Culture and the gender gap in major choice: An analysis using sibling comparisons

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Abstract
In this paper we study the role of culture on gender roles – preferences and beliefs about the appropriate role of women in society – for the gender gap in choice of major, using the epidemiological approach. We focus on second-generation immigrants in Sweden and compare the major choices at high school and college of opposite-sex siblings. Controlling for sibling fixed effects allows us to more convincingly than in previous literature control for factors apart from culture on gender roles that may affect educational choices. We use the female relative share in traditionally male fields to proxy for culture on gendered beliefs about educational choices in the source country. We find a negative gender gap in the probability of having majored in a STEM or male-dominated field, and that this gender gap varies with the proxy for culture on gender roles. We observe the same pattern when we study the probability to have majored in a female-dominated field. Our results clearly indicate that policies aimed at changing stereotypical gendered beliefs about educational choices have the potential to decrease the gender gap in major.

Keywords: Culture, sibling fixed effects, second-generation immigrants, gender gap, major choice, STEM

JEL: I24, J15, J16, J24

1. Introduction

Women's educational attainment has increased relative to that of men in many OECD countries, and today we observe a reversed gender gap with higher female graduation rates both in high school and in college (see e.g. Almås et al. 2016; OECD 2016a; Blau and Kahn 2017). Despite this educational catch up, there are still large gender differences in choice of major – a difference that has remained strikingly constant over time (see e.g. Ceci et al. 2014; OECD 2016a). More specifically, females specialise in science, technology, engineering, and mathematics – the so-called STEM disciplines – to a lesser extent than males, and are, on the other hand, overrepresented in social science and health and nursing. For example, among individuals aged 25–64 with tertiary education in OECD countries men were about three times more likely to have majored in a STEM field compared to women. In contrast, women were three times more likely to have majored in health and nursing (OECD 2016b). A large number of studies document that these gender differences in education majors are an important determinant of the gender wage gap (see e.g. Turner and Bowen 1999; Machin and Phuani 2003; McDonald and Thornton 2007; Black et al. 2008; Flabbi 2011; Blau and Kahn 2017). In addition, Blau and Kahn (2017) demonstrate that while the relative gains of females in educational attainment and labour market experience since the 1980s have resulted in a decreased importance of these factors in explaining the gender wage gap, gender differences in occupations remain a significant determinant of the wage gap. Thus, it is important to understand why males and females make different choices regarding education major in order to design policies with the aim of reducing the gender wage gap.

In this paper, we focus on if culture on gender roles – preferences and beliefs about the appropriate role of women in society – is associated with the gender gap in choice of major. For this purpose, we use the epidemiological approach to quantify the causal impact of culture (Fernández 2008). This means that we focus on the educational choices made by second-generation immigrants who were born in the same country and have thus been exposed to the same labour market, regulations, laws, and institutions in the host country but differ in terms of their culture on gender roles. The premise is that immigrants bring with them their culture from their country of birth and transmit their cultural beliefs to their children, implying that both first and second-generation immigrants' outcomes are potentially influenced by the ancestry country's culture on gender roles.[1]

We contribute to this literature by being the first study to focus on the gender gap in choice of major. In addition, we use several and new proxies for culture in this setting. Rather than focusing on source-country characteristics that capture beliefs about gender equality in general or on the labour market, we make use of variables that more precisely capture gendered beliefs about educational choices. Finally, we have access to high-quality Swedish register data that enables us to link the second-generation immigrants not only to their parents but also to their full siblings. Since we are able to identify siblings in the data, we can make use of sibling comparisons that allows us to control for all time-invariant factors within families that affect siblings equally, e.g. socio-economic background, parenting styles and networks, school environment and school quality, living area, and local labour market situation, factors that are often very difficult to fully account for (see Finseraas and Kotsadam 2017). This makes it more likely than in previous literature that we can interpret the findings as causal.

We restrict our attention to second-generation immigrants born in Sweden in 1960–1977. Since we want to compare the educational choices of male and female siblings, we further restrict the sample to individuals who have at least one full sibling of the opposite sex. We observe their educational attainment and orientation at the age of 30 – an age at which most persons have made their high school and/or major choice. We focus on the choice of major made at high school and/or college. High school is typically the first time that children are able to choose and have control over the subjects that they study, and already at this point we can observe women's lower representation in STEM fields (Kahn and Ginther 2017). In Sweden, children at this level sort into different educational programmes that differ in the extent to which they include more-advanced math and science courses. The choice of field of study at high school typically determines what type of education the individual is eligible for at the university level. We have access to detailed information on field of study for the individual's highest attained education categorized by the Swedish Educational Terminology (SUN) that follows the International Standard Classification of Education (ISED97). Using this information we construct three outcomes to capture different aspects of the gender gap in majors: the

[1] For an overview on how culture contributes to differences in individuals' economic and social outcomes, see Fernández (2011).

probability to have a major in a (i) STEM field, (ii) male-dominated field, and (iii) female-dominated field.

To proxy for culture on gender roles in the source country we make use of data from the World Bank collected by the UNESCO Institute for Statistics. Using this data, we construct two main source-country variables to measure the educational segregation by gender in the source country: the share of females enrolled in (i) engineering, manufacturing, and construction (henceforth EMC) and (ii) science. We argue these measures capture gendered beliefs about educational choices. We also use two alternative measures of culture that capture beliefs about whether women should pursue studies at high school and college. For this purpose, we use the female share in college education and the expected years of schooling. Finally, we follow previous literature and include the labour force participation rate ratio that should capture beliefs about gender roles in the labour market.

We find a negative gender gap in the probability of having majored in a STEM or male-dominated field, and that this gender gap varies with the proxy for culture on gender roles. For example, a one standard deviation increase in the female relative share in EMC is related to an about 2-percentage point reduction of the sibling gender gap in a STEM or male-dominated field. We observe the same pattern when we study the probability to have majored in a female-dominated field. When using more standard cultural proxies we find the opposite result; the gender gap in major actually increases for siblings originating in countries with higher female years of expected schooling and labour force participation rate. Thus, although improvements in these latter measures may lead to increased gender equality in some aspects, they do not contribute to reducing the gender segregation in terms of education major. In contrast, our results clearly indicate that policies aimed at changing stereotypical gendered beliefs about educational choices have the potential to decrease the gender gap in major.

This paper contributes to the large and growing literature on the gender gap in major choice, which has primarily focused on the relative importance of gender differences in monetary factors, e.g. expected earnings, and non-monetary factors, e.g. abilities and preferences.[2] Generally, this literature point towards the importance of gender differences in preferences.

[2] See Altonji et al. (2016) for an excellent overview of the determinants for major choice and Kahn and Ginther (2017) for an excellent literature review of the underrepresentation of women in STEM-fields.

Although gender differences in expected earnings do appear to affect major choice, their impact is modest in size (see e.g. Beffy et al. 2012; Wiswall and Zafar 2015). In addition, there is no evidence that gender differences in beliefs about future earnings can explain the gender gap in college major (Zafar 2013). Further, when it comes to gender differences in abilities, it has been argued that men and women have innately different abilities that induces them to choose different education majors (Kimura 1999). However, findings that also very gifted men and women tend to choose different majors renders this hypothesis little explanatory power (Lubinski and Benbow 1992). Another possible explanation is gender differences in mathematical achievement and other pre-college test scores. Previous research shows that there are such differences, and that they are correlated with major choices at both high school and college, but they can only explain a small part of the gender gap in major choice (e.g. Turner and Bowen 1999; Dickson 2010; Xie and Shaumann 2003; Riegle-Crumb et al. 2012; Zafar 2013; Gemici and Wiswall 2014). Studies further show that the gender differences in achievement are mutable by family, teachers, culture, stereotypes, and role models throughout the schooling process, generating gendered preferences and gendered beliefs about abilities that shape major choices (see e.g. Kahn and Ginther 2017). Thus, most studies point at the importance of gender differences in preferences in explaining the gender gap in major choice (e.g. Xie and Shaumann 2003; Zafar 2013; Gemici and Wiswiall 2014; Wiswall and Zafar 2015). For example, Zafar (2013) uses a framework that allows him to study the relative importance of preferences and beliefs about ability. He finds that gender differences in preferences is the most important determinant of the gender gap in major choice, while gender differences in beliefs about ability can only explain a small, and insignificant, part of the gap. In particular, Zafar, along with others, argue for the importance of changing attitudes about gender roles in reducing the gender gap in major (Xie and Shaumann 2003; Zafar 2013).

There is a growing literature that indicates that culture on gender roles explains variation in economic outcomes.[3] However, to date few studies have investigated how the source-country culture on gender roles is related to educational outcomes, and to our knowledge there is no paper focusing on major choice. Using the epidemiological approach, Abada et al. (2018) find that educational attainment among immigrant children is associated with culture on gender

[3] A number of recent papers have shown that originating from a country with a traditional culture on gender roles makes immigrant women and their daughters supply less labour, engage more in household work, and have higher fertility rates (e.g. Antecol 2001, 2000; Fernández and Fogli 2006, 2009; Blau et al. 2011, 2013; Eylem Gevrek et al. 2013; Hwang 2016; Finseraas and Kotsadam 2017).

roles, measured by the female labour force participation, in the parents' birth country. Nollenberger et al. (2016) study second-generation immigrants in nine different countries and show that the math gender gap is lower for the groups with parents from more gender-equal countries. They conclude that parents' culture on gender roles explains about two thirds of the math gender gap. In addition, a number of studies explore the importance of culture by using regional variation in gendered beliefs about mathematics and science, and find that girl's achievement in STEM is better in more gender equal countries (Guiso et al. 2008; Fryer and Levitt 2010; Pope and Sydnor 2010). Thus, this literature suggest that culture on gender roles is a potentially important determinant of the gender gap in majors.

The remainder of the paper is organised as follows. In section 2, we present data and descriptive statistics followed by the empirical strategy in Section 3. In Section 4, we present our results and robustness checks, and finally, in Section 5 we conclude.

2. Data and descriptive statistics

2.1 Data

In this paper we use register data from the longitudinal data base LISA provided by Statistics Sweden. The data contains information on individual characteristics such as educational attainment and orientation and other demographic and labour market variables. We observe all individuals 16 years and older residing in Sweden during the years 1990 to 2007 and the data enables matching individuals to their parents and siblings. We restrict our attention to second-generation immigrants born in the years 1960 to 1977 and who have completed at least two years of high school. Individuals are defined as second-generation immigrants if they have a foreign-born mother. This implies that we allow the father to be foreign born or native born, and that persons with a foreign-born father and a native-born mother are excluded from our main analysis. Furthermore, since we want compare educational choices of male and female siblings, we restrict the sample to those having at least one opposite-sex full sibling.

We focus on major choices made at high school and college. The main reason for studying both levels is that high school is the first time that children are able to choose and have control over the subjects that they study. As a result, we can observe women's lower representation in STEM fields already at this point (Kahn and Ginther 2017). Another reason is that this also increases the number of observations and thus the statistical power of the analysis. The sibling comparisons requires both opposite-sex siblings to pursue college education. Among the cohorts under study, the share of families where both siblings continue to college is relatively low and amounts to 19 percent. Focusing on the college level only would thus result in a small sample.

We use information on educational attainment and orientation at age 30. At this age most persons have made their choice of high school and/or college major. We have chosen not to study choices of major that are made after the age of 30 since later choices may be influenced by other factors and have different motivations than those made at earlier ages. Our data includes detailed information on the field of education for the individual's highest attained education categorized by the Swedish Educational Terminology (SUN). The SUN standard follows the main international system for classification of educational programmes: the International Standard Classification of Education (ISCED97) maintained by UNESCO. The outcomes analysed will be the probability to have a major within a (i) STEM field, (ii) male dominated field, and (iii) female dominated field. The following ISCED97 categories are STEM fields: Life science (EF42), Physical science (EF44), Mathematics and statistics (EF46), Computing (EF48), Engineering and engineering trades (EF52), and Manufacturing and processing (EF54). Female and male dominated fields are classified by calculating the share of males and females with majors in different fields using data for the Swedish population aged 31–65 in the year 1990. Fields with more than 80 percent males (females) are classified as male (female) dominated. For a list of the included fields in each category, see table A1 in the appendix.

We match individuals to all their opposite-sex siblings born in 1960 to 1977. This implies that individuals with more than one opposite-sex sibling will be observed several times in the data. The source country is identified by using information about the mother's country of birth, implying that if the mother's and father's country of birth differ the mother's country is used. We restrict the sample to source countries for which we have at least five observations with non-missing information on the source-country variables, resulting in 22 source countries. Furthermore, we exclude individuals with missing information on educational attainment. In total, the sample comprises 35,203 individuals, 42,158 observations, and 21,079 sibling pairs.

To proxy for source-country culture on gender roles we rely on data on educational enrolment from the World Bank collected by the UNESCO Institute for Statistics. We use information on the source-country share of enrolled female and male students in tertiary education within eight different fields: (1) agriculture, (2) education, (3) engineering, manufacturing, and construction, (4) health and welfare, (5) humanities and art, (6) science, (7) services, and (8) social science, business, and law.[4] We consider (3) engineering, manufacturing, and construction (EMC) and (6) science to capture traditionally male dominated subjects best. Our main variables of interest will be the female relative share in field (3) and (6) calculated as the share of women out of all enrolled women in the field divided by the share of men out of all enrolled men in the field. A value above one implies that it is more common among females to choose the field, while a value below one means that the share of men enrolled in the field is higher than the corresponding share among women. The closer the value is to zero, the stronger is the source-country culture of traditional gender roles regarding educational choices. Relying on a relative measure has the advantage that it controls for measurement errors that affect men and women similarly (e.g. Blau et al. 2013).

In addition, we use information on variables capturing source-country gender differences in educational attainment. We specify two variables: the female relative share in tertiary education, i.e. the share of women continuing to tertiary education relative to the corresponding share among men, and the ratio between women's and men's years of expected schooling. These variables should capture traditional gender roles regarding whether women should pursue high school or college education. Furthermore, following previous literature we also include a measure of traditional gender roles in labour market and household work, namely the labour force participation rate ratio.

The source-country female relative shares in EMC and in science are measured in 2004. The motivation for choosing this specific year is because of high data availability. From a theoretical point of view, it is not clear at which point in time the source-country culture on gender roles should be measured. We will rely on future values on source-country culture, an approach that has been previously applied in the literature and is accurate if culture evolves slowly over time (Fernández 2007). The data indicates that the degree of gender educational

[4] This categorization follows the definition of broad groups and fields of education in ISCED97. Science includes life science, physical sciences, mathematics and statistics, and computing. See UNESCO (1997) for more information.

segregation in the source countries is quite stable over time (see figure A1 and A2 in the appendix), a pattern that is also confirmed in previous research (see e.g. Ceci et al. 2014; OECD 2016a; Speer 2017). This strengthens our belief that relaying on future values of source-country culture on gender roles is a valid approach when culture is measured by gender segregation in fields of education.

Since women's participation in the labour force and college education have increased over time and the speed of this development is likely to vary across countries, relaying on future values of these variables might be misleading. Fernández and Fogli (2009) argue that the culture that parents and society transmit can be reflected in the behaviour of persons in the source country at the time of observation of the outcomes of the second generation in the host country. Therefore, we will measure source-country gender differences in labour market participation and educational attainment as close to the year of the educational choice as possible. We allow the source-country labour market participation, years of expected schooling, and enrolment in tertiary education to be measured up to ten years before or after the year of educational choice. Using information on graduation year and length of education we can approximate the year when an individual made the choice of education by calculating graduation year minus length of education. The graduation year is missing for some individuals, partly because not all students apply for a degree. For individuals with missing information we approximate the year of educational choice by birth year plus seven (the school starting age) plus years spent in education. This implies that an individual born in 1970 made the choice of major in terms of high school programme after finishing primary education (nine years in Sweden) at age 16, i.e. in 1986. If the individual continues to college education the college major choice is made after finishing secondary education (three years in Sweden), i.e. in 1989 (1970+7+9+3). A disadvantage of this approximation is that it does not take into account gap years or that individuals might have repeated a grade.

2.2 Descriptive statistics

In table 1 we display the summary statistics for our sample of second generation immigrant siblings. Consistent with what has been found in previous literature, the proportion continuing to higher education is slightly higher at 38 percent for women than the 34 percent observed among men. Almost 60 percent of the males major in a STEM field, whereas the corresponding number for females is about 10 percent. In the source countries relatively more males are enrolled in EMC and science. Girl's enrolment rate in EMC (science) is about 23 (57) percent of the male enrolment rate. Furthermore, the women in the source countries tend to participate in labour market work to a lower degree than men, but at the same time they have higher educational attainment than men.

[Table 1 about here]

Table 2 reports summary statistics at the source country level. There appears to be large variations in female relative enrolment in EMC and science across countries. The female relative share in EMC varies from 0.15 in the US to 0.50 in Syria. In Iraq and Iran, the share of the girls enrolled in science is about 80 percent higher than the share among boys, whereas in Denmark and Norway the corresponding enrolment rate is about 33 percent lower among girls. Women's labour force participation rate is only about 10 percent of the male rate in Afghanistan and Iraq, while it is almost at parity in China and Finland. As regards educational attainment, the female relative years of expected schooling and share in tertiary education is lowest in Afghanistan. In contrast, in many of the European countries and in the US females have higher educational attainment than males.

From table A2 in the appendix it emerges that the pairwise correlations between the source-country share in EMC or science and the variables measuring educational attainment or labour market participation are negative and rather low. This indicates that the source country variables measuring gendered beliefs on educational choices that we use in this paper might capture different aspects of the source-country culture in comparison to the source-country female relative educational attainment and labour force participation that often been used in previous literature.

[Table 2 about here]

3. Empirical strategy

To explore whether culture on gender roles is associated with major choice at high school and college, we use the epidemiological approach (Fernández 2008). Thus, we exploit the fact that second-generation immigrants share the same labour market, regulations, laws and institutions in the host country but have been exposed to differential cultural beliefs from their parents. Empirically, we follow a recent extension of this approach suggested by Finseraas and Kotsadam (2017) and compare the major choices at high school and college of opposite-sex siblings. The advantage of this approach is that it allows us to control for other factors than culture on gender roles that may affect educational choices in a more extensive way. In previous literature, one has typically tried to control for parental human capital and other source-country characteristics to rule out other influences than culture. The sibling fixed effects model allows us to control for that as well as other relevant factors that are difficult to fully account for. In particular, we can control for all time-invariant factors within families that affect siblings equally, e.g. socio-economic background, parenting styles and networks, school environment and school quality, living area, and local labour market situation during childhood. By using sibling comparisons, the gender differential among opposite-sex siblings should then only pick up the impact from the source-country culture on gender roles that affects daughters and sons differently.

We estimate linear probability models (LPM) using the following specification:

$$Y_{isc} = \alpha_s + \beta_1 Female_{is} + \beta_2 X_c Female_{is} + T_{is} + \varepsilon_{isc} \qquad (1)$$

Y_{isc} is the outcome variable for individual *i* in sibling pair *s* originating in source country *c*. Note that an individual who has multiple opposite-sex siblings will appear several times in the data. α_s is the sibling fixed effects. Thus, in this model identification comes from variation within sibling pairs. $Female_{is}$ is an indicator for if individual *i* in sibling pair *s* is female and X_c is the source-country variable of interest. Since X_c is common to each sibling pair, its first-order effect is absorbed by the sibling fixed effect. T_{is} is a set of dummy variables for birth year. ε_{isc} is the error term. We have chosen not to include additional individual controls since they are likely to be endogenous (Fernández 2011). We estimate robust standard errors clustered on sibling pair. β_1 then shows the average gender gap in the outcome variable among sibling pairs. The coefficient of interest, β_2, shows the extent to which the gender difference among siblings vary with the source-country culture. For reasons of comparison, we also estimate the standard specification used in the literature excluding the sibling fixed effects and including the first-order effect of X_c.

$$[illegible] = \beta_1 [illegible] + \beta_2 [illegible] + \beta_3 [illegible] + [illegible] + \varepsilon [illegible] \quad (2)$$

In this case, β_1 shows the average gender gap in the outcome variable. The coefficient of interest is β_3 that shows the extent to which the gender difference vary with the source-country culture.

We use three different outcome variables that are equal to one if the individual has a major in a (i) STEM field, (ii) female-dominated field, and (iii) male-dominated field, and zero otherwise. We use two main source-country variables to proxy for culture: the female relative share in EMC and the female relative share in science. We argue that these variables best capture gendered beliefs about educational choices. For purpose of comparison, we will also use two source-country variables that are more likely to capture beliefs on whether women should pursue high school or college education or not: the female relative years of expected schooling and the female relative share in tertiary education. Finally, to enable a comparison with previous literature, we also use the female relative labour participation rate as a measure of traditional gender roles in the labour market.

4. Results

4.1 Main results

Table 3 presents the results for the probability to have majored in high school or college in a STEM field using the alternative proxies for culture. Our preferred specifications – including siblings fixed effects – are presented in the even-numbered columns. Columns (1) and (2) show the result from a linear probability model where culture is proxied by the female relative share in EMC. As we saw in the descriptive statistics, females have a considerably lower probability to have STEM-field major. The difference amounts to 57.4 percentage points and is statistically significant at the 1 per cent level. Our coefficient of interest – the interaction between the source-country characteristic and the female indicator – is positive and precisely estimated. This indicates that the gender gap in the probability of choosing a STEM major is smaller for individuals (siblings) who originate in countries with a higher female relative share in EMC. In both specifications, the estimate is about 36 percentage points. Thus, a 1-percentage point increase in the female relative share in EMC is associated with a 36-percentage point reduction in the gender gap. Alternatively, a one standard deviation increase in the female relative share in EMC is related to a 1.8 percentage point reduction of the sibling gender gap in STEM.[5] Interestingly, specification (1) shows that coming from a country with a 1-percentage point higher female relative share in EMC decreases males probability to have STEM education by 34 percentage points while the corresponding estimate for females is positive amounting to 2 percentage points (–0.343+0.364).

[Table 3 about here]

Columns (3) and (4) present the corresponding results using the female relative share in science as a proxy for culture. Again, our estimate of interest is positive in both specifications indicating that the gender gap decreases for siblings (individuals) who come from countries where women are more likely to pursue studies in science. However, the estimates are in this case considerably smaller – 0.048 and 0.047 – and weakly or not statistically significant. The smaller estimates are not surprising based on the descriptive statistics showing a generally higher representation of women within this field across all source countries. This reflects that *Science* is a broader category that includes majors such as medicine with a relatively high female share.

Columns (5)–(8) present the results using proxies for culture that are more likely to capture beliefs on whether women should pursue high school or college education or not. As in columns (1)–(4), women have a considerably lower probability to have a STEM education than men. In columns (5) and (6), we use the female relative share in tertiary education as proxy for culture. In this case the results point in the same direction as when culture is proxied by the female relative share in EMC and Science. Thus, originating from a country where women increasingly participate in college education reduces the gender gap in the probability of having a STEM education. However, the estimate of the interaction term is substantially smaller in both specifications and weakly significant when sibling fixed effects are included.

Using the female relative years of expected schooling as a proxy for culture yields a negative coefficient of the interaction term (see columns (7) and (8)). This suggests that the gender gap actually increases for individuals/siblings with ancestry in countries where the female relative years of expected schooling are higher. In our preferred specification, the estimate amounts to

[5] This has been calculated, using estimates from column (2), as [illegible]$_2$ $\times$ [illegible]

27.8 percentage points and is statistically significant at the 1 per cent level. In this case, the specification without sibling fixed effects indicates that the gender gap does not vary with the source-country characteristic; the estimate is both smaller in magnitude and is not statistically significant.

Finally, we also observe a negative estimate in both specifications when we use the female relative labour force participation rate as proxy for culture (see columns (9) and (10)). Including sibling fixed effects increases the estimate somewhat: 19.8 percentage points compared to 18.2 percentage points in the specification without sibling fixed effects. This suggests that the sibling difference in the probability of choosing a STEM major is larger among siblings originating in countries with a relatively high female relative labour force participation rate.

Table 4 shows the corresponding results when we use the probability to have an education within a male-dominated field as outcome variable. In all columns, females have a lower probability to have a major in a male-dominated field. Columns (1) to (4) reveal very similar results as those presented in Table 3. In column (2) the coefficient of the interaction term is positive and amounts to 37.6 percentage points, indicating that the sibling gender gap in the probability of choosing a male-dominated field decreases with the female relative share in EMC. A one standard deviation increase in the female relative share in EMC is related to a 1.9 percentage point reduction of the sibling gender gap in male-dominated fields. The estimate is positive also when we use the relative share in science as a proxy for culture, but is considerably smaller and not statistically significant. We see a similar result, when using the female relative share in tertiary education as proxy for culture (see column (8)). In this case the estimate amounts to 11 percentage points and is statistically significant at the 1 per cent level.

[Table 4 about here]

As in table 3, the sibling gender gap is higher among siblings originating in countries where the female relative years of expected schooling are higher. The estimate amounts to 24.7 percentage points and statistically significant ant the 1 per cent level. We see a similar result when using the female relative labour force participation rate as proxy for culture. In this case, the precisely estimated coefficient of the interaction term amounts to 16.7 percentage points.

In table 5, we present results for the probability of having an education within a female-dominated field. All in all, the results point in the same direction as in tables 3 and 4, but since the outcome variable is the mirror image of the previous ones, the gender gap is of opposite sign. Women have a statistically significantly higher probability than men to have a major in a female-dominated field. This is the case in all specifications except in columns (7) and (8). We observe a negative estimate of the variable of interest both in columns (2) and (4) amounting to 24.6 and 7.9 percentage points, respectively. As regards the female relative share in EMC, a one standard deviation increase in this measure corresponds to a 1.2 percentage point decrease in the sibling gender gap in female-dominated fields. For science the corresponding number is 1.0 percentage point. Thus, among siblings originating in countries with a high female relative share in EMC or science the sibling difference is smaller than among siblings originating in countries with a low share. The estimate when using the female relative share in tertiary education also point in a similar direction, but it is relatively small and not statistically significant.

[Table 5 about here]

When we use female relative expected years of schooling and labour force participation rate as proxies for culture we find large positive estimates, amounting to 33.2 and 25.4 percentage points, respectively. Thus, the sibling gender difference in the probability of having an education in a female-dominated field increases with female relative expected years of schooling and the female relative labour force participation rate.

To sum up, when we use measures for culture that should capture gendered beliefs about educational choices more directly, we find that originating in a country with less gender segregation in education decreases the gender gap in education majors. In addition, if there is a tradition in the source country that women continue to college this also appear to increase (decrease) women’s representation in STEM and male-dominated (female-dominated) fields. In contrast, increasing years of expected schooling and the labour force participation rate among women is associated with a reduced (increased) likelihood that women major in STEM and male-dominated (female-dominated) fields. Thus, although improvements in these measures may lead to increased gender equality in some aspects, they do not contribute to reducing the gender segregation in terms of education major.

So far we have studied education choices made both at the high school and college level. In Tables 6 and 7 we present results for major choices made at the college level only. Here, we focus on the estimates for our main proxies for culture: the source-country female relative share in EMC and in science. In Table 6, we use the same sample as in Tables 3–5. Focusing only at the college level reduces the sample size substantially – by about 80 per cent. This is not surprising since among the cohorts studied a relatively large share did not go on to college. [6] In addition, the sibling comparison requires that both opposite-sex siblings have college education. This of course greatly reduces the precision of our estimates. However, the results point in the same direction as before although the estimates are generally smaller and not statistically significant.

[Table 6 about here]

Table 7 shows results where we in order to increase the sample size include all second-generation immigrants. Thus, here we drop the opposite-sex sibling comparisons. For all outcomes, we see a similar pattern as that observed when studying both the high school and college level in Tables 3–5. The gender gap in the probability of having a STEM major or a major in a male-dominated field is smaller for individuals originating in countries with a relatively high female relative share in EMC or science. As expected, we observe the opposite pattern for the probability of having an education within a female-dominated field.

[Table 7 about here]

4.2 Robustness analysis (performed and planned)

In our main analysis, the sibling fixed effects control for time-invariant factors within families that affect siblings equally. However, time-varying unobservable factors, such as changes in parental behaviour and networks or improvements of living standards, might affect siblings differently. This should not be a problem, at least not for internal validity, given that fact that the birth order of siblings is random. However, studies using the epidemiological approach to explore if culture can explain biased sex ratios find evidence of sex selective abortion among immigrants from China, India, South Korea, and Taiwan in the US and the UK (Abrevaya et

[6] In our sample 19 percent of the sibling pairs include two siblings with college education, 33 percent of the sibling pairs have one sibling with college education and the other one without college education, and 48 percent of the sibling pairs consist of two siblings without college education.

al. 2009; Almond and Edlund 2008; Dubuc and Coleman 2007). As a sensitivity check, we follow Fineraas and Kotsadam (2017) and run regressions where we exclude immigrants from these countries (China and India), and the results do not change. Further, it is reasonable to assume that factors within the family are more likely to be time invariant if the age gap between siblings is smaller. To reduce the potential bias from omitted time-varying unobservable factors we will also perform a robustness test where we restrict the age gap between siblings to be a maximum of X years.

In addition, it is possible that the source-country culture on gender roles vary not only due to culture, but also because of differences in economic development in the source countries. Should economic development also affect daughters and sons differently this needs to be taken into account in the model. Therefore, we test if the results are robust to the inclusion of an interaction between source-country GDP per capita and the indicator for female. Moreover, to control for that changes in the business cycle and labour market opportunities may have differential effects for females and males we control for an interaction between birth year and the female dummy variable.

To investigate if the mother's or father's culture matter most we have performed a sensitivity analysis where the source country is defined according to the birth country of the father. In addition, we test if the results are robust to excluding children with one native parent.

In our baseline results fields of education with more than 80 percent males (females) are classified as male (female) dominated. We have tested the robustness of the results when this threshold is altered to 70 percent and 90 percent. The results are not sensitive to how we classify fields as male or female dominated.

Finally, we have performed a robustness test where all source-country variables are measured in the same year. This implies that we measure the source-country labour market participation, years of expected schooling and enrolment in tertiary education in the same year (2004) as the source-country female relative share in EMC and in science.

5. Conclusion

In this paper we focus on if culture on gender roles – preferences and beliefs about the appropriate role of women in society – is associated with the gender gap in choice of major. For this purpose, we use the epidemiological approach to quantify the causal impact of culture (Fernández 2008). This means that we focus on the educational choices made by second-generation immigrants who were born in the same country and have thus been exposed to the same labour market, regulations, laws, and institutions in the host country but differ in terms of their culture on gender roles.

We make a number of contributions to this literature. This is the first study to focus on the role of culture for the gender gap in choice of major. In addition, we use improved proxies for culture in this setting. Rather than focusing on source-country characteristics that capture beliefs about gender equality in general, we make use of variables that more precisely capture gendered beliefs about educational choices that socialises females and males into certain fields: the female relative share in traditionally male fields (engineering, manufacturing, and construction (EMC), and science). Finally, access to high-quality and extensive Swedish register data allows us to make use of sibling comparisons and control for all time-invariant factors within families that affect siblings equally. This makes it more likely than in previous literature that we can interpret the findings as causal.

We focus on second-generation immigrant siblings and the choice of major at high school or college. More specifically, we study the gender gap in the probability to have majored in a (i) STEM, (ii) male-dominated, and (iii) female-dominated field. We find a negative gender gap in the probability of having majored in a STEM or male-dominated field and that this gender gap varies with the proxy for culture on gender roles; these gender gaps are lower for siblings who originate in countries with a higher female relative share in EMC. More specifically, a one standard deviation increase in the female relative share in EMC is related to an about 2-percentage point reduction of the sibling gender gap in a STEM or male-dominated field. This impact of culture is line with previous findings from studies closely related to ours, both in terms of magnitudes (e.g. Finseraas and Kotsadam 2017) and direction (e.g. Nollenberger et al. 2016). We observe the same pattern when we study the probability to have majored in a female-dominated field: a one standard deviation increase in the female relative share in EMC (science) corresponds to a 1.2 (1.0) percentage point decrease in the sibling gender gap in female-dominated fields.

When using more standard cultural proxies we find the opposite result; the gender gap in major actually increases for siblings originating in countries with higher female years of expected schooling and labour force participation rate. Thus, although improvements in these latter measures may lead to increased gender equality in some aspects, they do not contribute to reducing the gender segregation in terms of education major. This is not surprising since even in countries where gender equality of opportunity is high, e.g. in Sweden, we still observe a high degree of gender segregation in education and occupation. In contrast, when we use measures for culture that should capture gendered beliefs about educational choices more directly, we find that originating in a country with less gender segregation in education decreases the gender gap in education majors. This clearly indicates that policies aimed at changing stereotypical gendered beliefs about educational choices may have the potential to decrease the gender gap in major.

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Tables

Table 1: Descriptive statistics

	(1) Female	(2) Male
Birth year	1968.416	1968.451
	(4.712)	(4.722)
Share with college education	0.380	0.340
	(0.485)	(0.474)
Share in STEM fields	0.098	0.586
	(0.298)	(0.492)
Number of sisters	1.358	1.193
	(0.630)	(0.475)
Number of brothers	1.199	1.374
	(0.487)	(0.661)
Year made educational choice	1987.920	1987.461
	(6.210)	(6.000)
Source-country female relative share in EMC	0.229	0.229
	(0.055)	(0.055)
Source-country female relative share in science	0.568	0.568
	(0.125)	(0.124)
Source-country female relative labour force participation rate	0.773	0.772
	(0.132)	(0.131)
Source-country female relative years of expected schooling	1.044	1.043
	(0.058)	(0.059)
Source-country female relative share in tertiary education	1.035	1.029
	(0.160)	(0.158)
Observations	17,556	17,647

Included are individuals with a foreign-born mother and at least one opposite-sex full sibling. Displayed are sample means and standard deviations within parentheses.

Table 2: Source-country characteristics

	Source-country female relative				
	share in EMC	share in science	labour force participation rate	years of expected schooling	share in tertiary education
Afghanistan	0.266	0.895	0.071	0.511	0.174
Chile	0.292	0.475	0.445	0.976	0.840
Ethiopia	0.373	0.915	0.742	0.632	0.233
India	0.459	0.997	0.413	0.676	0.507
Iraq	0.409	1.833	0.129	0.750	0.581
Iran	0.198	1.694	0.155	0.837	0.661
China	0.191	0.236	0.845	0.865	0.496
Lebanon	0.265	0.706	0.267	0.989	0.842
Syria	0.502	0.932	0.221	0.852	0.690
Turkey	0.329	0.955	0.436	0.761	0.535
Former Yugoslavia	0.291	0.603	0.508	1.057	1.331
Greece	0.366	0.569	0.529	1.001	1.016
Poland	0.215	0.498	0.769	1.029	1.350
Romania	0.356	1.115	0.807	0.990	0.913
Hungary	0.171	0.380	0.747	1.010	1.143
US	0.152	0.565	0.729	1.057	1.192
UK	0.175	0.426	0.692	1.007	0.921
Germany	0.264	0.607	0.606	0.956	0.762
Denmark	0.368	0.340	0.797	1.011	1.066
Finland	0.198	0.614	0.848	1.073	1.052
Iceland	0.248	0.299	0.809	0.993	1.257
Norway	0.212	0.330	0.783	1.029	1.101
Average	*0.228*	*0.568*	*0.774*	*1.043*	*1.029*

Table 3: Probability to have STEM education.

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Source-country female relative share in engineering and manufacturing	-0.343***									
	(0.062)									
Source-country female relative share in engineering and manufacturing*female	0.364***	0.366***								
	(0.071)	(0.100)								
Source-country female relative share in science			-0.046*							
			(0.027)							
Source-country female relative share in science*female			0.048	0.047						
			(0.031)	(0.044)						
Source-country female relative share in tertiary education					-0.099***					
					(0.025)					
Source-country female relative share in tertiary education*female					0.197***	0.078*				
					(0.029)	(0.040)				
Source-country female relative years of expected schooling							0.145**			
							(0.064)			
Source-country female relative years of expected schooling*female							-0.075	-0.278***		
							(0.074)	(0.104)		
Source-country female relative labour force participation rate									0.197***	
									(0.026)	
Source-country female relative labour force participation rate*female									-0.182***	-0.198***
									(0.030)	(0.043)
Female	-0.574***	-0.574***	-0.518***	-0.517***	-0.697***	-0.575***	-0.416***	-0.203*	-0.350***	-0.337***
	(0.017)	(0.023)	(0.018)	(0.026)	(0.030)	(0.042)	(0.078)	(0.109)	(0.024)	(0.034)
Observations	42,158	42,158	42,158	42,158	37,712	37,712	37,832	37,832	41,996	41,996
R-squared	0.269	0.650	0.269	0.649	0.272	0.652	0.272	0.652	0.270	0.650
Sibling fixed effects	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes

Robust standard errors, clustered on sibling pair, in parentheses. ***p<0.01 **p<0.05 *p<0.1. The dependent variable is a dummy variable equal to one if the individual's high school or college education is in a STEM field, and zero otherwise. All regressions include dummy variables for birth year.

Table 4: Probability to have education within male dominated field.

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Source-country female relative share in engineering and manufacturing	-0.330***									
	(0.062)									
Source-country female relative share in engineering and manufacturing*female	0.375***	0.376***								
	(0.068)	(0.096)								
Source-country female relative share in science			-0.052*							
			(0.027)							
Source-country female relative share in science*female			0.041	0.041						
			(0.030)	(0.042)						
Source-country female relative share in tertiary education					-0.191***					
					(0.026)					
Source-country female relative share in tertiary education*female					0.275***	0.110***				
					(0.027)	(0.038)				
Source-country female relative years of expected schooling							0.094			
							(0.064)			
Source-country female relative years of expected schooling*female							-0.010	-0.247**		
							(0.070)	(0.098)		
Source-country female relative labour force participation rate									0.179***	
									(0.027)	
Source-country female relative labour force participation rate*female									-0.144***	-0.167***
									(0.029)	(0.041)
Female	-0.585***	-0.585***	-0.523***	-0.522***	-0.785***	-0.615***	-0.491***	-0.244**	-0.388***	-0.370***
	(0.016)	(0.023)	(0.017)	(0.025)	(0.029)	(0.040)	(0.073)	(0.103)	(0.023)	(0.032)
Observations	42,158	42,158	42,158	42,158	37,712	37,712	37,832	37,832	41,996	41,996
R-squared	0.293	0.661	0.292	0.660	0.294	0.662	0.296	0.662	0.293	0.661
Sibling fixed effects	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes

Robust standard errors, clustered on sibling pair, in parentheses. ***p<0.01 **p<0.05 *p<0.1. The dependent variable is a dummy variable equal to one if the individual's high school or college education is in a field with a share of males above 80 percent, and zero otherwise. All regressions include dummy variables for birth year.

Table 5: Probability to have education within female dominated field.

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Source-country female relative share in engineering and manufacturing	0.080***									
	(0.031)									
Source-country female relative share in engineering and manufacturing*female	-0.246***	-0.246***								
	(0.065)	(0.092)								
Source-country female relative share in science			0.013							
			(0.013)							
Source-country female relative share in science*female			-0.079***	-0.079**						
			(0.029)	(0.040)						
Source-country female relative share in tertiary education					0.069***					
					(0.014)					
Source-country female relative share in tertiary education*female					-0.082***	-0.022				
					(0.024)	(0.034)				
Source-country female relative years of expected schooling							0.074**			
							(0.032)			
Source-country female relative years of expected schooling*female							0.219***	0.332***		
							(0.063)	(0.090)		
Source-country female relative labour force participation rate									-0.011	
									(0.013)	
Source-country female relative labour force participation rate*female									0.233***	0.254***
									(0.027)	(0.038)
Female	0.319***	0.319***	0.307***	0.308***	0.353***	0.291***	0.040	-0.078	0.082***	0.066**
	(0.015)	(0.022)	(0.017)	(0.024)	(0.025)	(0.036)	(0.066)	(0.094)	(0.021)	(0.030)
Observations	42,158	42,158	42,158	42,158	37,712	37,712	37,832	37,832	41,996	41,996
R-squared	0.114	0.568	0.114	0.568	0.119	0.569	0.118	0.568	0.116	0.569
Sibling fixed effects	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes

Robust standard errors, clustered on sibling pair, in parentheses. ***p<0.01 **p<0.05 *p<0.1. The dependent variable is a dummy variable equal to one if the individual's high school or college education is in a field with a share of females above 80 percent, and zero otherwise. All regressions include dummy variables for birth year.

Table 6: Choice of college major. Sibling sample.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
VARIABLES	STEM				Male dominated				Female dominated			
SCFR in EMC	-0.016				-0.263*				0.102			
	(0.140)				(0.139)				(0.072)			
SCFR share in EMC*female	0.006	0.004			0.215	0.215			-0.067	-0.075		
	(0.161)	(0.228)			(0.158)	(0.224)			(0.133)	(0.188)		
SCFR share in science			-0.043				0.010				0.003	
			(0.056)				(0.056)				(0.026)	
SCFR share in science*female			0.049	0.051			-0.011	-0.009			-0.061	-0.061
			(0.066)	(0.093)			(0.062)	(0.089)			(0.055)	(0.077)
Female	-0.369***	-0.368***	-0.395***	-0.396***	-0.411***	-0.410***	-0.355***	-0.356***	0.164***	0.166***	0.184***	0.184***
	(0.038)	(0.054)	(0.039)	(0.055)	(0.037)	(0.053)	(0.037)	(0.052)	(0.031)	(0.044)	(0.032)	(0.045)
Observations	7,928	7,928	7,928	7,928	7,928	7,928	7,928	7,928	7,928	7,928	7,928	7,928
R-squared	0.148	0.629	0.148	0.629	0.160	0.622	0.160	0.622	0.049	0.565	0.049	0.565
Sibling fixed effects	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes

Robust standard errors, clustered on sibling pair, in parentheses. ***p<0.01 **p<0.05 *p<0.1. The dependent variable is a dummy variable equal to one if the individual has a college major within a STEM/male dominated/female dominated field and zero if a college major within another field. All regressions include dummy variables for birth year.

Table 7: Choice of college major. Full sample.

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	STEM		Male dominated		Female dominated	
SCFR in EMC	-0.349***		-0.333***		0.093***	
	(0.061)		(0.060)		(0.033)	
SCFR share in EMC*female	0.329***		0.331***		-0.119**	
	(0.074)		(0.069)		(0.061)	
SCFR share in science		0.044*		0.031		0.018
		(0.026)		(0.026)		(0.015)
SCFR share in science*female		-0.014		-0.019		-0.040
		(0.032)		(0.029)		(0.027)
Female	-0.446***	-0.362***	-0.430***	-0.343***	0.198***	0.193***
	(0.018)	(0.019)	(0.016)	(0.017)	(0.014)	(0.016)
Observations	42,110	42,110	42,110	42,110	42,110	42,110
R-squared	0.158	0.157	0.166	0.165	0.058	0.058
Sibling fixed effects	No	No	No	No	No	No

Robust standard errors in parentheses. ***p<0.01 **p<0.05 *p<0.1. Regressions include all second-generation immigrants born in Sweden in 1960–1977. The dependent variable is a dummy variable equal to one if the individual has a college major within a STEM/male dominated/female dominated field and zero if a college major within another field. All regressions include dummy variables for birth year.

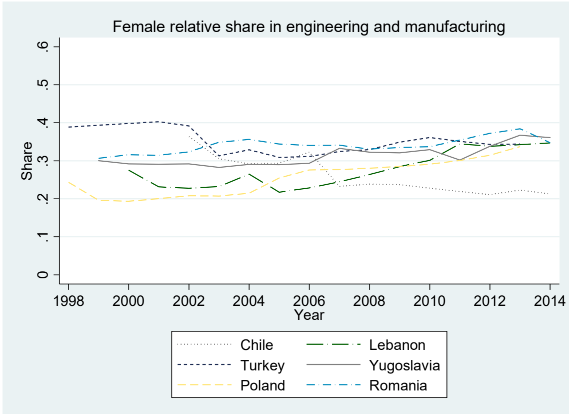
Appendix

Table A1: SUN educational orientation 2 digit level

	All fields		**STEM fields**	
1	Broad, general education	42	Biology and environmental sciences	
8	Reading and writing skills for adults	44	Physics, chemistry and earth sciences	
9	Personal development	46	Mathematics and other natural sciences	
14	Teaching methods and teacher education	48	Computing	
21	Art and media	52	Engineering and engineering industries	
22	Humanities	54	Materials and manufacturing	
31	Social and behavioural sciences			
32	Journalism and information		***Male dominated fields***	***Share males %***
34	Business, commerce and administration	38	Law and jurisprudence	70.8
38	Law and jurisprudence	44	Physics, chemistry and earth sciences	76.4
42	Biology and environmental sciences	46	Mathematics and other natural sciences	73.2
44	Physics, chemistry and earth sciences	52	Engineering and engineering industries	92.7
46	Mathematics and other natural sciences	58	Town planning and structural engineering	91.3
48	Computing	62	Agriculture, horticulture, forestry and fishery	87.9
52	Engineering and engineering industries	86	Security services	95.2
54	Materials and manufacturing			
58	Town planning and structural engineering		***Female dominated fields***	
62	Agriculture, horticulture, forestry and fishery	14	Teaching methods and teacher education	28.2
64	Animal health	72	Health care and nursing	13.3
72	Health care and nursing	76	Social work and social care	13.2
76	Social work and social care	81	Personal services	16.2
81	Personal services			
84	Transport services			
85	Environmental protection			
86	Security services			

Table A2: Correlations Source-country variables

	Source-country female relative share in EMC	Source-country female relative share in science	Source-country female relative share in tertiary education	Source-country female relative years of expected schooling
Source-country female relative share in science	-0.172***			
Source-country female relative share in tertiary education	-0.237***	-0.310***		
Source-country female relative years of expected schooling	-0.573***	-0.0583***	0.729***	
Source-country female relative labour force participation rate	-0.541***	-0.155***	0.504***	0.753***



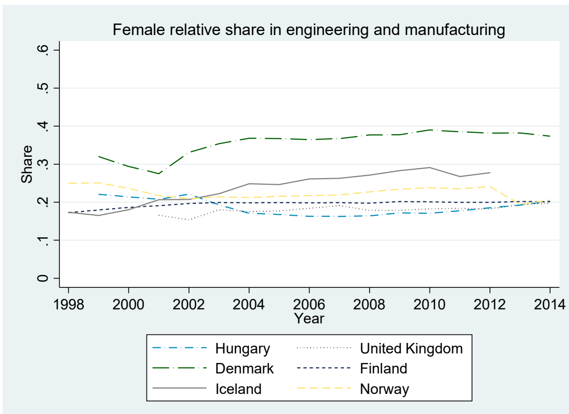


Figure A1: Female relative share in engineering, manufacturing, and construction by source country and year. Included are source countries with data for at least 12 years.

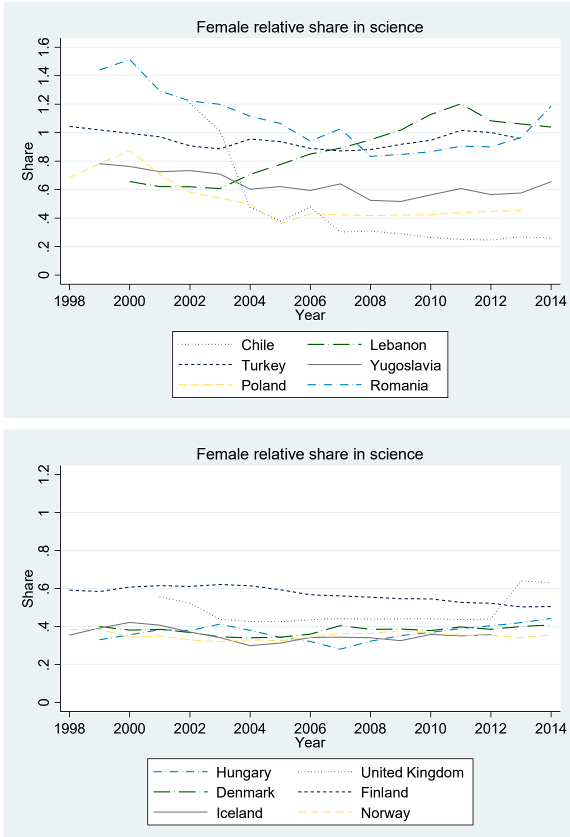


Figure A2: Female relative share in science by source country and year. Included are source countries with data for at least 12 years.