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Exploring the STEM Gender Ratio

A macroanalysis of Europe and MENA

by

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Abstract: The gender-equality paradox is the phenomenon of finding more developed, egalitarian countries generally experience higher gender equality while, for example, having a relatively low share of female graduates from STEM fields in tertiary education. The presence of the paradox in several developed egalitarian countries indicates that the female share of STEM graduates must be influenced by other than gender inequality. This study explores women's empowerment and economic opportunities relationship to the ratio of female STEM graduates in Europe and MENA. It also explores other contextual factors and their relationship to women choosing a STEM degree since the previous literature is more focused on the micro level and mainly having a mathematical achievement focus. This study builds a panel dataset of 39 countries in Europe and 11 countries in MENA. Through a stepwise developing pooled OLS regression, this study concludes that there is a weak positive relationship between women's empowerment and economic opportunities, measured by the WBL index, and the female share of STEM graduates. Furthermore, a small regional difference between Europe and MENA is shown. This thesis concludes that further investigation of the field is of importance since there is no clear explanation to why some countries have higher female shares of STEM graduates.

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1. Introduction

1.1 Research problem

"Achieve gender equality and empower all women and girls" (UN, 2021) is the fifth goal of the United Nations Agenda 2030 for sustainable development. UNESCO (n.d) predicts that greater inclusion of women would foster economic growth, which underlines the importance of increasing women's empowerment and reducing gender differences to achieve sustainable economic and social development for all in the future.

In social science research, there is a relatively newly discussed phenomenon called the gender-equality paradox, The phenomenon describes how gender segregation between occupations is more pronounced in more developed and egalitarian countries (Breda et al., 2020). This is often measured as the share of women who graduate from a STEM (science, technology, engineering, and mathematics) education. There is, for example, a higher share of women amongst STEM graduates in Algeria (58 % in 2018) than in Sweden (36 % in 2017) (World Bank, 2021) though the gender inequality index (GII) is 0.429 and 0.039, respectively. (0, complete equality, and 1, absolute inequality). Suggesting that the female share of STEM graduates must be driven by other factors than GII.

Sahay and Cihak (2018) show in a study at the International Monetary Fund (IMF) that women are underrepresented at all levels of the global financial system. Finn and Northern (in Yaluma & Tyner, 2018, p. 4) summarize the problem with this well:

> The United States wastes an enormous amount of its human capital by failing to cultivate the innate talents of many of its young people, particularly high-ability girls and boys from disadvantaged and minority backgrounds. That failure exacts a great cost from the nation's economy, widens painful gaps in income, frustrates efforts to spur upward mobility, contributes to civic decay and political division, and worsens the inequalities that plague so many elements of our society (Finn & Northern in Yaluma & Tyner, 2018, p. 4).

The importance of equality in STEM occupation will become even more important for equality in society since STEM occupations are rising and are predicted to be the future jobs as they drive innovation, inclusive growth, and sustainable development (Fayer, Lacey & Watson, 2017; UNESCO, n.d).

The problem in many promoting initiatives in the Nordic is that supporting, inspiring, and informing women in STEM fields does not deal with the underlying problem of the sex-segregated labor market, reducing women's incentives to choose this type of career. Thus, the focus is on fixing the women and not the problem, which Myers et al. (2019) call STEMinism. In other words, it asks women to identify the problem and fix it for themselves (Jansson & Sand, 2021). In most countries in the Middle East, patriarchy plays a major role in cultural norms, which affect women's access to education in the region. The male-centric and male-dominated cultural tradition ensures that women have a subordinate place in society, and policies that empower women are not normally a priority (Ostrosky, 2015).

A study by Stoet and Geary (2018) suggests that students are influenced by their perception of their relative academic strength, confidence, and interest in the subject, which affects their educational path and career choices. Where relative academic strength is defined as many women may succeed well in non-STEM subjects and STEM subjects. Still, since men typically perform better in STEM than in reading, women have a relative academic strength in reading. Hence, dealing with men's underperformance in reading might be as important in increasing women's representation in STEM careers as it is to encourage women's performance and attitudes toward STEM. Studying and understanding women's choice of a STEM degree versus a non-STEM degree lies in the importance of diversity to nurture innovation, thus including different female perspectives. An example showing that modern inventions are designed for men is the seatbelt. Still, in 2021 the female test dummy for vehicle safety test only represents the fifth percentile female (108 lb, 4 ft 11 in) while using the 50^{th} percentile male, which lays the basics, for example, seatbelts and airbags leading to women are about 13 to 20 percent more likely to be killed in similar motor accidents than men. Furthermore, these female test dummies are scaled-down versions of male dummies and do not consider sex differences in mass distribution, bone structure, density, and muscle (Frye, Ko & Kotnik, 2021; NHTSA, 2021; Linder & Svedberg, 2019). Thus, a more equal STEM workforce would possibly promote innovation more representable to the needs of society. It is necessary to look for the origin of the gender differences in education because educational choices are partly a phenomenon due to social construction and not something innate to the person.

1.2 Aim, contribution, and limitations

Gender equality is highly relevant in today's society and is reflected in United Nations Agenda 2030 for sustainable development. As the gender-equality paradox is a newly observed phenomenon, little research has been done exploring why countries with high gender inequality have a relatively high share of women in STEM education. This thesis will contribute by investing through pooled OLS regression models how women's empowerment and economic opportunities, as an alternative measure of gender equality, is related to differences in the STEM graduation's ratio, more broadly, inform about gender disparities and education segregation. Even though there have been analyses of the STEM gender gap, it is mainly in the US and differences between men and women in mathematical ability. To the best of the author's knowledge, this is the first study analyzing whether women's empowerment and economic opportunities affect the share of female STEM graduates between Europe and MENA on a macro-level. Hence, this study investigates the relationship between women's empowerment and economic opportunities and women in STEM and possibly explain the reasons for gender disparities among STEM graduates by answering the research questions presented below.

Research question 1

What is the relationship between women's empowerment and economic opportunity and the female share of STEM graduates in tertiary education in Europe and MENA between 2000-2019?

Research question 2

Are there any regional differences in the relationship between women's empowerment and economic opportunity and the female share of STEM graduates in tertiary education between Europe and MENA?

This paper focuses on 39 representative European countries and eleven representative MENA countries. In previous research on the gender-equality paradox, European countries generally have higher GII but a low share of female STEM graduates. In contrast, MENA countries tend to be found at the other end of the relation between the two, with a higher female STEM graduate's ratio. Hence these two regions expect to show how the included factors affect the share of females choosing a STEM degree to understand whether deep-rooted cultural behavior and norms affect the academic choice. This will be based on a pooled OLS model, including economic, educational, and societal factors.

1.3 Outline of the thesis

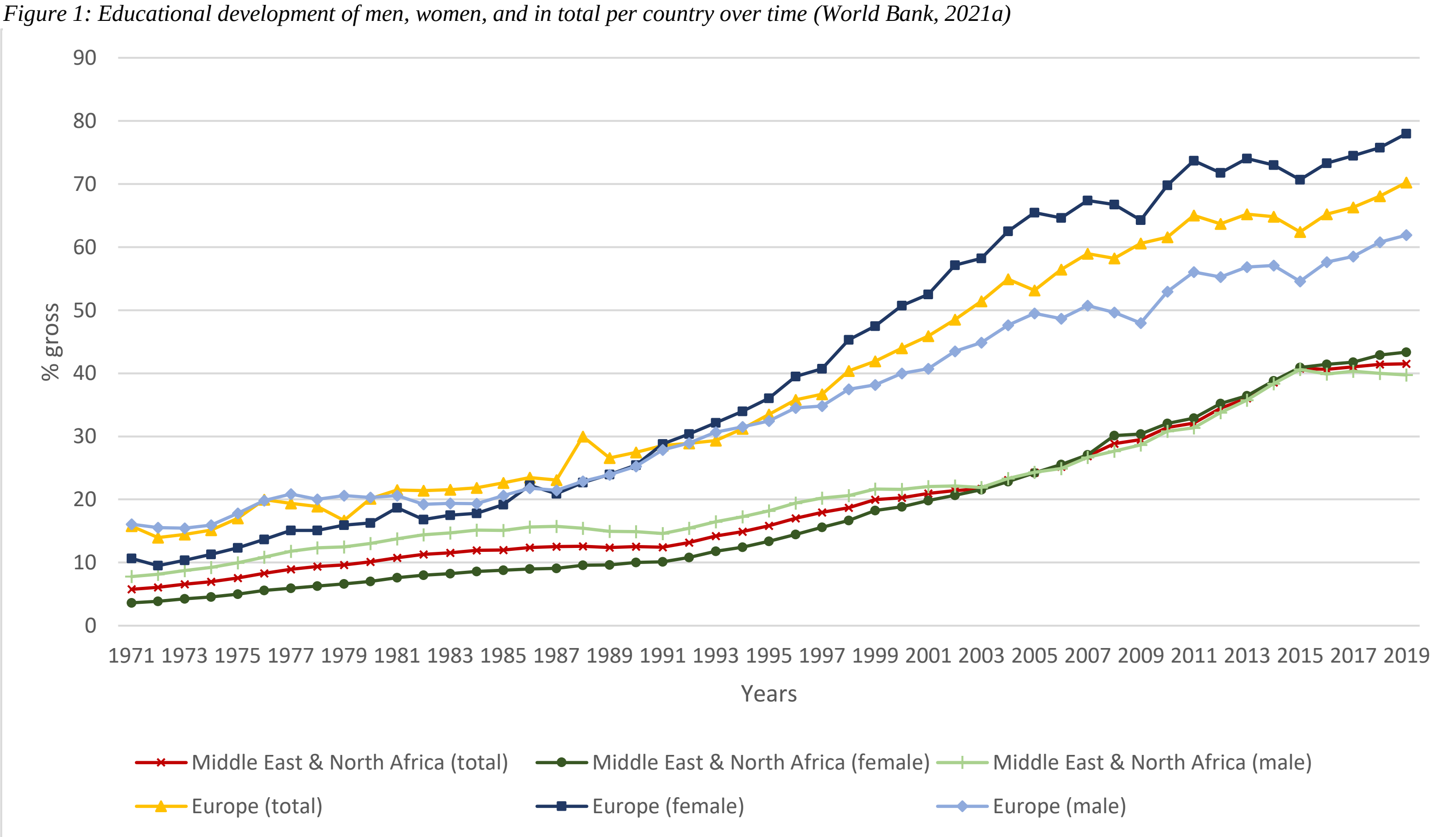
The following section presents background to women's education, female labor force participation rate, and the STEM context. The findings from previous literature and provides insight into the association between gender disparities and women in STEM are presented in section three followed by theoretical frameworks. The data and the theoretical motivation for each variable included in the analysis are covered also covered in section four. Section five consists of the methodology and data. Section six presents the results of the pooled OLS regressions, which are then discussed and concluded with suggestions for further research.

2. Background

2.1 Development of women's education

I It is familiar to most that women's education historically lags behind men's. However, this is more pronounced in some countries and is also often a result of social institutions, that is, societal roles and the social structure. In Europe, the average level of educational attainment is generally higher than in MENA, as can be seen in Figure 1 which shows the gross enrollment rates in total and separate men and women for Europe and MENA. Figure 1, further shows that women's enrollment in Europe and MENA has passed that of men. The total enrollment in Europe has historically been higher than in MENA; however, the total enrollment in Europe has increased more than in MENA. Most countries worldwide have achieved gender parity in completing primary and lower secondary education (Williams, 2011; Masanja, 2010). Many countries in the MENA region and Europe have a reverse gender gap in total enrollment in tertiary education, with a larger share of women in tertiary

Figure 1: Educational development of men, women, and in total per country over time (World Bank, 2021a)



education (World Bank, 2021; UNDP, 2020). In contrast, the female share of STEM graduates is generally high in MENA and low in Europe.

In most countries in the Middle East, patriarchy plays a major role in cultural norms, which affect women's access to education in the region. The male-centric and male-dominated cultural tradition ensures that women have a subordinate place in society, and policies that empower women are not normally prioritized (Ostrosky, 2015). In the mid to late 20th century, the female illiteracy rate in MENA was much higher than that of men and compared to women in other developing countries, mainly due to girls in MENA being less likely to have access to primary schooling than boys (El-Sanabiy, 1989). This is a consequence of the strong culture in MENA and social traditions that women marry out of their families, and parents expect their sons to support them in old age rather than their daughters (Ostrosky, 2015). Hence, parents invest in their sons' further education rather than their daughters since their daughter's income would support her new family or her husband's parents.

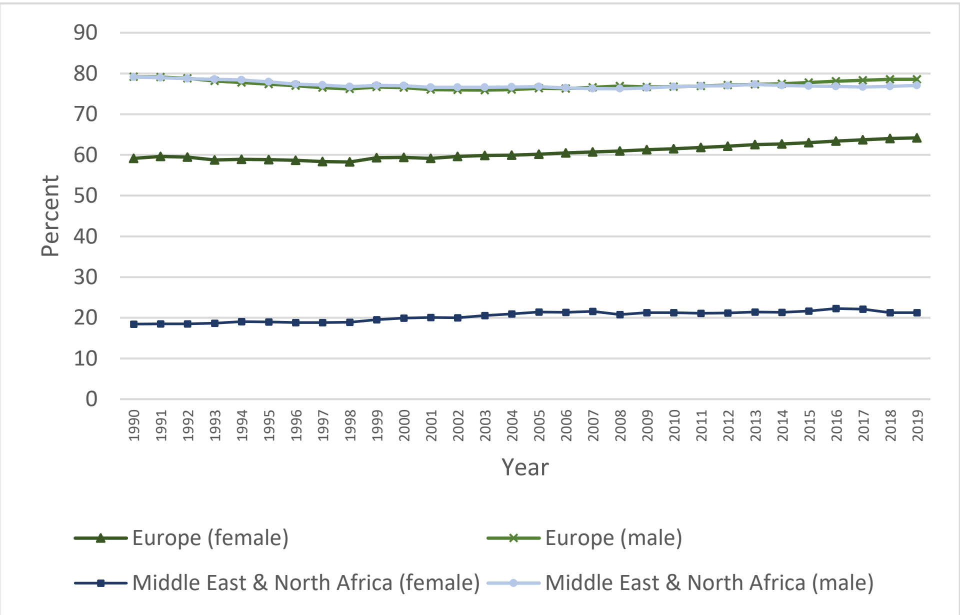
The education women in MENA receive does not always improve their knowledge and skills and to prepares them for work. The low quality is often because these women are not expected to enter the labor force, which will be discussed in the next section (Ostrosky, 2015). Culture often plays a major role in how cultural contexts affect politics in MENA; for example, gender politics are strongly influenced by cultural perceptions of women (Qarmout & D'Angelo, 2022). Some gender disparities in MENA are likely rooted in these cultures' high value of women's purity. The cultural institutions that favor men can themselves fade naturally with economic modernization, which makes it possible for gender gaps to close, but there is also room for decision-makers to speed up the process (Jayachandran, 2015)

This is also the case in Europe, where culture plays a central role in state and local identity-building processes in local, regional, and national contexts. In Europe, the European Union (EU) plays a crucial role in the cultural context due to the Union's lack of cultural legitimacy. Culture is one of the European integration's most complex and controversial areas (Patel, 2013). However, cultural influences do not seem to have persistent effects on women's empowerment and economic opportunities. It is also reflected in the higher share of women entering higher education at earlier decades in Europe suggesting that the cultural norms are more persistent in MENA. The EU has possibly promoted cultural integration between countries with different cultures, which has given rise to more willingness to change, despite some resistance (Patel, 2013).

2.3 Female labor force participation

A discussion of women's labor force participation is important because it concerns her future prospects and why women choose to enter higher education and might choose a certain path. The average female labor force participation (FLFP) rate has not dramatically changed in Europe or MENA, as shown in figure 2, showing the average FLFP rate in Europe and MENA between 1990 and 2019. This also means that the historically low participation of women in MENA remains low, with around only one-fifth of the female population between the ages of 15- 64 participating in the workforce. This is one of the main struggles in MENA, with a high share of women with high educational attainment but a low percentage actually entering the labor force. This is partly due to discriminatory employment practices, and partly because, although many companies in MENA are initially interested in employing women, these companies are cautious about hiring. They assume that society's restrictions on women would prevent them from succeeding in their jobs (Ostrosky, 2015).

Figure 2: Labor force participation rate (ages 15-64) for men and women over time (author's calculations) (World Bank, 2021a)



Furthermore, men in MENA generally have higher participation in the labor force than women due to families attaching more importance to the employment of their sons. This implies that it would be socially inappropriate for a woman to be employed instead of a man in a competitive labor market. This also creates problems in measuring the quality of women's education and opportunities; their education cannot be evaluated through the jobs they receive after graduation. This suggests that women's education is mainly a placeholder title that gives status to their families (Jayachandran, 2015). Therefore, women's degrees can become practically useless professionally due to the lack of jobs available to the overall population and men who traditionally fill these jobs before women. Hence, women's education becomes unnecessary in the eyes of families, societies, and governments due to its current lack of societal gain (Ostrosky, 2015).

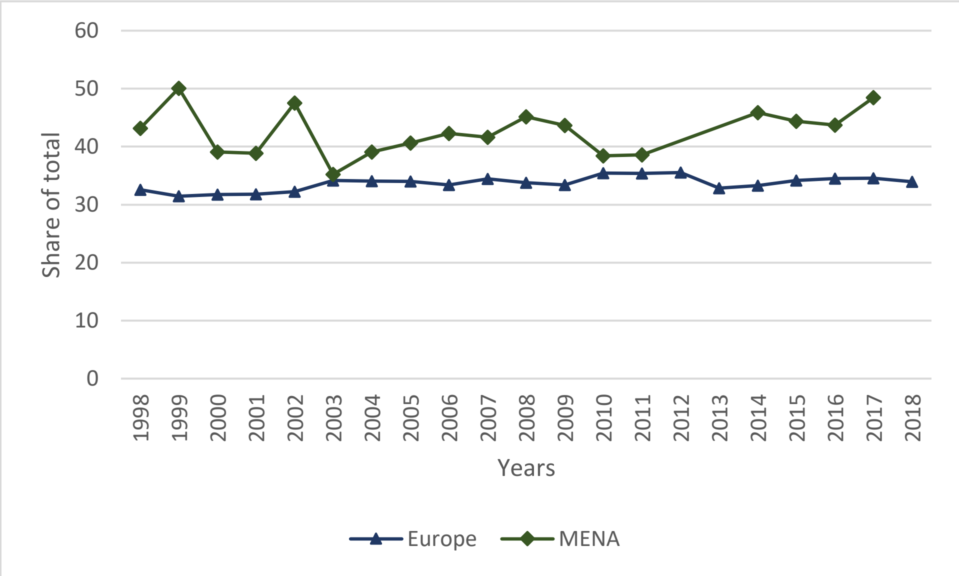
The culture of MENA countries is somewhat reflected in European history, where women's "God-given" destiny was thought to be child-rearing, marriage, and care work. The average working woman in Europe during the mid-20st century was a young woman without children (Vlasblom & Schippers, 2004). It can be assumed that rules for how to live have been written by men and disadvantaged women's choices in society. However, in modern Europe, there has been a shift from the male breadwinner to a dual-earner society, meaning that gender roles have changed in especially Western countries (De Hauw, Grow & Van Bavel, 2017). The female participation rate among married women has generally increased over the recent decades. A reason for this increase is changes in behavior and characteristics of women; women for example have higher education and postpone families, mothers nowadays tend to have fewer children, and some do not have children at all, due to better access to contraceptives and health care. However, such generalizations can give a wrong picture since this progress is somewhat more progressive in Western than Eastern Europe due to their socialistic background (Vlasblom & Schippers, 2004). Women's income potential has increasingly become an important decisive factor for family formation, hence the FLFP rate has increased. Still, both Eastern and Western Europe have made more progress towards women's empowerment than MENA (Sweeney, 2002).

2.4 The STEM context

The main contemporary issue in tertiary education is women's lower participation in STEM. STEM workers are crucial for the world's innovative capacity and competitiveness in the global market, since foreign investors seek highly skilled and inexpensive labor. Hence, gender disparities in education tend to lead to less competitiveness on the worldwide market (Beede, et al., 2011; Roudi-Fahimi & Moghadam, 2006). "The political, social and technological history of each country around the world is different, and so the resulting systems of education, and specifically technology education, are also different, and are aligned with that history" (Williams, 2011, p. 26). Figure 3 show that the share of female

STEM graduates in MENA have been higher than the of Europe, when looking at the regional perspective, stretching back to the first year of data availability of the variable.

Figure 3: Female share of STEM graduates per region over time (Author's calculation) (World Bank, 2021b)



Studies have shown that these gender differences in STEM are not a result of gender differences in biological factors or innate ability but rather the brain's ability to expand and create new connections and that pedagogical performance, including in STEM subjects, is influenced by experience (UNESCO, 2017). Hence, funding initiatives and studies on education have focused increasingly on STEM education over the past years, particularly on women. This is because STEM has been found to have a positive relationship with economic growth as globalization and the rapid development of ICT are changing society (Hooker, 2007). STEM is important for promoting diversity, otherwise, innovation adapted for men is created, as in the seatbelt example. The problem in MENA is that women, in general, choose STEM on other grounds than future work in STEM occupation and MENA's high level of women in STEM education does little good today. In Europe, women to a larger extent choose non-STEM fields in tertiary education but often work within this area later. Therefore, the differences are important to explore.

It should be noted that there are careers that are not STEM by definition, although they often require STEM knowledge. For example, university programs related to health care (such as nursing and medicine) have a majority of women. This may partly explain why fewer women than we estimate spend a university degree in STEM areas despite obvious STEM ability and interest (Stoet & Geary, 2018).

3. Previous literature

The issue of gender inequality in education in particular has attracted a great deal of attention from microeconomists. Women's participation in advanced education has significantly improved during the last decades, though several studies show that there are still gender inequalities in STEM education in many countries (Salvi Del Pero & Thévenon, 2015). A large portion of previous research has been done in an American context, where the emphasis has been put on gender gaps in mathematical achievements and how this is affected by stereotypes looking at the micro-level. Generally, American studies have shown female students' abilities in mathematics and science are equal to or better than their male classmates through standardized tests, showing no gender difference in test scores up through secondary school in the US (Lindberg et al., 2010). Furthermore, Fryer and Levitt (2010) found no gaps in math performance in Middle Eastern countries despite women's low status. Özel, Özel and Thompson (2013) have shown that there is a strong relationship in Turkey between eighth-graders socioeconomic background and their math performance. Xie, Fang, and Shauman (2015) discuss that gender gaps in STEM education persist even though gaps in test scores diminish hence, other factors must be the explanation for different STEM ratios.

Hango (2013) suggests that the gender disparity in STEM education is due to other factors than ability. Even men with low mathematical ability are more likely to enter a STEM education than women with high mathematical ability. In several countries in the MENA region with fairly low gender equality, there is no gender disparity in STEM education, and the only male-dominated subject is engineering (Islam, 2019). Gender differences in STEM fields are still common in Western societies, and a major contributing factor to these differences is gender differences in career-related preferences. El-Hout, Garr-Schultz, and Cheryan (2021) explored factors explaining this. They argue that the cultural aspect of masculine standards is overlooked. Cooray and Potrafke (2011) similarly studied the political, cultural, and religious influence on gender inequality in education. They found that neither autocratic regimes nor democracies discriminate by gender when providing educational opportunities. Culture and religion showed to influence gender inequality in education, and discrimination against girls was more pronounced in Muslim dominated countries.

Niederle and Vesterlund (2010) imply that gender inequalities in STEM education can be caused by differences in competitive attitudes, potentially due to early stereotypes. The stereotype is that main STEM fields, led by parents and teachers, estimate boys' mathematical ability over girls', generating a stereotypical threat (see Xie, Fang, & Shauman, 2015 or Lindberg et al., 2010).

Stoet and Geary (2018) on the other hand suggest that a reason for the occurrence of the gender-equality paradox could be due to intra-individual differences in academic competence. The attendant influences one's expectations of the value of pursuing one type of career versus another. In more egalitarian countries liberal mores, combined with the smaller economic costs of refraining from a STEM path, reinforce the influence of intra-individual academic forces. Resulting in the differentiation of girls' and boys' academic focus during upper secondary education and later in college, increasing the gender differences in science as an academic strength and graduation with STEM degrees. Whereas in less-equal countries, a well-paid STEM career can seem like an investment in a more secure future, leading to gender differences being weakened or neglected in less-equal countries.

Many previous models analyzing the gender inequality in STEM use mathematics test scores as the dependent variable to see whether there is a gender gap in achievement which also is the foundation for the gender-equality paradox (see Breda et al., 2020; Stoet & Geary, 2018; Nollenberger, Rodríguez-Planas, & Sevilla, 2016). This study, however, will focus on women's empowerment and economic opportunities and how it affects women's choice of pursuing a STEM degree, which is more linked to qualitative studies on the subject (for example, Xie, Fang & Shauman, 2015). They state that sociocultural perspectives provide more nuanced explanations for the gender gap. Theories of expected value emphasize, for example, the influence of the cultural environment, the interactive nature of interest formation and perseverance and the cumulative influence of these processes on both individual results and opportunity structures in STEM education.

4. Theoretical framework

The theoretical framework for this article stems from the discussion on inequality in education and women in STEM introduced in the previous section and can be connected to three main theories:

1. One dimension of the theoretical framework for this article is the sex stereotypical image that several previous studies linked to women choosing non-STEM education in countries with higher equality.

2. The liberal feminism theory elaborates on this theory laying a foundation for the connection between women's opportunities and their choices.

3. The expectancy-value theory is presented, commonly used to explain an individual's academic choices, and the gender-equality paradox as these two are closely connected to the methodology of this study.

4.1 Liberal feminism theory

Liberal feminism theory, on the other hand is based or rooted in the ideals of equality and freedom, which is important for gender relations (Azuh et al, 2017). The main goal of liberal feminism is to ensure equal opportunities for the sexes, and liberal feminists in education intend to remove obstacles that prevent girls from reaching their full potential. The conceptual basis consists of three main themes: 1) equal opportunities; 2) socialization and sex stereotypes; 3) gender discrimination (Acker, 1987). Feminist theories guide understanding gender inequality and as guides to action. Liberal feminism suggests that gender inequality has its origins in historical traditions that have created barriers to women's advancement. Furthermore, liberal feminism emphasizes issues such as individual rights and equal opportunities as a basis for social justice and reform. In addition, this framework presupposes that the socialization of women in gender roles contributes to the inequality that women experience in society (Wienclaw, 2011). Individuals are considered socialized, by the family, school, and media, to traditional attitudes and orientations that limit their future unnecessarily to sex stereotypical professional and family roles (Acker, 1981). The sex-role socialization framework ignores factors that should be analyzed within the framework of sex-role socialization (Arnot, 1981; Connell, 1985; Middleton, 1984): the notions of discrimination, justice, rights, and fairness. Gender reform feminisms, such as liberal feminism laid the theoretical foundation for second-wave feminism. Their policies are practical and a good way to address gender inequalities.

4.2 Sex-stereotypical Image

A sex-stereotypical image of science has persisted for many decades, and it was first identified by Mead and Mattraux (1957), though it reasonably existed long before then. Sex-stereotypical images have been a limiting factor in women's career prospects and are mainly due to socially created barriers and low expectations of success (Hackett & Bentz, 1981). Aronsson and Steele (1995) identified the so-called 'stereotype threat,' that is, the fear of confirming a negative stereotype of one's group; for example, in this case, women are not as good as men in STEM subjects. These tendencies are shown by Ambady et al. (2001) and Farenga and Joyce (1999) to exist already in the age of 9-13. Children are affected by positive and negative stereotypes, which affect their performance. Further, there was a strong relationship around the stereotypical perception amongst the observed children regarding that technology subjects are more suitable for boys to study than girls. This result resembled in the enrolled masters and doctoral students in this field.

4.3 Expectancy-value theory

The theoretical baseline of educational demand is based on the concept that education creates costs and benefits for the individual and that their relationship determines the individual's behavioral response (Stafford, Lundstedt & Lynn, 1984). This has been developed into different theories regarding a broader picture of what influences and determines the costs, benefits, and individual response. Eccles (1983) proposed an expectancy-value model for performance and choice. The theory was initially studied in the mathematics achievement field and was then taken to explain the individual's choice of academic path. The expectancy-value model suggests that expectations of success and task value are shaped by different factors. These include student's characteristics (abilities, past experiences, goals, self-perceptions, beliefs, expectations, interpretations) and environmental impact (cultural environment, norms, socialists' beliefs, and behaviors) (Eccles & Wigfield, 2002; Wigfield & Eccles, 2001). The framework implies that students will invest more in an academic domain when they expect to succeed and value achievements. The environmental impact can be brought to a macro perspective by analyzing norms of marriage and childbearing in society and women's labor force participation.

4.4 Analytical framework

The analytical framework is based on Wigfield and Eccles (2001), Wang and Degol, (2013), and Breda et al.'s (2020) study of the gender equality paradox and factors affecting the academical choice. This section discusses the theoretical connection to the main variables in this study: the female shares of STEM graduates and women's empowerment and economic opportunities. Furthermore, three main categories can be outlined to affect an individual's academic choice and the female share of STEM graduates: economic, educational, and societal factors.

In this study, gender inequalities in STEM education are measured by the share of female STEM graduates of the total STEM graduates in tertiary education. This is to investigate mainly what affects women's choice of having a degree in a STEM field since this lies the foundation of who is eligible to work in the STEM occupation and thus increase women's representation in this sector. This can be wishful because some of the most well-paying jobs exist in this sector. UNECSO (2017) argues that it is a human right to give girls equal access to STEM education as it enables them to pursue the career they choose and not be hindered by cultural norms and beliefs.

As the liberal feminism theory suggests a major concern in education is socialization, gender roles and sex stereotypes. This indicates that having achieved equal opportunities and more gender equality, a woman can choose to not face sex stereotypes in education by choosing a non-STEM subject without losing her social status or respect from society and family. Hence, a women's empowerment and economic opportunities should negatively affect the female share of STEM graduates. However, this study can only say whether more opportunities are associated with a lower share of female STEM graduates and not whether this is due to gender stereotypes, interests, or another origin.

4.4.1 Economic factors

The economic factors aim to represent the overall development of a country, how much resources are put to prepare students for further education and whether the education is only for the wealthier share of the population. GDP per capita is a generally accepted measure of a country's wealth and living standards. It has been used in previous studies on gender inequality in education (see for example Dollar & Gatti, 1999). It will be used in this study as an approximate of how developed a country is, adopted from Breda et al. (2020). Their study GDP per capita showed a negative correlation with female STEM graduates. The conclusion was that segregation across fields will not decrease by itself when countries become more egalitarian and developed.

The second factor measuring the economic context is government expenditures in secondary education. Investing in secondary education is an important factor in women's choice of choosing STEM subjects in tertiary education. Having the resources to increase confidence in one's, particularly women's, own ability and self-efficacy in STEM subjects has shown to be a key role in who is STEM-ready at the end of upper secondary education (McNally, 2020; Ejiwale, 2013). Hence, higher expenditures in secondary education are expected to have a positive relationship with women choosing a degree within the STEM field. The last measure is the income share held by the highest 10 percent to capture whether there are the riches of the population that can afford education. Since boys are generally prioritized in MENA to attain education, this variable aims to capture the income inequalities that can cause fewer women to attain education and those who choose educations with higher prestige, such as STEM (El-Sanabiy, 1989). Rizk and Hawash (2020) show that these tendencies exist in some countries in MENA, that there are education inequalities between rich and poor, which has also been observed in Europe (Breen, Luijkx, Müller & Pollak, 2010).

4.4.2 Educational factors

The educational factors aim to capture the overall education's relation to the female share of STEM graduates. The first factor is the human capital which is measured by the average years of schooling among the population aged 25 and older. Although average school years are not the best proxy for human capital, it does not give an insight into the quality of the school; but the availability of data makes it advantageous to use. This factor is used to capture the impact of the earlier generation's education on education segregation. It is expected to have a negative impact because if earlier generation have a higher educational attainment, it is likely that there are more unpronounced male domains rooted in earlier generations and is more difficult to change and have a higher impact on the decision of todays (female) students.

Second, the enrollment in tertiary education aims to measure the total enrollment in tertiary school. This variable is used to detect if the general population does not choose higher education. Because low tertiary education enrollment a high female share of STEM graduates is less surprising since it could be a sign that there is only a smaller part of the population that is enrolled in tertiary education and hence there is only equality in a very small part of the population whereas it is large disparities in other parts of the population. Hence, a positive relationship indicates that the gender inequality applies relatively equal over the population, whereas a negative relationship suggests that there is gender equality in STEM education only for a smaller share of the population.

4.4.3 Societal factors

The societal factors aim to capture social and cultural norms around women affecting the educational choice these are measured by FLFP rate, marriage rate and fertility rate. Firstly, FLFP aims to capture the effect a woman's future have on her educational choice. As discussed earlier, an individual who expects to work after graduation might consider more womanly dominated fields to avoid discrimination throughout her working life, whereas if she does not expect to work after graduation, she is more likely to choose a more male dominated subject for higher social status. This variable accounts for cultural changes in a women's choice/obligation to be a homemaker. A better measure would have been the mean age at first child since marriage rates are lower, especially in Europe (Lesthaeghe, 2014), however, data on this was poor in MENA between 2000 and 2019, hence marriage rate assumes to be the best measure in this case.

Fertility rate is used to reflect how many children the general mother has and aims to represent the cultural norm of having children young and the use of contraceptives, since this is often reflected as a lower fertility rate (Lesthaeghe, 2014). A lower fertility rate indicates that the female population in general uses some kind of contraceptive and has seen to have a negative relationship with education, that when women delay having children (and have fewer children) they can attain a higher education which is key to empowering women as individuals, however, these benefits can only be reaped if women receive at least a basic education (Roudi-Fahimi & Moghadam, 2006). Hence, the fertility rate is expected to have a negative relationship with the female STEM share due to that higher educated women tend to have fewer children. The last societal factor concerns religion which has been shown to influence gender inequality in education (Cooray & Potrafke, 2011) and is closely linked to the cultural norms in a country since religion is often rooted far back in history.

5. Methodology and Data

The methodology for this study is guided by the theoretical framework and the previous research objectives presented in the previous sections. The purpose of this study is to measure the effects of the relationship between women's empowerment and economic opportunities and the share of women among STEM graduates between 2000 and 2019 utilizing OLS regressions. Pre-collected data is compiled to a panel dataset, which makes it possible for studies over a set of countries over time to examine the variation within an entity instead of the variation between, which makes it possible to control for properties that are unobserved but are fixed omitted variables (Wooldridge, 2010). In addition, the design of panel data makes it possible to reduce the unwanted sample bias by using a quasi-experimental design with fixed effects (Angrist & Pischke, 2009).

Since few similar studies have been done in a macro perspective, the regression model will be developed with a stepwise strategy with multivariate models. A pooled OLS model figures as the baseline in this study, building up to the final model by adding the economic, educational, and societal factors in three steps. The final model including all factors which will include with country-specific fixed effects to control for time-invariant unobserved country-individual heterogeneity. As pooled OLS models provide the most understandable and natural benchmarks against which to assess fixed-effect models. This enables us to get closer to seeing a causal effect between the explanatory and the explained variable because the country fixed effects solve the omitted variable bias of time-invariant variables (Allison, 2009). Furthermore, the Chow test, LM test and Hausman test suggest that the pooled OLS with fixed effects is the most appropriate model for this analysis.

Previous studies suggested that broader contextual factors play a crucial part in the choice of academic path. These studies included factors such as life satisfaction and family background as explanatory factors. Based on the theoretical framework, the categories that affect the share of female STEM graduates have been outlined: economic, educational, and societal. These three categories are shaped by the expectancy-value theory and the gender equality paradox. Since there are few quantitative studies analyzing the relationship in a macro perspective, this study explores factors used in other gender inequality contexts and micro studies of educational achievements and have tried to find macro factors reflecting variables that have shown important in other studies It would have been wishful to include a measure of the relative academic strength between boys and girls, such as Programme for International Student Assessment (PISA) as suggested by Stoet and Geary (2018) however since studying MENA between 2000 and 2019 the selected countries did not participate at a regular basis. It was not found to be an appropriate factor to include. The difficulties of doing a panel analysis in this field is that several variables concerning gender inequality are not regularly collected for all countries, as for the example with PISA.

The selection of regions is due to their vast differences in female STEM graduates and gender inequality, as well as their different historical cultures that can influence the choice of degree. As the theory and previous research points out, in more egalitarian countries, stereotypes, biological and psychological factors are likely to have a greater influence on the choice of degree due to the more liberal mores of these cultures. The studied countries are selected based on the available data mainly tailored by the dependent variable female STEM graduates. The European sample further excludes de facto independent countries and other dependencies, but it does include countries such as Turkey, which also is part of other regions. The countries in the MENA sample are based on the World Bank's definition of the region for a list of all countries see appendix 1. The studied period has necessary been tailored by data availability on the share of female STEM graduates which has narrowed the country sample. Due to a lack of data on the share of female STEM graduate's variable before 2000 in many covered countries, the period is limited to 2000-2019. However, since data is missing on some years in some variables. To solve this problem, the period has been divided into four periods with the average value over five years in each period for all variables.

5.1 Model

The model used in this study to evaluate how women's empowerment and economic opportunities relate to the share of female STEM graduates is established upon previous models. Since there have mainly been done micro-level and qualitative studies the model has been adopting factors affecting gender disparities in other areas such as educational attainment and achievement, mainly in primary and secondary education (Nollenberger, Rodríguez-Planas, & Sevilla, 2016), and also factors shown to affect the choice of field in higher education (Wigfield & Eccles, 2000; Wang & Degol, 2013). Some variables are not adaptable to a macro-perspective since they are only applicable at micro-level such as parents' education. The base model used in this study is a pooled OLS to distinguish a general relationship between the dependent and independent variables and can be written as:

(1) $FSTEM_{it} = \alpha + \beta_1 WBL_{it} + \beta_2 lnGDP_{it} + \beta_3 SECONDEXP_{it} + \beta_4 TOPINC_{it} + \beta_5 TERT_{it} + \beta_6 HC_{it} + \beta_7 FLFP_{it} + \beta_8 MARRIAGE_{it} + \beta_9 FRATE_{it} + \beta_{10} MUSLIM_i + \beta_{11} UNAFFILIATED_i + \eta_i + \theta_t + \varepsilon_{it}$

Where FSTEM is the average share of female graduates in STEM fields in each period, WBL is the average WBL index score in each period, lnGDP is the logged average GDP per capita in each period, SECONEXP is the average government expenditures on secondary education in each period, TOPINC refers to the average income share held by the 10th wealthiest quantile of the population each period, TERT is the average total enrollment in tertiary education each period, HC is the average years of schooling among the population over 25 in each period, FLFP refers to the average female labor force participation rate each period, MARRIAGE is the average age at which women marry for the first time, and FRATE is the average fertility rate in each period. MUSLIM and UNAFFILIATED are two dummy variables where 1 represents a majority of the population as Muslim or unaffiliated. i denotes the country, and t denotes the year. η and θ denote the time-invariant and time-variant components, respectively, and ε denoting the regression error term. Model (1) represents the regressions 1 to 5 in the result section.

Model (2) below represents the sixth regression in the result section. This model includes an interacting variable to analyze potential regional differences in the relationship between MENA and Europe and can be specified as follows:

(2) $FSTEM_t = \alpha + \beta_1 X_i + \beta_2 WBL_{j,t} X_i + \beta_3 WBL_{it} + \beta_4 lnGDP_{it} + \beta_5 SECONDEXP_{it} + \beta_6 TOPINC_{it} + \beta_7 TERT_{it} + \beta_8 HC_{it} + \beta_9 FLFP_{it} + \beta_{10} MARRIAGE_{it} + \beta_{11} FRATE_{it} + \beta_{12} MUSLIM_i + \beta_{13} UNAFFILIATED_i + \eta_i + \theta_t + \varepsilon_{it}$

In this model *X* denotes the regional dummy, where 0 in Europe and 1 in MENA. Finally, fixed effects are included, and as discussed, the fixed-effects method eliminates the variance of country fixed effects, but time fixed effects remain. A Wald test was run on whether to include year fixed effects, but the null hypothesis could not be rejected, indicating that such control should not be included in the final fixed effects specification model; thus, η is excluded but θ remains. Furthermore, the dummy variables representing religion (*MUSLIM* and UNAFFILIATED) are excluded since they are time-invariant and the fixed effects model control for such. Model 3 represents regression 7 in the result section and can be written as:

$$(3)\ FSTEM_t = \alpha + \beta_1 WBL_i + \beta_2 WBL_{j,t}X_i + \beta_3 lnGDP_{i,t} + \beta_4 SECONDEXP_{i,t} + \beta_5 TOPINC_{i,t} + \beta_6 TERT_{i,t} + \beta_7 HC_{i,t} + \beta_8 FLFP_{i,t} + \beta_9 MARRIAGE_{i,t} + \beta_{10} FRATE_{i,t} + \theta_t + \varepsilon_{it}$$

In this model the effect of the *WBL* variable for MENA would then be given by the sum of $\beta_1 + \beta_2$, and the effect of the baseline region Europe would be given as β_1 only.

5.2 Data

To investigate in the relationship between the share of STEM female graduates and women's rights, we have assembled a macro dataset with information on STEM ratio, women's rights, GDP per capita, government expenditures in secondary education, income inequality, tertiary enrollment, human capital, FLFP, age of first marriage, fertility rate, and religion, for a large set of countries over time. The final dataset consists of 39 countries in Europe and 11 countries in MENA between 2000-2019. This is an unbalanced panel as the country-level data is not available in every year. Hence, to achieve more a balance panel five-year average of all variables has been calculated per country in all four periods. The initial sample included all European countries except de facto independent countries and other dependencies, and all countries in MENA[1] were included. However, as said, the data availability of the female share of STEM graduates from tertiary education is limited which narrowed the country sample size from 49 in Europe and 20 in MENA to 39 and 11 respectively, a list of all included and excluded countries can be found in appendix 1.

5.2.1 Descriptive statistics

Tables 1 and 2 below present the summary statistics of all variables included in this study. They are separated by region to get a greater picture of the sample of each region. The mean female share of STEM graduates in Europe (table 1) is 33.5 percent and in MENA (table 2) 42 percent for the entire period. That is Europe has on average had an 8.5 percentage point lower share of female STEM graduates. Table 1 further shows that the female shares of STEM graduates in Europe range between 15.7 percent and 49.1 percent with a standard deviation of 6.5 percentage points. In MENA (table 2) the female shares of STEM graduates range from 24.7 percent and 55.7 percent with a standard deviation of 8.6 percentage points. Looking at the variable of interest, the WBL index, the average value over the studied period is 86.0 in Europe and 39.2 in MENA, where the max value 100 indicates full score. The index score range between 55.8 and 100 in Europe with a standard deviation of 10.4 and between 23.8 and 73.6 with a standard deviation of 14.2 in MENA. These standard deviations show that the share of female STEM graduates and WBL index scores in countries in each region vary, but in general MENA have a higher share of female share of STEM graduates and Europe have higher score on the WBL index indication more female empowerment and economic opportunities.

Table 1: Descriptive Statistics over Europe, for summary of data sources see Appendix A2

Variable	Obs	Mean	Std. Dev.	Min	Max
Female share of STEM graduates ratio	138	.335	.065	.157	.491
WBL index	156	86.002	10.407	53.75	100
GDP per capita (log)	156	10.088	.695	8.176	11.645
Expenditures in secondary education (%)	125	.02	.005	.007	.035
Income share held by highest 10 % (%)	148	.249	.026	.182	.323
Enrollment in tertiary education (%)	146	.609	.198	.105	1.399
Human capital (years)	156	11.166	1.447	5.72	14.12
FLFP (%)	156	.635	.103	.259	.853
Age of first marriage (years)	127	28.142	3.044	21.9	33.55
Fertility rate	156	1.58	.248	1.136	2.403
Muslims	156	.077	.267	0	1
Unaffiliated	156	.051	.221	0	1

Table 2: Descriptive Statistics over MENA, for summary of data sources see Appendix A2

Variable	Obs	Mean	Std. Dev.	Min	Max
Female share of STEM graduates ratio	34	.42	.086	.247	.557
WBL index	44	39.165	14.228	23.75	73.625
GDP per capita (log)	44	10.028	.986	8.309	11.821
Expenditures in secondary education (%)	24	.019	.009	.004	.047
Income share held by highest 10 % (%)	16	.286	.036	.214	.331
Enrollment in tertiary education (%)	37	.316	.146	.106	.674
Human capital (years)	43	8.082	1.815	3.6	11.56
FLFP (%)	44	.284	.125	.131	.588
Age of first marriage	27	26.02	1.831	23.1	29.5
Fertility rate	44	2.502	.587	1.456	4.02
Muslims	44	1	0	1	1
Unaffiliated	44	0	0	0	0

5.2.2 Share of female STEM graduates

Our dependent variable, the share of female STEM graduates in tertiary education is measured as the share of women among all graduates from tertiary education a certain year. Data is collected from World Bank gender statistics (2021b). This source was chosen due to greater availability than other sources and because it is a commonly used an international financial institution which increases its reliability.

5.2.3 Women, Business, and the Law

The main variable of interest in this study is the Women, Business, and the Law (WBL) index obtained from the World Bank (2022), which is used to measure women's empowerment and economic opportunities. The variable is selected to represent how women's choice of pursuing a STEM degree is affected by the number of alternative career paths present, something which typically has its root in cultural views and norms. WBL is a World Bank Group project aiming to collect data regarding laws and regulations influencing women's economic opportunity. The group has compiled an index based on eight indicators: mobility, workplace, pay, marriage, parenthood, entrepreneurship, assets, and pension. The WBL index is compiled based on 35 yes or no questions divided over eight topics representing different stages of a woman's career. The answers are normalized per topic on 0 to 100, where 100 represents the highest possible score, equaling more rights for women. Finally averaging all topics result in the WBL index score. An example of a question is: “Can a woman get a job in the same way as a man?”. For example, two yes and two no on a topic gives the score of 50 on that indicator.

5.2.4 Economic factors

Gross Domestic Product (GDP) per capita is used as a measurement of the development level. Data on GDP per capita was collected from World Bank (2021a), many other sources exist for GDP measures, however since the World Bank provides data on several other variables used in the model specifications, other sources were ruled out. The GDP per capita used in current international dollar, converted by Purchase Power Parity (PPP) to ensure stability to compare between countries. Per capita is generally a more suitable measure to compare living standards and welfare across countries. To account for nonlinearity the logarithm of GDP per capita is used in this study.

Government expenditures in secondary education is obtained from UNESCO Institute for Statistics (UIS) (2021) and is measured as a share of GDP. Government expenditures in secondary education are collected through country governments responding to UIS's annual survey. A higher proportion of GDP spent on education indicates a higher government priority for education, but also a higher capacity of the government to increase revenue for public spending, relative to the size of the country's economy. However, when interpreting this indicator, it should be remembered that in some countries the private sector or households can finance a higher proportion of the total funding for education, which means that government expenditure seems lower than in other countries. In some observations, the data on total public expenditure on education refer only to the Ministry of Education of the country, though other ministries that can also spend part of their budget on education activities.

Data for income share held by highest 10 percent is obtained from the World Bank (2021a) and is measured as the percentage share of income or consumption is the share that accrues to the 10th wealthiest quintile. Income distribution measures are important background indicators for shared wealth, however measuring income and consumption is challenging due to timeliness, frequency, quality, and comparability of household surveys is poor in many countries. Information on income or consumption distribution are assembled from nationally representative household surveys.

5.2.5 Educational factors

The enrollment in tertiary education is obtained from the World Banks (2021a) and is measured as the gross enrollment ratio. This is the total enrollment in tertiary education regardless of age as a share of the population of the age group that officially corresponds to this level of education. Tertiary education normally requires the successful completion of education at the secondary level as a minimum condition of admission. The enrollment indicator is based on annual school surveys. This measure has some limitations as it does not reflect dropouts or overage, or underage enrollment. However, by using a one source for population data, estimates, definitions, and interpolation methods are standardized. This ensures a consistent methodology across countries, minimizing potential enumeration problems in national censuses. Human capital is measured by the average years of schooling among the population aged 25 and older. The data on average years of schooling is obtained from UNDP's Human Development Reports.

5.2.6 Societal factors

Data for the FLFP rate is obtained from the World Banks Gender Statistics (2021b) and is measured as the share of the female population between the ages of 15 and 64 who supply labor to produce goods and services during a specific period. Including women who are employed and women who are unemployed but actively seeking work. The limitations of this variable are that it does not include unpaid workers and family workers. Access to well-paid occupations for women is still unequal in many occupations and countries worldwide. Thus, including labor force statistics by gender are important for monitoring gender differences. The data is harmonized to improve comparability between countries and over time. It considers differences in data source, coverage, methodology and other country-specific factors. The estimates are mainly based on nationally representative labor force surveys; other sources are used only when no survey data was available.

Age of First Marriage accounts for cultural changes in a women's choice/obligation to be a homemaker. The variable is measured as the mean age of females, aged 15-54 at the survey date when they entered their first marriage and are obtained from The World Banks Gender Statistics (2021b). A better measure would have been the mean age at first child since contemporary marriage rates are lower, however, data on this was poor in MENA between 2000 and 2019, hence it was included in the overall model but excluded in the regional comparison due to reducing the number of observations in MENA remarkably.

Fertility rate is measured as the average number of children a woman would have if she lived to the end of her fertility years and gives birth according to age-specific fertility rates for the year. It is obtained from World Bank (2021a). The total fertility rates are mainly based on data of registered births from vital registration systems. For countries without registration systems, fertility rates are generally based on extrapolations from trends observed in censuses or surveys from earlier years. The estimated rates are generally considered reliable measures of fertility in the recent past.

Religion is measured by using two dummy variables, the first (Muslims) takes the value 1 when the population in a country is Muslim dominated and 0 otherwise. The second dummy variable takes the value 1 if the majority of the population is unaffiliated: agnostics, atheists, and people who do not identify with any particular religion in the surveys and otherwise 0. A 0 on both these dummies means a Christian dominated population. Other religions are not covered since none of the countries in the sample had other dominating religions than these.

The data is obtained from Pew Research Center (2015) since this source had the most available cross-sectional data. To ensure reliability on the source, the data was compared to other sources such as United Nations and Association of Religion Data Archives. However, this source was used since Pew Research Center provided easily accessible data with percentage shares of the populations and included all countries of interest. Dummy variables are used based on the assumption that religiosity rarely changes in a major way in a short time, and any indication of when this does happen is more likely to be related to changes at the state or governmental level (for example the Iranian Revolution).

5.3 Robustness check

Using panel data often implicates serial correlation. Serial autocorrelation means that variables are correlated over time, thus observations are influenced by past observations. For example, GDP does not take on a random value; for GDP to take a value a certain year, the previous year's value reasonably must be similar. Other variables in the study can also be affected by autocorrelation, which is a fragility with the model specification. Serial correlation does not bias the results, but the presence of serial autocorrelation means that the standard errors are unreliable. This can lead to optimistic significance of regressors and erroneous conclusions about the model's predictive power. This problem needs to be addressed for efficient estimators.

Another possible issue is the presence of heteroscedasticity. This occurs when the distribution of error terms is different across data over time. This inconsistent variance in the error terms can lead to underestimated standard errors and the coefficients becoming ineffective. To account for heteroscedasticity, clustered standard errors are used on all regressions. Using clustered standard errors also solves the issue of serial autocorrelation by grouping the standard errors around individual countries in this case, to achieve homoscedastic consistent standard errors.

5.4 Methodology limitations

The results of the study are a direct result of the data quality from the data sources, and this means that any errors or biases in the data sources can also be shown in results. To minimize its impact and uphold reliability, well-established data sources have been used, the data used have been presented clearly in tables, and the causal relationship has been discussed in text in order to be as open and transparent as possible.

Although multivariate regressions were used in this analysis, capturing all aspects of women's rights is difficult, and such interpretation should be limited. Especially since the model is, to the best of the authors knowledge, a first exploration of a macro perspective, adapted from other studies (for example Breda, et al., 2020; Stoet & Geary, 2018; . Xie, Fang, and Shauman, 2015) of gender inequality and education choices. It is also difficult to include all factors that may influence women's choice of a particular field, which increases the possibility of omitted variable bias, something that was tried to negate as much as possible in the final model. In addition, through limited previous research on the subject in a macro perspective, this study may suffer from a lack of internal and external validity, but by choosing variables based on previous studies and theories of gender inequality in education, this issue has been tried to be minimized. The MENA sample in this study consists of few countries and few observations due to a lack of data collection, likely affecting the results.

Furthermore, there is a possibility that the results are because there is reverse causality of the STEM ratio to the other variables and should be considered when the results are being interpreted. Whilst discussing the correlation and relationship between the female share of STEM graduates and the WBL index, it could be reasonable to think that changes in women's rights causes changes in the female STEM graduates' ratio, as opposed the other way around. However, making statements about causality should be made with caution and should be avoided. Instrumental variables are considered to be a useful strategy for dealing with these issues. Though, since this study is, to the best of the author's knowledge, a first exploration, instrumental variables are more appropriate for future research.

Limitations with the fixed effects approach are that the estimates are susceptible to attenuation bias from measurement errors of the included variables and do not measure what they are intended to do. When using the fixed effects model, the intuitions are that the variables are persistent. However, that is not always the case; measurement errors often tend to change from year to year, which means that the inside variation can be noisier than observed. In addition, adjustment for fixed effects can remove both good and bad variations; in other words, it can remove useful information about the variables of interest. There can also persist problems with unobserved heterogeneity due to unmeasured time-varying properties. The fixed effects also do not allow for time-invariant variables. Despite this, the purpose of this study makes the fixed effects approach the most appropriate model due to its many advantages of eliminating omitted variable bias of time-invariant variables.

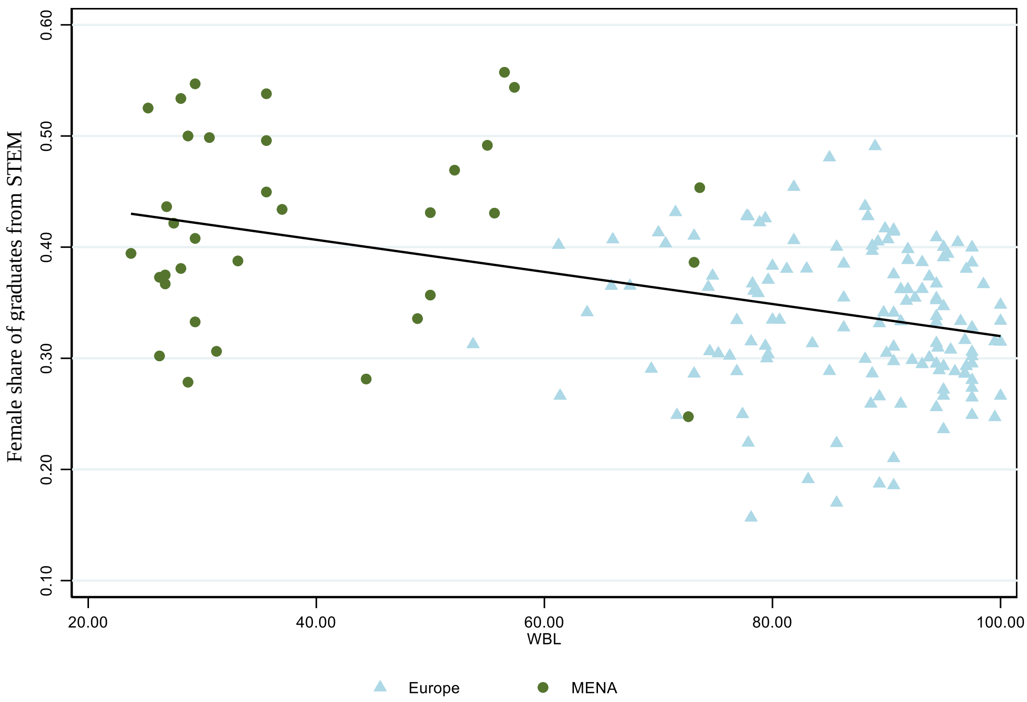
6. Analysis

6.1 Results

The purpose of this study is to provide a pooled analysis of the relationship between women's empowerment and economic opportunities, measured by the WLB index, and the share of female STEM graduates from tertiary education. The focus is to look at general relationships based on data from Europe and MENA and then to compare whether there are regional differences in the relationship between the independent variable WBL index and the dependent variable female STEM graduates.

Figure 4 begins investigating in the simple correlation between female STEM graduates and women, business, and the law index, showing a clear negative trend. This suggests that increases in women's empowerment and economic opportunities are associated with a lower share of women choosing a degree within a STEM field as expected from theory and previous research. This simple graphic depiction gives us reason to examine the relationship more in-depth. Figure 4 shows that it is also evident that regional clustering underlines these trends. Europe tends to exhibit higher scores on the WBL index, indicating higher women's rights and opportunities, and a lower share of women with STEM degrees. MENA, on the other hand is mainly clustered in the upper left corner showing low scores on the WBL index and a high share of female STEM graduates. It is also evident that economies with equal shares of

Figure 4: Female STEM graduates vs. women, business, and the law index with regions (Author's Calculations, for a summary of data sources, see Appendix A2).



female STEM graduates have vastly different WBL index scores. This gives reason for investigating in the regional differences between Europe and MENA in the relationship.

he pooled OLS regressions are presented in table 3, as such stepwise specification makes it possible to draw more precise conclusions since this is, to the best of the author's knowledge, a first exploration of the macro perspective through an OLS regression model. Clustered standard errors are used on all regressions to account for heteroskedasticity and address serial autocorrelation. Regression (6) in table 2 is based on model 2 and includes an interacting term between a region dummy (Europe is 0 and MENA is 1) and the independent variable WBL index. Last is the regression corresponding to model 3 which includes country fixed effects to eliminate omitted variable bias due to time-invariant variables. As can be seen in regression (7) in Table 3, this means that the dummy variables are excluded since they do not vary over time, though the interaction term is still included.

F-tests indicate that all regression hold some significant explanatory power. R2 values are given for the pooled OLS models (1-6) and the within R2 value for the model with fixed effects (7). These show an increasing explanatory power as the control variables are stepwise included, except for the regressions with country fixed effects (7) which show a relatively low explanatory power when accounting for countries' time-invariant characteristics.

Table 3: OLS regression output with Female share of STEM graduates ratio as dependent variable (author's calculations)

		Female share of STEM graduates ratio					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Region						-0.0765	
						(0.165)	
WBL index	**-0.00144*** **	**0.00105** **	**0.00102***	**0.00204** **	**0.00231** **	0.00199	**0.00228** **
	(0.000385)	(0.000505)	(0.000515)	(0.000935)	(0.000931)	(0.00126)	(0.000851)
Region x WBL index						-0.00234	**0.00145***
						(0.00248)	(0.000811)
GDP per capita (log)		**-0.0533*** **	**-0.0529*** **	**-0.0433** **	**-0.0398** **	**-0.0378***	-0.0148
		(0.0195)	(0.0158)	(0.0165)	(0.0161)	(0.0201)	(0.0396)
Expenditures in secondary education (%)		-1.118	-1.020	**-2.830** **	**-2.497***	-1.164	0.978
		(1.981)	(1.980)	(1.285)	(1.339)	(1.312)	(2.787)
Income share held by highest 10 % (%)		0.198	0.125	0.0434	0.0846	0.359	0.502
		(0.305)	(0.264)	(0.231)	(0.242)	(0.306)	(0.309)
Enrollment in tertiary education (%)			0.0501	0.0422	0.0472	0.0410	0.0185
			(0.0377)	(0.0518)	(0.0582)	(0.0557)	(0.0619)
Human capital			-0.00468	-0.00657	-0.00718	-0.0104	-0.00741
			(0.00772)	(0.00734)	(0.00771)	(0.00745)	(0.00929)
Female labor force participation rate (%)				-0.0671	-0.0772	-0.139	-0.0855
				(0.123)	(0.133)	(0.142)	(0.131)
Age of first marriage				-0.00321	-0.00407	-0.00159	-0.00135
				(0.00360)	(0.00364)	(0.00334)	(0.00344)
Fertility rate				0.0128	0.0139	0.0326	-4.14e-05
				(0.0182)	(0.0201)	(0.0200)	(0.0404)
Muslims					0.0109	**0.0773*** **	
					(0.0477)	(0.0270)	
Unaffiliated					0.0398	0.0483	
					(0.0293)	(0.0302)	
Constant	0.464***	0.763***	0.799***	0.806***	0.760***	0.654***	0.305
	(0.0323)	(0.194)	(0.199)	(0.167)	(0.158)	(0.207)	(0.374)
Country fixed effects	No	No	No	No	No	No	Yes
Observations	172	120	118	95	95	95	95
R-squared	0.171	0.216	0.248	0.397	0.424	0.497	0.213

The result indicates that the WBL index has a positive relationship with the share of female STEM graduates from tertiary education, (except for regressions 1) and this relationship is significant in all regressions except regression (6) and increases in magnitude once country fixed effects are included. Important to note is that the coefficient for the WBL index in regression (6) relates to the effect in Europe (0.00199), whilst the coefficients in regressions (1-5) is the total effect when the effects in Europe and MENA are not separated.

This relationship is contrary to what was expected that the more rights women have, the more often she opts out of STEM to avoid. These results indicate that increasing rights is associated with a higher female STEM graduate's ratio. Looking at regression (7) with fixed effects the female share of STEM graduates in Europe is associated with an increase of 0.0023 percentage points when the WBL score increases by one point. The corresponding effect in MENA is 0.0037 percentage units (0.00228 + 0.00145), the difference in effect between the regions is 0.001. Thus, changes are the WBL index is associated with a larger increase in the STEM graduate's ratio in MENA than Europe. However, this is a relatively small effect of on the share of female STEM graduates since an increase from a WBL index score of 0 (minimum) to 100 (maximum) would only increase the STEM ratio with 0.2 percentage points in Europe and 0.4 percentage points in MENA. Furthermore, when using the variance inflation factor (VIF) test the WBL index show a value below 5 which is acceptable for all regression without the interaction term. When including the interaction term between the WBL index and region the VIF test reported a high value which is expected for interaction terms as the two variables are also included separately in the model.

Among the economic factors, GDP per capita shows a negative relationship with the STEM ratio for all regression models and is statistically significant except for the regression with country fixed effects (7). This is as expected according to the results from previous literature, the more developed a country is the lower share of women graduate with a STEM degree. Furthermore, when accounting for country fixed effects (7) government expenditures have, as expected, a positive relationship with the STEM ratio. However, this is not statistically significant, and interpretations should be done with caution since regression (4-5) show a significant negative relationship with the STEM ratio. This also applies to the variable income share held by the 10^{th} wealthiest quantile which show no significant relationship. Still, the insignificant relationship is in accordance with the expectations from previous literature that suggesting that wealthier families can provide for both sons and daughters to study higher education leading to more gender equality only among the wealthiest. Since this relationship is not significant it requires further investigation to see whether this hypothesis is true, which this study can not conclude. All three economic factors reported a VIF between 1.5 and 3.5 which does not indicate a multicollinearity problem.

None of the educational factors showed any significant relationship with the share of women graduating with a STEM degree. This study can therefore not say that a high share of the population enrolling in tertiary education as well as the level of human capital in society measured as the average years of schooling matters for the share of female STEM graduates. However, the insignificant relationships are as expected, with increasing enrollments associated with an increasing share of women choosing a STEM degree. Suggesting when the total enrollment increases the women seem to choose STEM fields. In addition, the insignificant results show that increasing human capital levels in society are associated with decreasing shares of women among STEM graduates. The VIF test of the educational factors does not indicate on a multicollinearity problem with values below 3 for all regressions.

The same results are showing for the societal factors, except the dummy variable for Muslims show a significant relationship with the share of female STEM graduates in regression (6). However, the VIF test for this variable is 5.65 which is quite high and thus any interpretation of this result should be done with caution due to the risk of multicollinearity. This could be due to that all included countries in MENA have Muslims dominated population, hence the correlation between the region and Muslim dummy takes a high value of 0.85. Studying the insignificant relationships, the results show that FLFP rate have a negative relationship with the share of female STEM graduates, in line with what was expected. Women who study and then expects to enter the labor force choses more according to her interests or the stereotypical image. However, this study cannot confirm this hypothesis. Furthermore, the VIF test report a slightly high value of the FLFP rate variable of suggesting a possibility of multicollinearity problems with this variable and interpretations should be done with caution.

The insignificant negative effect by age at first marriage is in accordance with the expectations of higher age of first marriage is associated with a decrease in the share of female STEM graduates. The fertility rate suggests that women who expect to have more children is associated with choosing a degree within STEM. Even if these are not significant relationships, they indicate that women who expect to marry early and have many children choose to study STEM fields, however such interpretations cannot be confirmed by this study. The low values of the VIF tests do not indicate problems with multicollinearity.

In summary, the result suggests that there is a positive relationship between the WBL index, and the female share of STEM graduates in general and a regional difference between Europe and MENA can be observed. However, this effect is relatively small and is not in accordance with previous literature. The economic factors have more significant relationships with the share of female STEM graduates, though when controlling for country fixed effects none of the contextual factors showed any significant relationship with the dependent variable. Since the dummy variables are excluded from the fixed effect regression model (7) multicollinearity does not seem to be an issue except for possibly with the FLFP variable.

6.2 Discussion

The objectives of this study were to investigate whether women's empowerment and economic opportunities affect women's choice of choosing a degree within the STEM field, and to distinguish whether this factor may affect the proportions of women in STEM in Europe and MENA differently. The outcome of this quantitative exploration is that women's empowerment and economic opportunities, measured by the WBL index, seem to influence the female share of STEM graduates, but a relatively small and positive effect was not expected. The previous literature and theory suggested a negative relationship due to women with more choices and opportunities assumed to choose away from male domains (such as STEM) to avoid stereotypes and due to lower self-efficacy in these domains because of the stereotypical threat. Furthermore, regional differences were investigated and a small significant difference between Europe and MENA could be observed. This result indicated that changes in the WBL index is associated with a higher effect in MENA than in Europe and implies that both regions have a positive relationship between women's empowerment and economic opportunities.

It also examined how different contextual factors affected women's STEM ratio, adapted from Wigfield and Eccles (2001), Wang and Degol, (2013), and Breda et al.'s (2020) study of the gender-equality paradox. These factors could not confirm any significant relationship with the share of female STEM graduates. Though the insignificant relationships for the contextual factors showed effects as expected based on previous literature of gender inequality in education.

The scatterplot analysis (Figure 4) indicated that there was a negative relationship between the WBL index score and the share of women graduating from STEM fields. This analysis further showed that there was a regional clustering with Europe generally located with a low share of female STEM graduates and a high score on the WBL index and MENA generally with a high share of female STEM graduates and a low score on the WBL index. However, the multivariate analysis (Table 1) contradicts this negative relationship when the contextual control variables are included (economic, educational, and societal factors). Furthermore, when including country fixed effect this positive relationship holds. This could be due to spurious correlation, which means that an unspecified variable affects both the dependent and independent variable, hence the relationship changes when controlling for background variables.

Previous literature and theory suggested that women choose away from STEM in more egalitarian countries, for example, due to the stereotype threat (Aronsson & Steele, 1995) and due to influence by intra-individual differences (Stoet & Geary, 2018). However, this study cannot confirm that stereotype threats and egalitarian countries have liberal mores which reinforce the influence of intra-individual academic forces, so women choose non-STEM educations. It does however show the opposite relationship, though since this effect is relatively small, the relationship needs further investigation. Contradicting results as these could be due to that the model in this study is a first exploration and needs further analysis. Possibly a combination of micro and macro-level factors is to prefer to cover more individual characteristics and environmental characteristics.

As the liberal feminism theory suggests origins in historical traditions have created barriers to women's advancement but can also be that women who have fewer choices also need to work harder to get respected whereas men in the same culture do not need to work hard to be good. Furthermore, liberal feminism emphasizes issues such as individual rights and equal opportunities, which are much lower for women in MENA, scoring less than half of the mean on the WBL index, than in Europe (Table 1 & Table 2). This indicates that the different shares of female STEM graduates stem from different historical norms and beliefs affecting women's rights and opportunities. Furthermore, this is reflected in European countries' tendencies of being further in reducing gender inequalities but still, gender stereotypes are still shown. According to liberal feminism theory, both of these persist because individuals are considered socialized by the family, the school, and the media to traditional attitudes and orientations that limit their future unnecessarily to sex stereotypical professional and family roles (Wienclaw, 2011; Acker, 1987). Hence, this indicates that there needs to be further investigation in how an individual's characteristics (abilities, past experiences, goals, self-perceptions, beliefs, expectations, interpretations) and environmental impact (cultural environment, norms, socialists' beliefs, and behaviors) relates to the choice of choosing STEM. This theory suggests that perhaps women who experience the possibility of choosing something where she can reduce the exposure to gender stereotyping as there are in STEM fields being a male domain. But if a woman will experience gender inequalities regardless of her choice of field might choose the one where she can earn the most respect from society and family. Because she may not even be working with it in the future or even enter the labor force.

Women's empowerment and economic opportunities can thus be surmised as being interested in analyzing the share of female STEM graduates due to that it reflects women's prospects and possibilities. However, with the theory in mind and the contradicting results, the relationship between women's empowerment and opportunities and the STEM ratio needs further investigation, exploring other possible connections. The effect of poverty on women's academic choice since this study, even if insignificant, shows a possible correlation between income inequalities could be further investigated. Based on this study, going more deeply on country and individual level would possibly show more prominent results, for example studying corruption and same-sex schooling versus mixed schooling. Previous literature has suggested a regional difference affecting the share of female STEM graduates in the two regions, Europe and MENA, which is in line with the results from this study. These differences need further investigation by cross-sectional comparison to study how all contextual factors can have different effects in different regions. What affects women's choice at different levels of gender inequalities, there is a possibility that there are different factors affecting the choice depending on the progress of gender equality, which needs to be further investigated. Women continue to face gender stereotypes and discrimination that can profoundly impact their educational choices and career paths. Removing these barriers would put an end to educational segregation by gender.

6.3 Conclusion

The aim of this study was to investigate the relationship between shares of female STEM graduates and women's empowerment and economic opportunities. Whether they choose according to their prospects and expectations. On one hand the female labor force participation rate in MENA is relatively low and a woman might expect to not remain in the workforce for such a long period and they choose what makes her more respectable in the society. On the other hand, theory indicate that women in Europe avoid STEM partly because it has a history of being a male dominant sector and consequently difficulties with climbing the company ladder and partly because they choose accordingly to their interests which are likely to be affected by society's sex stereotypical image that begins affecting girls as early as primary school.

The results of this study show a weak positive relationship between women's empowerment and economic opportunities and the share of female STEM graduates in contrary to the expectations of previous research of gender inequality in education and academic choices. Implicating that women's rights possibly have some relation to women choosing a degree in STEM fields and its likely origin from deep rooted historical norms and beliefs. The contextual factors did not confirm any significant relationships when controlling for country fixed effects. Thus, the model should be analyzed with other measurements and try to capture different aspects that could affect women's academic choice.

The development of gender inequalities and disparities will differ based on historical differences. Researching in this area is not to remove cultural diversity but to understand what hinders women from choosing STEM. Countries should have economic and social incitement to understand the cultural expectations of men and women and, through this insight be able to work more accurately to increase equality in STEM professions. As a final note, this thesis wants to highlight the weak knowledge in the area and encourage further research in the field.

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Appendix 1

Table 3: List of countries by region

Europe		MENA
Included:	Italy	**Included:**
Albania	Latvia	Algeria
Armenia	Lithuania	Bahrain
Austria	Luxembourg	Iran, Islamic Rep.
Azerbaijan	Malta	Jordan
Belgium	Moldova (Republic of)	Lebanon
Bulgaria	Netherlands	Morocco
Croatia	Norway	Oman
Cyprus	Poland	Qatar
Czech Republic	Portugal	Saudi Arabia
Denmark	Romania	Tunisia
Estonia	Serbia	United Arab Emirates
Finland	Slovakia	
France	Slovenia	
Georgia	Spain	
Germany	Sweden	
Greece	Switzerland	
Hungary	Turkey	
Iceland	Ukraine	
Ireland	United Kingdom	

Excluded:	**Excluded:**
Bosnia and Herzegovina Kazakhstan North Macedonia Russian Federation Belarus Andorra Liechtenstein Monaco Montenegro San Marino	Djibouti Egypt, Arab Rep. Iraq Israel Kuwait Libya Syrian Arab Republic West Bank and Gaza Yemen, Rep.