both, the two relevant skills domains for STEM, the main estimation results report the effect of being female on the math intensity (Table 1) and science intensity (Table A3 in Appendix) of occupations. For mathematics and science requirements individually, Table 1 and Table A3 in Appendix report four specifications, including different covariates<sup>10</sup> (columns 1-4).

While the results suggest a very small gender gap in favour of men in occupations with higher science intensity, i.e. only a 4 point difference on the 100-point scale (Table A3 in Appendix), they also suggest a statistically and economically significant gender gap in favour of men in occupations with higher mathematics intensity (Table 1). The gender gap in occupations with higher mathematics intensity, a 14 point difference, is about three times the gender gap for occupations with higher science intensity (Table A3 in Appendix, column 4). For occupations with either higher science or mathematics intensity, the gender gaps do not differ much from the raw mean differences, even when

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<sup>8</sup> In the Swiss education system 1 is the lowest grade, 6 is the highest, and students pass with a grade of 4.

<sup>9</sup> The GRIT scale ranges from 1 (low) to 5 (high).

<sup>10</sup> The covariates include absolute grades (in mathematics, school language and foreign language), relative grades (difference between mathematics and school language), study and job-related preferences, several individual and family characteristics and aggregated information about the education system in the region where they live.

controlling for absolute grades (in math, school language and foreign language), relative grades (math-school language), study- and job-related preferences and motives, individual and family characteristics and aggregated information of the education system in the region of living.

Moreover, the gender gap could be unequally pronounced for the mathematics intensity at the quantiles. The quantile regression estimates suggest that the gender gap in occupations with higher mathematics intensity remains stable along the distribution of occupational mathematics requirements (Table A5 in the Appendix).

While the results suggest a gender gap in favour of men in occupations with higher mathematics intensity, men and women choose occupations with similar overall skill intensity (i.e. the effect of being female on the average intensity of all four skill domains; see Appendix Table A4). Indeed, the results indicate that students compensate for lower requirements intensity in one skill dimension by higher requirement intensity in another skill dimension. While men choose occupations with higher mathematics intensity than women do, women choose occupations with higher language intensity than men do.<sup>11</sup>

These equally large gender gaps in occupations with higher mathematics or language intensity potentially suggest that students exploit their comparative advantage in language or mathematics. However, the estimation results for the specification controlling for grades do not suggest that students' grades and relative math-language grades explain the gender gaps (Table 1, column 2). This finding contradicts that of Breda and Napp (2019). The reason is that the analysis in this paper differs from theirs in at least four ways which likely explain the differences: First, students' grade differences, by gender and subject, are very small in the sample. Second, in this paper ability is measured by school grades, not by PISA scores. Third, Breda and Napp (2019) investigate students' *intentions* to pursue mathematics-intensive studies, while this paper studies the *actual* vocational

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<sup>11</sup> A similar picture occurs when we estimate the effect of being female on relative occupational requirements (difference between mathematics and language requirements). The results also suggest that being a woman is associated with completing an apprenticeship with relatively higher language intensity than mathematics intensity (-27 points). This finding is robust when we control for grade differences in the two domains. The results are available upon request.

choices of individuals. Fourth, they use PISA questions to define mathematics-intensive study fields, while this paper uses expert ratings for occupational skill requirements.

*Table 1: Mathematics requirements*

	Mathematics requirement			
	(1)	(2)	(3)	(4)
<i>Gender</i>				
Female	-14.506*** (1.306)	-14.764*** (1.214)	-13.755*** (1.357)	-13.496*** (1.389)
<i>Motivation motives</i>				
Social contact			0.629* (0.307)	0.434 (0.322)
Higher education			0.802*** (0.276)	0.676** (0.276)
Continuous education			0.560** (0.223)	0.375 (0.222)
Job security			0.491* (0.246)	0.466 (0.281)
Creativity			0.410** (0.181)	0.333* (0.189)
Work/Family balance			0.870** (0.379)	0.717** (0.344)
Helping people			-0.517* (0.299)	-0.538* (0.277)
Salary prospects			0.427 (0.254)	0.444* (0.252)
Career prospects			0.655* (0.324)	0.523 (0.313)
Constant	54.959*** (0.902)	52.906*** (1.597)	28.604*** (8.485)	33.827*** (11.738)
<i>Control</i>				
Grades	No	Yes	Yes	Yes
Other	No	No	No	Yes
R-squared	0.20	0.25	0.30	0.37
Observations	600	600	600	600

*Notes:* The dependent variable ranges between [1,100], where 100 indicates the highest requirement. Grades include reported grades from 9th grade in mathematics, language and foreign language as well as relative grades. ‘Social Status’ is the reference category of the ranked motivation motives. ‘Other’ includes education from siblings and parents, GRIT score, share of baccalaureate graduates by canton and gender, nationality and school type. Standard errors are in parentheses and clustered at the cantonal level.

\*\*\* significance at the 1% level, \*\* significance at the 5% level, \* significance at the 10% level.

The magnitude of the gender gap in occupations with higher mathematics intensity is associated with tremendous labour market consequences in wages, i.e. one-point higher mathematics intensity is associated with a 0.9% higher wage over the entire working life (see Buser, Peter, and Wolter 2017). As wages most strongly correlate with mathematics requirements (see Buser, Peter, and Wolter 2017), labour market consequences will be most pronounced for women in occupations with low mathematics intensity. The gender difference in mathematics requirements of 13.5 points (Table 1, Column 4) corresponds to a wage disadvantage for women relative to men of around 12%. This wage disadvantage is of similar magnitude to the 18% wage difference between the median salary of women and men in Switzerland in 2022, uncontrolled for occupation, experience, education, or other factors.<sup>12</sup>

### **6.3 Gender differences in labour market expectations?**

The results suggest that women do not simply choose occupations with lower overall skill intensity but occupations with higher language intensity and, consequently, with lower average wages. Given these findings, the question arises as to why women decide for lower paying occupations: i) Do women, knowing that these occupations offer lower pay, choose occupations with higher language intensity, or ii) do women choose occupations with higher language intensity based on a misconception about wage returns to language and mathematics skills?

To answer these questions, a convenience sample of several school classes was surveyed about their career choices in the canton of Zurich in summer 2019.<sup>13</sup> Students assessed the importance of mathematics, school language, foreign languages, science and social skills for future income, for the possibility of further education and for their happiness in the workplace. Students ranked the importance of skills on a scale from 1 to 10, where 10 is associated with the highest importance.

The survey timing and design ensure that a retrospective rationalisation of students' does not drive their answers. By surveying the students in the summer, students had not

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<sup>12</sup> For the wage gap in Switzerland in 2022 see: <https://www.payscale.com/products/data/pay-equity-report/>?. Last Accessed March, 24<sup>th</sup> 2025.

<sup>13</sup> The author thanks Jérôme Hirschi for providing the calculations based on a survey conducted by Anne Brenøe, Lexi Schubert and Stefan C. Wolter.

definitely chosen an occupation<sup>14</sup>, but they had extensively thought about their career choice. Because a majority of students later deviate from their initial occupational career intentions (see Jaik and Wolter 2019), it is most likely that students revised their career intentions after they participated in the survey. Moreover, it is unlikely that the students held precise information on occupational skill requirements. While the survey has the advantage of addressing the question of whether students base their occupational choice on misconceived wage returns to skills, it cannot be used to rule out the possibility that students project high returns in those skills that they themselves love or in which they feel strong (self-assessment).

The survey provides tentative evidence suggesting that women's belief about future wage returns to language and mathematics skills does not correspond to the actual returns observed on the Swiss labour market. Focussing on the economic consequences of the mathematics gender gap, Table 2 reports the gender differences in students' perceived wage returns to skills. On average, young women report that school language skills and foreign language skills are more important for future wages than mathematics skills. In contrast, on average, young men think that mathematics skills are more important for future wages than school language and foreign language skills. Strikingly, the main analysis suggests the same gendered pattern for language and mathematics intensity: a gender gap in favour of men in occupations with higher mathematics intensity and a gender gap in favour of women in occupations with higher school language intensity.<sup>15</sup>

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<sup>14</sup> Students do sign their apprenticeship contracts during a period of several months, starting five months after the survey.

<sup>15</sup> Unlike in the survey on students' perception of skill importance on future wages, the data of the main analysis does not include social skill requirements.

Table 2: Relative importance of skills for future wages, by gender and skills.

Skill dimension	Male	Female	Difference (Male-Female)
Mathematics	7.925	6.538	1.388***
School Language	6.642	8.441	-1.799***
Foreign Language	5.642	7.548	-1.907***
Science	4.925	5.699	-0.774
Social Skills	7.493	8.957	-1.464***
Observations	67	93	

Notes: Answers range between [1,10], where 10 indicates the highest importance. \*\*\* significance at the 1% level. All statistically significant differences are also significant after controlling for observable differences

## 7. Discussion

Occupational choice research has clearly shown the under-representation of women in mathematics- and science-related fields of study. However, this research focuses on i) high-ability (university) students, rather than a wider spectrum of students and ii) the choice between STEM or non-STEM fields, not the specific choice between mathematics and science. This paper presents new evidence on the gender gap in the occupational choice of young Swiss students by using a career choice dataset on career choices. The dataset on career choices comprises a representative student survey, administrative data on education trajectories and data on occupational skill requirements in mathematics, natural sciences, school language and foreign language.

Conditional on school grades and occupational motives and preferences, the analysis suggests a large gender gap in favour of women in occupations with higher language intensity and an equally large gender gap in favour of men in occupations with higher mathematics intensity. The results show that the gender gap in favour of men in occupations with higher math intensity is three times as high as in occupations with higher science intensity. These results suggest that gender segregation within STEM and non-STEM occupations is mainly associated with the mathematics intensity, not the science intensity, of an occupation. Moreover, the results suggest that women's choice of occupations with lower mathematics intensity is associated with large income losses for which higher language intensity cannot compensate.

Further research is necessary to understand how students' use and perception of skills as well as their perception of occupational skill requirements explain these gender differences in occupational choice. Given the results, further research on the perception

of skill requirements should focus on gender differences in students' perception of mathematics skills, a factor that lies outside the scope of this paper. Furthermore, while this paper provides first tentative evidence on gender differences in students' perception of labour market returns to mathematics and language skills, more research is needed for disentangling whether students misperceive wage returns to mathematics and language skills or whether students project high wage returns to skills that they feel strong in.

Policy-oriented research aimed at closing the gender gap in career and study choices relating to mathematics intensity should therefore focus on both self-perception of one's own skills and knowledge, and perceptions about skill returns.

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## Appendix: Additional tables

Table A1. Descriptive Statistics

	Total	S.D.	Male	Female	Difference (Male- Female)
	(1)	(2)	(3)	(4)	(5)
<i>Skill requirement</i>					
Math	48.75	16.06	54.96	40.45	14.51***
Science	50.22	12.55	51.86	48.03	3.83***
Language	57.26	13.64	51.41	65.05	-13.64***
Foreign Language	30.08	21.23	24.38	37.70	-13.32***
<i>School Grades</i>					
Math	4.85	0.61	4.86	4.85	0.01
Language	4.86	0.05	4.76	5.00	-0.24***
Foreign Language	4.94	0.65	4.87	5.02	-0.15***
<i>Motivation Motives</i>					
Social Status	4.06	2.65	4.20	3.88	0.32
Social Contact	5.38	3.02	5.15	5.68	-0.53**
Higher education	4.70	3.18	4.77	4.62	0.15
Continuous education	6.00	2.65	6.04	5.95	0.09
Job security	6.63	2.61	6.57	6.71	-0.14
Creativity	4.86	2.78	5.01	4.66	0.35
Work/Family balance	6.14	2.79	6.05	6.26	-0.21
Helping people	5.37	2.71	4.89	6.00	-1.11***
Salary prospects	5.78	2.52	6.01	5.47	0.54***
Career prospects	6.08	2.79	6.31	5.77	0.54***
<i>Personality traits</i>					
GRIT	3.66	0.55	3.57	3.77	-0.20***

*Notes:* The table shows mean characteristics for men and women observed in 9th grade in 2019 and who continued afterwards with an apprenticeship. Requirements are on a scale between [1,100], where 100 is the highest requirement. School grades range between [1,6], where students pass with a minimum grade of 4 and 6 is the highest grade. Motivation motives range between [1,10], where 1 is the lowest ranking and respondents could assign each value only once. The higher the GRIT score, the more persevere is the respondent in achieving long-term goals. The GRIT ranges from 1 to 5.  
\*\*\* significance at the 1% level, \*\* significance at the 5% level, \* significance at the 10% level.

Table A2. Gender Gap and Language Requirements

	Language requirement			
	(1)	(2)	(3)	(4)
<i>Gender</i>				
Female	13.637*** (0.935)	13.111*** (0.973)	12.911*** (1.007)	13.337*** (1.101)
Constant	51.414*** (0.809)	50.673*** (1.540)	43.151*** (9.880)	47.927*** (11.981)
<i>Controls</i>				
Grades	No	Yes	Yes	Yes
Motivation factors	No	No	Yes	Yes
Other	No	No	No	Yes
R-squared	0.25	0.28	0.32	0.40
Observations	600	600	600	600

Notes: The dependent variable ranges between [1,100], where 100 indicates the highest requirement. Grades include reported grades from 9th grade in math, language and foreign language as well as relative grades. Motivation motives include 10 factors, i.e. good career prospects. ‘Social Status’ is the reference category. Other include education from siblings and parents, GRIT score, share of baccalaureate graduates by canton and gender, nationality and school type. Standard errors in parentheses and clustered at cantonal level.

\*\*\* significance at the 1% level, \*\* significance at the 5% level, \* significance at the 10% level.

Table A3. Gender Gap and Science requirements

	Science requirement			
	(1)	(2)	(3)	(4)
<i>Gender</i>				
Female	-3.834*** (1.245)	-3.723*** (1.258)	-4.535*** (1.183)	-4.073*** (0.992)
Constant	51.862*** (0.856)	51.688*** (1.629)	43.134*** (10.027)	45.921*** (11.532)
<i>Controls</i>				
Grades	No	Yes	Yes	Yes
Motivation motives	No	No	Yes	Yes
Other	No	No	No	Yes
R-squared	0.02	0.06	0.08	0.15
Observations	600	600	600	600

Notes: The dependent variable ranges between [1,100], where 100 indicates the highest requirement. Grades include reported grades from 9th grade in math, language and foreign language as well as relative grades. Motivation motives include 10 factors, i.e. good career prospects. ‘Social Status’ is the reference category. Other include education from siblings and parents, grit score, share of baccalaureate graduates by canton and gender, nationality and school type. Standard errors are in parentheses and clustered at the cantonal level.

\*\*\* significance at the 1% level, \*\* significance at the 5% level, \* significance at the 10% level.

Table A4. Gender Gap and Mean requirements

	Mean requirement			
	(1)	(2)	(3)	(4)
<i>Gender</i>				
Female	1.802** (0.723)	1.377* (0.714)	1.576** (0.732)	2.021** (0.750)
Constant	43.985*** (0.634)	42.811*** (1.201)	29.118*** (6.076)	33.956*** (5.053)
<i>Controls</i>				
Grades	No	Yes	Yes	Yes
Motivation motives	No	No	Yes	Yes
Other	No	No	No	Yes
R-squared	0.01	0.07	0.14	0.31
Observations	600	600	600	600

*Notes:* Mean requirement is the average of the four requirement domains. Grades include reported grades from 9th grade in math, language and foreign language as well as relative grades. Motivation motives include 10 factors, i.e. good career prospects. ‘Social Status’ is the reference category. Other include education from siblings and parents, grit score, share of baccalaureate graduates by canton and gender, nationality and school type. Standard errors in parentheses and clustered at cantonal level.  
\*\*\* significance at the 1% level, \*\* significance at the 5% level, \* significance at the 10% level.

Table A5: Quantile Regression

	Quantile Regression			
	0.2 Quantile	0.4 Quantile	0.6 Quantile	0.8 Quantile
<i>Gender</i>				
Female	-13.278*** (1.501)	-14.169*** (1.340)	-13.112*** (0.879)	-13.597*** (1.366)
Constant	9.725 (15.982)	22.418* (13.555)	34.931*** (10.896)	36.819*** (13.107)
<i>Controls</i>				
Grades	Yes	Yes	Yes	Yes
Motivation factors	Yes	Yes	Yes	Yes
Other	Yes	Yes	Yes	Yes
Observations	600	600	600	600

*Notes:* The dependent variable ranges between [1,100], where 100 indicates the highest requirement, the table shows the regression results of quantile regressions. Grades include reported grades from 9th grade in math, language and foreign language as well as relative grades. Motivation motives include 10 factors, i.e. good career prospects. ‘Social Status’ is the reference category. Other include education from siblings and parents, grit score, share of baccalaureate graduates by canton and gender, nationality and school type. Standard errors in parentheses and robust standard errors.  
\*\*\* significance at the 1% level, \*\* significance at the 5% level, \* significance at the 10% level.