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Master's Thesis of International Studies

Women's participation in STEM fields and the Gender-Equality Paradox Theory

여성의 STEM 분야 참여와 성 평등 역설 이론

August 2023

Development Cooperation Policy Program
Graduate School of International Studies
Seoul National University
International Cooperation

Melissa Rodríguez Forero

Women's participation in STEM fields and the Gender-Equality Paradox Theory

A thesis presented

By

Melissa Rodríguez Forero

A dissertation submitted in partial fulfillment

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Kim, Chong Sup

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Graduate School of International Studies
Seoul National University
International Cooperation

Melissa Rodríguez Forero

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Melissa Rodríguez Forero
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Chair __________(Seal)
Vice Chair __________(Seal)
Examiner __________(Seal)

Abstract

Women's participation in STEM fields and the Gender-Equality Paradox Theory

Melissa Rodríguez Forero
International Cooperation
Graduate School of International Studies
Seoul National University

Women's empowerment is intuitively related with gender equality. There is a collective believe that the most egalitarian countries have the highest participation of women in education, labor force, politics, and decision-making process. Women´s participation in areas like engineering, mathematics, technology, and science, is often seen as an indicator of development, of gender equality, and as a good step toward the achievement of Sustainable Development Goal number 5: *Achieve gender equality and empower all women and girls.* However, what happens when the evidence shows a different scenario? The Gender-Equality Paradox Theory implies that there is a negative correlation between higher gender-egalitarian indicators, and women's participation in STEM (*science, technology, engineering, and mathematics*) fields. This thesis will intent to prove this correlation, and suggest the factors that might be triggering this paradox.

Keyword: Gender-Equality Paradox, STEM fields, Gender Equality, Women's participation and decision-making, Socio-Ecological Model.

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Abbreviations

2030A	2030 Agenda for Sustainable Development
EE	Enabling Environment
GDP	Gross Domestic Product
GGGI	Global Gender Gap Index
GNI	Gross National Income
HCI	Human Capital Index
ICT	Information and Communications Technology
ILO	International Labor Organization
ISCED	International Standard Classification of Education
MDGs	Millennium Development Goals
NGOs	Non-Governmental Organizations
NPISHs	Non-Profit Institutions Serving Households
OECD	Organization for Economic Cooperation and Development
PISA	Programme for International Student Assessment
SD	Service Delivery
SEM	Socio-Ecological Model
S&E	Science and Engineering
SAGA	STEM and Gender Advancement
SDGs	Sustainable Development Goals
STEM	Science, Technology, Engineering, and Mathematics
STI	Science, Technology and Innovation
STI GOL	Science, Technology and Innovation Gender Objectives List
UIS	UNESCO Institute for Statistics
UN	United Nations
UNDP	United Nations Development Programme
UNESCO	United National Educational, Scientific and Cultural Organization
WEF	World Economic Forum

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Chapter 1. Introduction

1. Background

Gender equality and the empowerment of women and girls are key issues that need to be addressed in order to achieve the 2030 Agenda for Sustainable Development (2030A) and the Sustainable Development Goals (SDGs). In particular, achieving gender equality has been targeted as the fifth of the seventeen SDGs, and is thus considered a core element to achieve towards 2030.

Particularly, the 2030A has shown a shift from the Millennium Development Goals (MDGs), as the SDGs brought to attention structural constraints that were not included in the MDGs. Whereas the MDGs included 8 goals and 18 targets, the SDGs include 17 goals and 169 targets, with gender equality not only addressed as a separate goal with its own targets, but also considered a cross-cutting issue that must be addressed to fulfill all 17 goals.

This relevant document, was ratified in 2015 as a roadmap for all countries to follow, with the goal of “transforming our world” as has been noted by the United Nations, by improving economic, environmental, and social dimensions, while achieving greater sustainability, and creating better living conditions for all (Subba, 2022). However, at the current pace, not only on gender issues, but on all 17 goals highlighted in the 2030A, this document will not be fulfilled at the global level by 2030.

For example, the UN Women 2022 Gender Snapshot, shows alarming data on gender equality. Some of its findings suggest that at the current pace, it will take

286 years to eliminate discriminatory laws, and close gender gaps in legal protections for women and girls (UNWomen, 2022). In addition, it must be recognized that only one-third of the seats on local decision-making bodies are held by women, and that the glass ceiling remains intact, with only one in three managerial or supervisory positions held by a woman (UNWomen, 2022).

With regard to SDG5 and SDG9, related to industry, innovation and infrastructure, UN Women informed globally, that only 2 out of 10 positions in science, engineering, and ICTs are held by women (UNWomen, 2022), representing approximately 20% of women in these STEM fields.

Against this backdrop, the United Nations Development Program (UNDP), launched a global initiative in 2020 known as the "Decade of Action" towards the implementation of the 2030A, whose primary purpose is to accelerate the SDGs implementation in those countries lacking behind. As a result, world leaders announced more than 100 accelerated actions that represent a voluntary commitment to accelerate progress (UNDP, 2019).

Accordingly, additional actions need to be implemented for each of the 17 SDGs. Specifically, with regard to SDG5 towards the achievement of gender equality and the empowerment of all women and girls, some of the key issues that need to be targeted are: 1) women's political leadership; 2) violence against women; 3) sexual and reproductive rights; 4) unpaid care and domestic work; 5) legal rights; 6) quality education; and 7) employment opportunities.

Regarding the later, the United Nations, UN Women, the United National Educational, Scientific and Cultural Organization (UNESCO), and the World

Economic Forum (WEF), believe that increasing women's participation in STEM areas will not only empower women and girls, but will also allow countries to achieve higher levels of development, and offer “potential for individual and societal advancement” (UNWomen, Sticking points in STEM, 2019).

The World Economic Forum, for example, draws on a McKinsey & Company study that states that closing the gender-gap in labor force participation, will increase global GDP by an additional 25% by 2025 (WEF, 2017). Similarly, the European Institute of Gender Equality (EIGE) suggests that narrowing the gender gap in STEM education, could reduce the skill gaps, leading to an increase in employment and productivity, a reduction in occupational segregation, and an increase in the overall GDP level (EIGE, n.d.).

However, despite the abovementioned considerations, there is still an imbalance between women´s participation in STEM fields compared to men. According to the UNESCO Institute for Statistics (UIS), less than 30% of researchers worldwide are women (UIS, UNESCO Institute for Statistics, n.d.). Globally, 3% of women enroll in information and communications technology (ICT); 5% in natural science, mathematics, and statistics; and 8% in engineering, manufacturing, and construction (UNESCO, 2017), the three main categories when in comes to STEM fields. In addition, several studies suggest that “women in STEM fields publish less, are paid less, and do not progress as far as men in their careers” (UIS, 2015).

According to some research, the main determinants that have affected the enrollment of women in STEM areas both at an educational and professional level are considered to be the social norms, cultural constraints, and gender stereotypes.

In this regard, despite significant progress made in recent decades, there are still large gaps in women's participation in STEM fields compared to men (UNESCO, 2017), that need to be addressed.

Against this backdrop, policy-makers worldwide are making substantial efforts to increase women's participation in STEM fields, as a mechanism to empower women throughout their lives, starting with the careers they chose to study (tertiary education), and the jobs they might have in the future (S&E workforce).

Some examples that highlight these efforts are the success of the Chinese government 14th Five-Year Plan, that sought to strengthen science, technology, research, and development, towards a digital and innovative economy, through which women launched 50% of the new internet companies (UN, 2021).

On the other hand, the United Arab Emirates has made some of the most significant advances in the Global Gender Gap Index (GGGI) by increasing women's participation in politics, literacy rates, and enrolment in primary education; statistically, they reported that 46% of women in tertiary education are involved in STEM fields, two thirds in public positions, and 30% in decision-making roles (UN, 2021).

Finally, in Latin America and the Caribbean, some initiatives have focused on reducing the gender gap through public policies, legislation, national plans, and national development strategies; in particular, universities and scientific institutions are implementing initiatives aimed at attracting, retaining, and facilitating access for women in STEM careers (UNWomen, Women in Science, Technology, Engineering and Mathematics (STEM) in the Latin America and The Caribbean Region, 2020).

2. Problem Statement

While policy-makers around the world, are making great efforts to increase women’s participation in STEM fields as mentioned earlier, Gijsbert Stoet and David Geary point out that there is a negative correlation between the Gender Equality Index and women's participation in STEM fields, which they have called the “Gender-Equality Paradox” (Geary, 2018).

This means that despite the general assumption, their research shows that countries with higher gender equality indices, such as the Nordic countries, have lower participation of women in STEM fields. In the same line, countries with a low GGGI show higher participation of women in these fields.

Following their findings, and observing that in countries with the higher gender-sensitive policies this tendency hasn’t been reverted, the core issue that this study aims to understand, is why women in countries with a higher GGGI continue to choose other fields of study? Why is women’s participation in STEM fields lower than men´s participation in countries with a higher GGGI, despite strong efforts to promote their participation in these fields?

3. Significance of the study

Considering the above, this research aims to prove the Gender-Equality Paradox, and find the possible factors that could be responsible for the participation, or non-participation, of women in STEM fields.

Accordingly, this thesis is relevant as it aims to go beyond previous research on the Paradox, and not only prove and analyze it, but also show some possible factors that could explain it through data analysis.

The above-mentioned, will be useful not only from an academic perspective, but will also help policy-makers in formulating the post-2030 framework, that can lead the agenda of the next decades, where a more comprehensive approach towards gender issues should be implemented.

4. Research objectives

4.1. General Objetive:

- Explain the factors that might be triggering women's participation in STEM fields of study, and their relationship with the Gender-Equality Paradox theory.

4.2. Specific Objectives:

- Collect and analyze the most relevant literature related to the Gender-Equality Paradox, to comprehend the spectrum of research that has been done so far on the issue.
- Demonstrate the existence of the Gender-Equality Paradox, with the most recent available data, using a similar approach to the one used by Gijsbert Stoet & David C. Geary.
- Analyze the correlation between the share of women in STEM areas, with the GGGI, as well as with other independent variables, to create a general spectrum of the reasons that might explains women's decision-making process towards their involvement in STEM fields.

- Identify at least one factor that might explain the "Gender-Equality Paradox", to understand the determinants that might be triggering women's decision-making towards their involvement in STEM fields.

5. Structure of Study

This research will be divided into five chapters as follows: 1) introduction; 2) literature review; 3) data collection; 4) results & analysis; and 5) conclusions.

Accordingly, the purpose of this chapter was to provide a general overview of the importance of the achievement of gender equality and how it has been established as one of the core goals to be fulfilled towards 2030 and the achievement of the Sustainable Development Goals. In this sense, it intended to show how women's participation in STEM fields is assumed to be a positive indicator towards the achievement of SDG5 and how policy-makers are working on the implementation of different measured to achieve this goal. Finally, it gave a general overview of the Gender-Equality Paradox, which contradicts the general assumption about the relationship between GGGI and women's participation in STEM areas, and in that regard stated the core issues that will be addressed throughout this research.

The second chapter, will present the literature review related to the Gender-Equality Paradox. In particular, it will provide an overview of what some scholars have found on this topic, with particular emphasis on Gijsbert Stoet and David Geary's research paper *"The Gender-Equality Paradox in Science, Technology, Engineering, and Mathematics Education"*.

The third chapter, will present the data description and methodology used for this research, by presenting the dependent and independent variables that were used to demonstrate the paradox, as well as the Socio-Ecological Model as the methodological framework for the results analysis, in order to find the factor or factors that might explain this behavior. It will also give a brief overview of the instruments used for the data collection, and the hypothesis that framed this research. Later on, chapter four will present the findings of the data collection process, and the main results obtained from the data analysis.

Finally, chapter five will discuss the results in relation with the problem statement, as well as the limitations and weaknesses on the research, the main conclusion, and the implications of the final results.

Chapter 2. Literature Review

Women’s involvement and participation in STEM fields has been generally perceived as a positive indicator of the achievement of gender equality framed by the 2030A. However, Gijsbert Stoet and David Geary suggest that “countries with high levels of gender equality have some of the largest STEM gaps in secondary and tertiary education” (Geary, 2018). According to their research, there is a negative correlation between the gender-equality index and women's participation in STEM fields, which they have called *“The Gender-Equality Paradox”* (Geary, 2018).

They suggest that despite significant efforts toward understanding and changing the pattern in which women and girls are underrepresented in STEM fields, the sex difference in STEM engagement has remained stable for decades (Geary, 2018). Accordingly, they consider that, that stability in women’s underrepresentation in those areas, as well as the failure of the approaches to change that paradigm, calls for a new perspective on how to approach this issue (Geary, 2018).

Specifically, throughout their investigation, they used the Nordic Countries (*Finland, Iceland, Denmark, Norway, and Sweden*) as reference countries, due to their high level of gender equality, and consequently proved the negative correlation between Gender-Equality Indicators and women’s participation in STEM fields (Geary, 2018).

Through their research, Stoet and Geary propose that students' own rational decisions play a crucial role in explaining the educational-gender equality paradox. This is based on the *expectancy-value theory,* in which students use their performance as the base of their decision-making process about further educational and occupational choices (Geary, 2018).

Additionally, they consider that another factor that may influence engagement in STEM fields are those perceptions regarding the expected long-term value of a given academic path. Remarkably, the "fewer economic opportunities and higher economic risks" (Geary, 2018) that women face, may influence their decision-making process, as STEM occupations are relatively high-paying careers with greater opportunities and lower risks (Geary, 2018).

In that regard, their research suggests that "countries with lower levels of gender equality had relatively more women among STEM graduates than did more gender-equal countries" (Geary, 2018). These findings are paradoxically, as the countries with higher GGGI tend to give women and girls more education empowerment and opportunities, which theoretically will promote and encourage their participation in STEM fields (Geary, 2018).

As a result, they tried to explain this paradox by comparing the most egalitarian countries, which tend to be welfare states and have a higher level of social security, with those less-egalitarian countries, that are more insecure and have more difficult living conditions. Accordingly, they argue that this scenario in less-gender equal countries may influence the value of STEM occupations, given that they tend to be better paid and, in that regard, provide higher economic security (Geary, 2018).

Similar findings have been presented by Breda, Jouini, Napp and Thebault, who acknowledge that the underrepresentation of women in STEM fields has remained constant or even increased in the last two decades. Interestingly, in their findings this pattern is more evident in developed countries with more gender-equal economic and political opportunities and rights (Breda, Jouini, Napp, & Thebault, 2020).

Through their research, they highlight that the most common explanation for this Gender-Equality Paradox, is that in the most egalitarian countries, girls and boys have more freedom to express their "intrinsically distinct preferences and interests" (Breda, Jouini, Napp, & Thebault, 2020). Accordingly, this type of behavior tends to be more evident in wealthier countries that have developed more "emancipative, individualistic, and progressive values that give a lot of importance to self-realization and self-expression" (Breda, Jouini, Napp, & Thebault, 2020).

On the other hand, they address the "gender-math stereotype"[1] as they suggest that the underrepresentation of women in STEM fields is primarily evident in math-related fields. In that regard, they consider that math has less value in wealthier countries, as students can guarantee their career prospects and material security in different fields that are not necessarily related to math or STEM fields (Breda, Jouini, Napp, & Thebault, 2020).

Likewise, Spangsdorf and Forsythe, recognize as well the "Nordic gender equality paradox" in which despite having high rates in women's labor participation, as well as more women than men in secondary and tertiary education, there is still underrepresentation of women in top managing positions, and the labor market is as well strongly segregated. Differently than other studies, they suggest that this paradox might be explained by the lack of motivation, rather than to lack of

[1] *"Math is not for girls"* (Breda, Jouini, Napp, & Thebault, 2020)

opportunities or discrimination, which they have considered as the "glass slipper effect" (Spangsdorf & Forsythe, 2021).

Furthermore, the American Association of University Women (AAUW) highlights that those disparities between men and women in these areas has been considered as "evidence of biologically driven gender differences in abilities and interests" (AAUW, 2010), in which men are considered to be good in math, while women are better in language skills. However, they also recognize that culture also works as a determinant in their preferences, and in that regard, it is essential to address as well those stereotypes and biases that still pervade our societies (AAUW, 2010).

Particularly, they quote the research made by Joshua Aronson, in which he shows that even women that are highly interested and motivated by STEM majors and careers, are as well susceptible to those gender stereotypes, that in the long run can cause what he denotes as *disidentification* "a defense to avoid the risk of being judged by a stereotype" (AAUW, 2010).

Now, it is worth pointing out that all of the above-mentioned have proved that the Gender-Equality Paradox does exists in some contexts, specifically when using welfare states as the core subjects of the study. However, their conclusions regarding the reasons that might explain the paradox are still very limited as they are based on assumption regarding various characteristics of the subjects of study, the countries selected, and women's decision-making process. Accordingly, this research will intend to find at least one factor that might explain the paradox, and prove its relation or correlation with women's share in STEM fields.

Chapter 3. Data and Methodology

1. Data

This thesis used a mixed methodology of both qualitative and quantitative data, from a deductive reasoning, to prove the Gender-Equality Paradox, deeply analyze the research done by Gijsbert Stoet & David C Geary, and examine the correlation between the share of women in STEM areas, with the GGGI, as well as with other independent variables, to create a general spectrum of the reasons that might explain women's decision-making process towards their involvement in STEM fields.

The dependent variable that was used in this research was – women's participation in STEM areas. For that purpose, the indicator selected for its measurement was - female share of graduates from Science, Technology, Engineering and Mathematics (STEM) programs in tertiary education – taken from the DataBank of the World Bank. It involves the number of female graduates in tertiary education, expressed as a percentage of the total number of graduates in a given field of education, and in that regard, it is calculated by dividing the number of female graduates in a given field of education from tertiary education by the total number of graduates in the same field, and multiplying it by 100 (WB, 2021).

The data on education is collected by the UNESCO Institute of Statistics (UIS) from official responses on its annual education survey, while all the data is framed on the International Standard Classification of Education (ISCED) (WB, 2021).

On the other hand, this research used multiple independent variables that intended both to replicate the Gender-Equality Paradox, as well as to find the factors that might explain it. In that regard, in order to do so, the variables used can be observed in *Table 1*; nonetheless, those variables may vary depending on the step of the research, and the model used for each phase of analysis.

1.1. Step 1. Stoet & Geary analysis

The first step of this research was to analyze the Gender-Equality Paradox, as was presented by Gijsbert Stoet & David C. Geary on their paper "*The Gender-Equality Paradox in Science, Technology, Engineering, and Mathematics Education*". In that regard, four core variables where used: 1) Women's participation in STEM areas, measured by the share of women among STEM graduates in tertiary education; 2) Gender Equality, measured by the GGGI; 3) Educational Attainment, measured by the PISA 2018 scores; and 4) Overall Life Satisfaction, measured by the Overall Life Satisfaction score (OLS), from the OECD better life index.

Accordingly, in order to prove the Gender-Equality Paradox theory, the main analysis was made related to latest correlation between share of women in STEM areas, and GGGI.

In that regard, the core independent variable was – Gender Equality – measured by the Global Gender Gap Index (GGGI), from the World Economic Forum Global Gap Report from 2021. This report, is based on a methodology that integrates the latest statistics from international organizations and surveys, and compares countries gender gaps in 1) economic opportunities; 2) education; 3) health;

and 4) political leadership (WEF W. E., 2021). It then provides the GGGI on a scale from 0 to 1 where 0 = inequality; and 1 = equality.

The second independent variable was Educational Attainment, measured by PISA 2018, from which the OECD examines what students know in reading, mathematics and science. Specifically, it is considered as one of the most "comprehensive and rigorous international assessment of student learning outcomes" (OECD, 2018), as it indicates the quality and equity of learning outcomes.

Now, although the objective was almost to replicate the findings of Stoet and Geary, this research included 156 countries, from which only 62 were included in the original paper, providing information of 94 additional countries. Nonetheless, it's important to take into account that only 74 out of the 156 countries presented the PISA examination on 2018.

The core elements that were analyzed from the PISA 2018 results, were: 1) gender gap in relative academic strengths; 2) average score for boys vs. girls; 3) difference in relative academic strengths in mathematics, science and reading; 4) comparison in relative academic strengths of girls in mathematics, science and reading; 5) comparison in relative academic strengths of boys in mathematics, science and reading; and 6) relationship between the share of women among STEM graduates in tertiary education and the GGGI.

Finally, the third independent variable was Overall Life Satisfaction score (OLS), taken from the OECD better life index, in which people evaluate their life on a scale of 0 to 10, and an average of the self-evaluation is selected as the final result per country (OECD, Life Satisfaction. Better Life Index, n.f.).

Table 1. List of Variables

	VARIABLES
DEPENDENT	Share of women among STEM graduates in tertiary education
INDEPENDENT	Contributing family workers, female (% of female employment) (modeled ILO estimate) Economic Fitness Metric (Legacy) Educational attainment, at least Bachelor's or equivalent, population +25, female (%) (cumulative) Educational attainment, at least Master's or equivalent, population +25, female (%) (cumulative) Employment in industry, female (% of female employment) (modeled ILO estimate) Employment in services female (% of female employment) (modeled ILO estimate) Firms with female participation in ownership (% of firms) Firms with female top manager (% of firms) GDP per capita growth (annual %) Gender Gap in Relative Academic Strengths (AverageScoreBoys -AverageScoreGirls) GINI Coefficient Global Gender Gap Index 2021 (0 - 1) Households and NPISHs consumption expenditure (annual % growth) Human Capital Index (HCI), Female (0 -1) Multidimensional poverty, educational attainment (% of population deprived) Nondiscrimination clause mentions gender in the constitution (1=yes; 0=no) Overall Life Satisfaction score (Life Satisfaction OECD better life index) (0 - 10) PISA 2018. Relative Math Strength – Boys (zMath - zAverage Score) PISA 2018. Relative Math Strength – Girls (zMath - zAverage Score) PISA 2018. Relative Reading Strength – Boys (zReadingBoys - zReading Score) PISA 2018. Relative Reading Strength- Girls (zReadingGirls- zReading Score) PISA 2018. Relative Science Strength – Girls (zMath - zAverage Score) PISA 2018. Relative Science Strength -Boys (zMath - zAverage Score) Research and development expenditure (% of GDP) Vulnerable employment, female (% of female employment) (modeled ILO estimate) Wage and salaried workers, female (% of female employment) (modeled ILO estimate)

Taking into account the above-mentioned, the detailed analysis between share of women in STEM areas and GGGI, was made in the following scenarios: 1) 156 sampled countries; 2) 44 Asian countries; 3) 40 African countries; 4) 39 European countries; 5) 10 North European countries, separated from the previous group; 6) 28 countries from Latin America, the Caribbean, and North America; and 7) 5 countries from Oceania.

Accordingly, an analysis of the global scenario was made in order to have a general overview of how was the relationship between GGGI and women's participation in STEM areas on a global scale. In that regard, for the 156 sampled countries, 109 of them presented available data on share of women among STEM graduates in tertiary education on the World Bank DataBank. The descriptive statistic for these two variables can be observed on *Table 2*.

Table 2. Descriptive Statistics on 109 sampled countries (GGGI*STEM)

	Global Gender Gap Index 2021 (0 - 1)	**Share of women among STEM graduates in tertiary education**
N	156	109
Mean	0,70	34,72
Median	0,71	34,69
SD	0,07	9,67
Coefficient of variation	0,10	0,28
Kurtosis	1,37	1,44
Skewness	-0,47	-0,1140156
Min	0,44	0,00
Max	0,89	60,76

Then, following Stoet and Geary's research, as the Gender-Equality Paradox was proved in their research only for welfare states, specifically the Nordic countries, further analysis was made specifically on the fifth scenario related to the 10 Northern European countries *(Denmark, Estonia, Finland, Iceland, Ireland, Latvia, Lithuania,* *Norway, Sweden, and United Kingdom)*[2]. The descriptive statistics for the first step of this research can be observed on *Table 3*.

Finally, from this first step which intended to compare and observe the correlation between the dependent variable with other three independent variables, the fist assumption was:

Hypothesis 1: The Gender-Equality Paradox cannot only be proved in the Nordic countries, but also in all Northern European countries, when using the same variables as Gijsbert Stoet and David Geary.

1.2. Step 2. New models

The second step, was to explore new ways of approaching the issue, by involving new variables and new countries on the equation. The main goal in this differentiation was to understood the reason or reasons that might explain why women chose, or chose not, to involve in STEM fields, from a different perspective than the one used by Stoet and Geary. In that regard, six models where tested, from which only four of them resulted significant for this research.

[2] *Iceland could be fully included on the model as no data was available in share of women among STEM graduates in tertiary education.*

Table 3. Stoet & Geary Analysis. Descriptive Statistics on Northern European Countries

	N	Mean	Median	SD	Coefficient of variation	Kurtosis	Skewness	Min	Max
Share of women among STEM graduates in tertiary education	9	32,42	31,13	4,22	0,13	-1,64	0,37	27,40	38,38
Global Gender Gap Index 2021 (0 - 1)	10	0,81	0,80	0,05	0,06	-0,50	0,30	0,73	0,89
PISA 2018. Relative Math Strength by gender - Boys	10	-0,03	-0,03	0,07	2,38	-1,42	-0,18	-0,13	0,07
PISA 2018. Relative Math Strength by gender - Girls	10	0,03	0,02	0,07	2,53	-1,31	0,08	-0,08	0,13
Difference in Relative Math Strength between Girls and Boys	10	-0,06	-0,05	0,14	2,45	-1,37	-0,14	-0,26	0,14
PISA 2018. Relative Science Strength by gender - Boys	10	-0,04	-0,04	0,07	1,63	5,45	-2,03	-0,22	0,04
PISA 2018. Relative Science Strength by gender - Girls	10	0,04	0,04	0,08	1,98	3,33	1,30	-0,07	0,22
Difference in Relative Science Strength between Girls and Boys	10	-0,08	-0,08	0,15	1,79	4,32	-1,66	-0,44	0,11
PISA 2018. Relative Reading Strength by gender - Boys	10	-0,05	-0,04	0,09	1,73	-0,15	-0,27	-0,20	0,09
PISA 2018. Relative Reading Strength by gender - Girls	10	0,04	0,02	0,10	2,75	-0,52	0,33	-0,11	0,20
Difference in Relative Reading Strength between Girls and Boys	10	-0,09	-0,06	0,19	2,14	-0,34	-0,30	-0,40	0,20
Average Score for boys (relative scores)	10	-0,04	-0,03	0,07	1,70	0,22	-0,57	-0,18	0,06
Average Score for girls (relative scores)	10	0,03	0,03	0,08	2,24	-0,10	0,33	-0,09	0,17
Gender Gap in Relative Academic Strengths	10	-0,07	-0,06	0,15	1,95	0,04	-0,45	-0,35	0,15
Overall Life Satisfaction Score	10	7,05	7,15	0,56	0,08	-1,20	-0,13	6,20	7,90

1.2.1. Model 1. Top 10 GGGI vs. Top 10 STEM

The first model, intended on the first place, to explore if the Paradox could be proved not only when including countries with the higher GGGI, but when including as well those countries with the higher participation of women in STEM areas in order to observe how the correlation changed. The countries included can be observed in *Table 4.*

Table 4. Countries of Model 1. Top 10 GGGI vs. Top 10 STEM

TOP 10 GGGI	TOP 10 STEM	OTHERS
Iceland	Myanmar	*Colombia *(country of interest for the research)*
Finland	Algeria	*Denmark *(Nordic country that is not part of the TOP 10 GGGI; position: 11)*
Norway	Oman	
New Zealand	Tunisia	
Sweden	Benin	
Namibia	Brunei Darussalam	
Rwanda	Syria	
Lithuania	Peru	
Ireland	Qatar	
Switzerland	North Macedonia	

For the identification process, particularly by intending to prove the Gender-Equality Paradox, the indicators used were the GGGI from the Global Gender Gap 2021, and the female share of graduates from Science, Technology, Engineering and Mathematics (STEM) programs in tertiary education – taken from the DataBank of the World Bank.

Then, after the identification of those countries, the indicators of the independent variables in *Table 1* were correlated with the female share of graduates from STEM programs in tertiary education, in order to prove if there was a positive or negative correlation that could explain the Paradox. In that regard, seven independent variables resulted significant for the research:

1. **Economic Fitness Metric:** measure of the countries diversification and ability to produce complex goods on a globally competitive basis. Specifically, countries with the highest levels of economic fitness have: 1) capabilities to produce a diverse portfolio of products; 2) abilities to upgrade into ever-increasing complex goods; 3) tend to have more predictable long-term growth; and 4) attain good competitive position, relative to other countries (WB, Metadata Glossary, 2022)**.**
2. **Educational attainment, at least Master's or equivalent, female:** percentage of the female population, above 25 years, that attained or completed a master's degree or equivalent (WB, Metadata Glossary, 2022). The data is collected by the UNESCO Institute for Statistics, and is framed by the International Standard Classification of Education (ISCED) (WB, Metadata Glossary, 2022).
3. **GGGI:** *refer to the description included in Step 1. Stoet and Geary analysis*
4. **Human Capital Index, Female (HCI):** calculates the contribution of health and education to worker productivity (WB, Metadata Glossary, 2022). It is a measure of the human capital that a girls child born today can expect to acquire when she turns 18 (WB, The Human Capital Project: Frequently Asked Questions , 2022). It is ranked from 0 to 1, in which 1 implies that a child born today can expect to achieve full health and formal education when turning 18 (WB, Metadata Glossary, 2022).
5. **Multidimensional poverty, educational attainment:** "measure of poverty that captures the percentage of the population that has a deprivation in educational attainment in addition to income or consumption at the $2.15 international poverty line" (WB, 2022). It is composed of six indicators, including

educational attainment, in which the core parameters are: 1) at least one school-age child is not enrolled in school; and 2) no adult in the household has completed primary education (WB, 2022).

6. **Nondiscrimination clause mentions gender in the constitution:** it implies whether there is a nondiscrimination clause in the constitution which mentions gender. If the answer is "yes" (yes = 1) the constitution must mention "discrimination" or "nondiscrimination" clause. If the answer is "no" (no = 0), it implies that there is nondiscriminatory provision or language in the constitution (WB, Metadata Glossary, 2022).
7. **Research and development expenditure:** Gross domestic expenditure on research and development, which includes basic research, applied research, and experimental development. It is expressed as a percentage of the GDP (WB, Metadata Glossary, 2022)**.**

The descriptive statistics for model 1 can be observed on *Table 6.*

1.2.2. *Model 2. Key 3 Nordic vs. Top 3 STEM (PISA 2018)*

The second model included three key Nordic countries, with the most significant correlation between GGGI and share of women in STEM areas; the top 3 countries with the higher participation of women in STEM areas; and Colombia as a country of interest for the research.

Particularly, for this model, one independent variable that was intended to be analyzed was educational attainment, through PISA 2018 scores, which was a determinant element when choosing the countries of analysis. Accordingly, the seven countries for this model can be observed in *Table 5.*

Table 5. Countries used in Model 2. Key 3 Nordic vs. Top 3 STEM (PISA 2018)

KEY 3 NORDIC	TOP 3 STEM	OTHERS
Finland Norway Denmark	Brunei Darussalam Peru Qatar	Colombia *(country of interest for the research)*

Later on, the independent variables were correlated with the dependent variable listed on *Table 1,* in order to find tentative indicators that may explain the Gender-Equality Paradox. Although the 31 independent variables were tested, only seven, resulted significant for the research:

1. **Economic Fitness Metric:** *refer to the description on Model 1. Top 10 GGGI vs. Top 10 STEM.*
2. **GGGI:** *refer to the description included in Step 1. Stoet and Geary analysis.*
3. **GINI Coefficient:** Measures the extent to which the distribution of income or consumption among individuals or households within an economy deviates from a perfectly equal distribution. It is measured on a scale of 0 to 1, in which 0 implies perfect equality; while 1 implies perfect inequality.
4. **Human Capital Index (HCI):** *refer to the description on Model 1. Top 10 GGGI vs. Top 10 STEM.*
5. **Multidimensional poverty, educational attainment:** *refer to the description on Model 1. Top 10 GGGI vs. Top 10 STEM.*
6. **Nondiscrimination clause mentions gender in the constitution:** *refer to the description on Model 1. Top 10 GGGI vs. Top 10 STEM.*
7. **Research and development expenditure:** *refer to the description on Model 1. Top 10 GGGI vs. Top 10 STEM.*

The descriptive statistics for Model 2 can be observed on *Table 7.*

Table 6. Model 1. Descriptive Statistics on Top 10 GGGI vs. Top 10 STEM

	N	Mean	Median	SD	Coefficient of variation	Kurtosis	Skewness	Min	Max
Share of women among STEM graduates in tertiary education	21	42,11	42,50	11,89	0,28	-1,44	0,02	22,32	60,76
Global Gender Gap Index 2021 (0 - 1)	22	0,74	0,75	0,09	0,13	-1,18	-0,21	0,57	0,89
Multidimensional poverty, educational attainment (% of population deprived)	16	10,89	1,60	17,59	1,62	3,85	2,01	0,00	61,60
Educational attainment, at least Master's or equivalent, population +25, female (%) (cumulative)	16	8,87	11,00	6,32	0,71	-1,56	-0,09	0,20	18,50
Nondiscrimination clause mentions gender in the constitution (1=yes; 0=no)	16	0,81	1,00	0,40	0,50	1,28	-1,7	0,00	1,00
Research and development expenditure (% of GDP)	19	1,33	0,80	1,16	0,87	-1,10	0,72	0,10	3,50
Economic Fitness Metric (Legacy)	20	0,80	0,45	0,89	1,12	-0,09	1,11	0,00	2,70
Human Capital Index (HCI), Female (scale 0 -1)	20	0,67	0,65	0,14	0,21	-1,00	-0,52	0,40	0,80

Table 7. Model 2. Descriptive Statistics on Key 3 Nordic vs. Top 3 STEM (*PISA 2018*)

	N	Mean	Median	SD	Coefficient of variation	Kurtosis	Skewness	Min	Max
Share of women among STEM graduates in tertiary education	7	39,04	34,25	10,69	0,27	-1,88	0,35	27,40	54,34
Global Gender Gap Index 2021 (0 - 1)	7	0,75	0,73	0,09	0,12	-0,98	0,14	0,62	0,86
GINI Coefficient	6	36,17	34,65	9,97	0,28	-1,34	0,58	27,30	51,30
Multidimensional poverty, educational attainment (% of population deprived)	5	2,78	2,10	2,35	0,84	-2,88	0,30	0,30	5,40
Nondiscrimination clause mentions gender in the constitution (1=yes; 0=no)	6	0,50	0,50	0,55	1,10	-3,33	0,00	0,00	1,00
Research and development expenditure (% of GDP)	7	1,36	0,50	1,31	0,96	-2,45	0,46	0,20	3,00
Economic Fitness Metric (Legacy)	7	0,77	0,40	0,88	1,15	-0,10	1,13	0,00	2,30
Human Capital Index (HCI), Female (scale 0 -1)	7	0,70	0,70	0,10	0,14	-2,60	0,00	0,60	0,80

1.2.3. *Model 3. Key 3 Nordic vs. Top 3 STEM*

For Model 3, the same criterion of Model 2 was used; however, the differential element was that PISA 2018 was not considered as a core variable. In that regard, the countries that changed from Model 2 to 3, are only those categorized as top 3 STEM, as can be observed on *Table 8.*

Table 8. Countries used in Model 3. Key 3 Nordic vs. Top 3 STEM

KEY 3 NORDIC	TOP 3 STEM	OTHERS
Finland Norway Denmark	Myanmar Algeria Tunisia	Colombia *(country of interest for the research)*

Nonetheless, it is important to take into account that that differentiation between countries from Model 2 to 3, generated a substantial variation in the independent variables that where significant when running the correlations. Interestingly, for this particular case, 16 independent variables showed a significant correlation with the share of women in STEM areas:

1. **Contributing family workers, female:** refers to female family workers who hold "self-employment jobs" defined as “own-account workers in a market-oriented establishment operated by a related person living in the same household” (WB, Metadata Glossary, 2022)**.** The indicator includes two categories: 1) wage and salaried workers (employees); and (2) self-employed workers. Particularly, the self-employed category is subdivided in: a) self-employed workers with employees (employers); b) self-employed workers without employees (own-account workers); and c) members of producers'

cooperatives and contributing family workers (also known as unpaid family workers) (WB, Metadata Glossary, 2022).

2. **Economic Fitness Metric:** *refer to the description on Model 1. Top 10 GGGI vs. Top 10 STEM.*
3. **Educational attainment, at least Bachelor's or equivalent, female:** percentage of the female population, above 25 years, that attained of completed a bachelor's degree or equivalent (WB, Metadata Glossary, 2022). The data is collected by the UNESCO Institute for Statistics, and is framed by the International Standard Classification of Education (ISCED) (WB, Metadata Glossary, 2022).
4. **Educational attainment, at least Master's or equivalent, female:** *refer to the description on Model 1. Top 10 GGGI vs. Top 10 STEM.*
5. **Employment in industry, female:** refers to the percentage of female workers in the industry sector (mining and quarrying, manufacturing, construction, and public utilities) (WB, Metadata Glossary, 2022). It is classified by the ILO's International Standard Industrial Classification (ISIC) of all economic activities (WB, Metadata Glossary, 2022).
6. **Employment in services, female:** refers to the percentage of female workers in the service sector (wholesale and retail trade and restaurants and hotels; transport, storage, and communications; financing, insurance, real estate, and business services; and community, social, and personal services) (WB, Metadata Glossary, 2022). It's classified by the ILO's International Standard Industrial Classification (ISIC) of all economic activities (WB, Metadata Glossary, 2022).

7. **Firms with female participation in ownership:** percentage of firms with a woman among the principal owners (WB, Metadata Glossary, 2022)**.**
8. **Firms with female top manager:** percentage of firms in the private sector who have females as top managers. Particularly, top manager refers to the highest-ranking manager or CEO of the establishment, who may be the owner if she works as the manager of the firm (WB, Metadata Glossary, 2022).
9. **GGGI:** *refer to the description included in Step 1. Stoet and Geary analysis.*
10. **Households and NPISHs consumption expenditure:** the annual percentage growth of household and NPISHs (Non-Profit Institutions Serving Households) final consumption expenditure based on constant local currency (WB, Metadata Glossary, 2022).
11. **Human Capital Index (HCI):** *refer to the description on Model 1. Top 10 GGGI vs. Top 10 STEM.*
12. **Multidimensional poverty, educational attainment:** *refer to the description on Model 1. Top 10 GGGI vs. Top 10 STEM.*
13. **Nondiscrimination clause mentions gender in the constitution:** *refer to the description on Model 1. Top 10 GGGI vs. Top 10 STEM.*
14. **Research and development expenditure:** *refer to the description on Model 1. Top 10 GGGI vs. Top 10 STEM.*
15. **Vulnerable employment, female:** percentage of female 1) contributing family workers and 2) own-account workers as a percentage of total employment (*it is the sum of 1 and 2*).
16. **Wage and salaried workers, female:** percentage of female workers who hold the type of jobs defined as "paid employment jobs, where the incumbents hold

explicit or implicit employment contracts that give them a basic remuneration that is not directly dependent upon the revenue of the unit for which they work" (WB, Metadata Glossary, 2022).

Descriptive statistics for this Model can be observed in *Table 9.*

1.2.4. *Model 4. Nordic Countries*

The last model intended once again to prove the Gender-Equality Paradox, and find the possible factors that could explain it. The main difference was that for this model only the Nordic countries were selected *(Sweden, Denmark, Norway, Finland, and Iceland)* as they are the most representative welfare states. For this case, 15 independent variables showed a significant correlation

1. **Economic Fitness Metric:** *refer to the description on Model 1. Top 10 GGGI vs. Top 10 STEM.*
2. **GDP per capita growth:** defined as the gross domestic product divided by midyear population, represented as the annual percentage growth rate (WB, Metadata Glossary, 2022).
3. **Gender Gap in Relative Academic Strengths:** calculated by substantiating the average score of boys minus the average score of girls. *For the general definition refer to the description included in Step 1. Stoet and Geary analysis.*
4. **GGGI:** *refer to the description included in Step 1. Stoet and Geary analysis.*
5. **GINI Coefficient:** *refer to the description on Model 2. Key 3 Nordic vs. Top 3 STEM (PISA 2018).*

Table 9. Model 3. Descriptive Statistics on Key 3 Nordic vs. Top 3 STEM

	N	Mean	Median	SD	Coefficient of variation	Kurtosis	Skewness	Min	Max
Share of women among STEM graduates in tertiary education	7	42,55	34,25	14,84	0,35	-2,51	0,31	27,40	60,76
Global Gender Gap Index 2021 (0 - 1)	7	0,74	0,73	0,09	0,12	-1,64	0,36	0,63	0,86
Multidimensional poverty, educational attainment (% of population deprived)	6	9,45	3,60	11,73	1,24	-0,81	1,07	0,30	28,00
Contributing family workers, female (% of female employment) (modeled ILO estimate)	7	6,79	2,30	13,01	1,92	6,56	2,54	0,20	36,00
Educational attainment, at least Bachelor's or equivalent, population +25, female (%) (cumulative)	5	24,90	28,10	12,29	0,49	-2,76	-0,30	10,60	37,90
Educational attainment, at least Master's or equivalent, population +25, female (%) (cumulative)	5	8,40	10,90	5,95	0,71	-2,00	-0,69	0,30	13,70
Employment in industry, female (% of female employment) (modeled ILO estimate)	7	16,06	14,40	9,38	0,58	0,10	0,98	6,90	32,60
Employment in services female (% of female employment) (modeled ILO estimate)	7	74,64	79,00	19,12	0,26	0,20	-1,05	40,60	92,10
Firms with female participation in ownership (% of firms)	6	38,82	37,60	17,01	0,44	1,66	0,51	15,00	66,90
Firms with female top manager (% of firms)	5	18,32	12,90	13,34	0,73	3,22	1,78	8,30	41,10
Households and NPISHs consumption expenditure (annual % growth)	7	-3,27	-4,10	2,87	0,88	0,95	1,05	-6,60	2,00
Nondiscrimination clause mentions gender in the constitution (1=yes; 0=no)	7	0,57	1,00	0,53	0,94	-2,80	-0,37	0,00	1,00
Research and development expenditure (% of GDP)	7	1,40	0,70	1,28	0,91	-2,35	0,40	0,10	3,00
Vulnerable employment, female (% of female employment) (modeled ILO estimate)	7	23,96	16,60	22,68	0,95	-0,64	0,90	3,70	61,70
Wage and salaried workers, female (% of female employment) (modeled ILO estimate)	7	74,20	80,70	22,82	0,31	-0,72	-0,86	36,70	95,40
Economic Fitness Metric (Legacy) - 2015	7	0,90	0,60	0,84	0,94	-0,61	0,79	0,00	2,30
Human Capital Index (HCI), Female (scale 0 -1)	7	0,66	0,60	0,14	0,21	-2,35	0,05	0,50	0,80

6. **Multidimensional poverty, educational attainment:** *refer to the description on Model 1. Top 10 GGGI vs. Top 10 STEM.*
7. **Overall Life Satisfaction score:** *refer to the description included in Step 1. Stoet and Geary analysis.*
8. **PISA 2018. Relative Math Strength, Boys:** calculated by substantiating the z score of boy's performance in mathematics, minus the z average score (z scores = standardized scores). *For the general definition refer to the description included in Step 1. Stoet and Geary analysis.*
9. **PISA 2018. Relative Math Strength, Girls:** calculated by substantiating the z score of girl's performance in mathematics, minus the z average score (z scores = standardized scores). *For the general definition refer to the description included in Step 1. Stoet and Geary analysis.*
10. **PISA 2018. Relative Reading Strength, Boys:** calculated by substantiating the z score of boy's performance in reading, minus the z average score (z scores = standardized scores). *For the general definition refer to the description included in Step 1. Stoet and Geary analysis.*
11. **PISA 2018. Relative Reading Strength, Girls:** calculated by substantiating the z score of girl's performance in reading, minus the z average score (z scores = standardized scores). *For the general definition refer to the description included in Step 1. Stoet and Geary analysis.*
12. **PISA 2018. Relative Science Strength, Boys:** calculated by substantiating the z score of boy's performance in science, minus the z average score (z scores = standardized scores). *For the general definition refer to the description included in Step 1. Stoet and Geary analysis.*

13. **PISA 2018. Relative Science Strength, Girls:** calculated by substantiating the z score of girl's performance in science, minus the z average score (z scores = standardized scores). *For the general definition refer to the description included in Step 1. Stoet and Geary analysis.*
14. **Research and development expenditure:** *refer to the description on Model 1. Top 10 GGGI vs. Top 10 STEM.*
15. **Vulnerable employment, female:** *refer to the description on Model 3. Key Nordic vs. Top 3 STEM.*

Descriptive statistics for this Model can be observed in *Table 10.*

Furthermore, it is important to take into account that as this thesis represents social studies research, in the different steps and models used, a significant correlation was assumed when having a correlation coefficient equal or higher that 50%, $r \geq 0{,}50$.

Finally, after the establishment of the four alternative models, an additional core supposition that framed this research was:

> *Hypothesis 2: Women's participation, or lack of participation in STEM areas, can be attributed to multiple levels of their surrounding environment, which can be framed through the Socio-Ecological Model (SEM). Enabling environments like social protection policies, cultural values, income equality, and gender norms; as well as effective service delivery, are key determinants in women's decision-making towards their involvement in STEM areas.*

Table 10. Model 4. Descriptive Statistics on Nordic Countries

	N	Mean	Median	SD	Coefficient of variation	Kurtosis	Skewness	Min	Max
Share of women among STEM graduates in tertiary education - least available year (WB)	4	31,40	31,36	4,06	0,13	-5,22	0,02	27,40	35,48
Global Gender Gap Index 2021 (0 - 1)	5	0,84	0,85	0,05	0,06	0,82	-0,79	0,77	0,89
Overall Life Satisfaction score (Life Satisfaction OECD better life index) (0 - 10)	5	7,52	7,50	0,25	0,03	0,32	0,92	7,30	7,90
PISA 2018. Relative Math Strength - Boys	5	-0,08	-0,10	0,05	0,65	-1,77	0,63	-0,13	-0,01
PISA 2018. Relative Math Strength - Girls	5	0,08	0,09	0,05	0,67	0,07	-0,95	0,00	0,13
PISA 2018. Relative Science Strength -Boys	5	-0,07	-0,04	0,09	1,22	3,39	-1,72	-0,22	0,01
PISA 2018. Relative Science Strength - Girls	5	0,07	0,05	0,09	1,18	2,34	1,33	-0,02	0,22
PISA 2018. Relative Reading Strength - Boys	5	-0,10	-0,09	0,08	0,78	-1,72	-0,16	-0,20	-0,01
PISA 2018. Relative Reading Strength - Girls	5	0,09	0,08	0,09	0,98	-2,11	0,11	-0,01	0,20
Gender Gap in Relative Academic Strengths	5	-0,17	-0,17	0,14	0,82	-0,57	-0,09	-0,35	0,01
GINI Coefficient	5	27,84	27,60	1,43	0,05	1,30	0,67	26,10	30,00
Multidimensional poverty, educational attainment (% of population deprived)	5	0,90	1,00	0,82	0,91	0,09	0,61	0,00	2,10
GDP per capita growth (annual %)	5	-3,52	-2,40	2,63	0,75	3,19	-1,73	-8,00	-1,30
Research and development expenditure (% of GDP)	5	2,84	2,90	0,47	0,16	-0,40	0,39	2,30	3,50
Vulnerable employment, female (% of female employment) (modeled ILO estimate)	5	5,00	4,40	1,46	0,29	2,03	1,46	3,70	7,40
Economic Fitness Metric (Legacy)	5	1,44	1,70	1,05	0,73	-2,36	-0,41	0,10	2,50

2. Methodology

Before moving on into Chapter 4, it’s important to take into account the methodology that will be used for the data analysis regarding the results obtained.

Accordingly, the Socio-Ecological Model (SEM) was mentioned in hypothesis 2, as it consists on a way to frame the variables that were selected for this research. It is considered as one of the most comprehensive models to analyze the individual behavior as a consequence of its environment (Guy-Evans, 2020).

Particularly, the origin of this model can be attributed to Urie Bronfenbrenner, a psychologist that focused its research on how multiple elements in the environment or the context that surrounds a child, can alter his or her individual development (Guy-Evans, 2020). Particularly, he established the “five ecological systems”, composed of: 1) Microsystem; 2) Mesosystem; 3) Exosystem; 4) Macrosystem; and 5) Chronosystem.

Later on, further interpretations of his theory evolved to explain individual developments attributed to different actors, rather than just a child. In that regard, the Socio-Ecological Model (SEM) acknowledges that the behavior of an individual can be framed under four or five categories, depending on the approach used. Accordingly, some theorist and institutions have framed this model in different ways to have a broader spectrum, and analyze different issues, as can be observed on *Table 11*.

Table 11. Different Socio-Ecological Models

	Five Ecological Systems ***Bronfenbrenner***	**SEM** ***Johns Hopkins University***	**SEM** ***UNFPA***	**SEM** ***VAW prevention***	**SEM** ***GAD approach***
1	Microsystem	Individuals	Individual	Individual	Individual
2	Mesosystem	Family and Peer Networks	Interpersonal	Relationship	Family
3	Exosystem;	Community	Community	Community	Community
4	Macrosystem	Service Delivery	Systems/ Institutions	Societal	Social and Political context
5	Chronosystem	Enabling Environments	Policies/ Legislative		

Having these models in mind, as well as the variables selected for this research, it was important to select a SEM approach that makes a differentiation between the macrosystem and the chronosystem; the service delivery and the enabling environment; as well as between system and institutions, and policies and legislative categories; as all this thesis variables are framed under these two categories. In that regard, the VAW prevention, and the GAD categorization of the SEM were disregarded.

Accordingly, the remaining models that could be used for this approach were the ones with the characterization presented by Bronfenbrenner, UNFPA, and Johns Hopkins University. Accordingly, some examples in their characterization are detailed as observed on *Table 12*.

Finally, having the abovementioned comparison into account, the model that will be used for this thesis will have the following connotation, which includes characteristics of the three core models mentioned on *Table 12*. Accordingly, the classification of this thesis variables, will be framed as listed on *Table 13* and highlighted on *Illustration 1*.

Table 12. Bronfenbrenner, Johns Hopkins University, and UNFPA Socio-Ecological Model comparison

	Five Ecological Systems ***Bronfenbrenner*** (Guy-Evans, 2020)	**SEM** ***Johns Hopkins University*** (JohnsHopkinsUniversity, 2017)	**SEM** ***UNFPA*** (UNFPA, 2020)
1	Immediate environment of the child: family, school, teachers	Knowledge, skills, beliefs, values, perceived norms, emotions.	Girls and women
2	Interaction between the child and the microsystem	Partner and family influence, social support	Family, friends, social networks
3	Formal and informal structures: social and health care services, mass media	Leadership, access to information, social capital	Community-based organizations
4	Attitudes and ideologies of the culture	Access and quality services	Service systems, social institutions
5	Environmental changes that occur over the life course	Policies and regulations, gender norms, income equality	National, sub-national, and local policies

Table 13. Alternative SEM

	Category	**Criteria for categorization**
1	Individual	Women in STEM areas: Knowledge, skills, beliefs, values, perceived norms, emotions
2	Interpersonal/ Relationship	Partner and family influence, social support
3	Community	Economic conditions, local beliefs, social capital
4	Service Delivery (SD)	Access and quality services
5	Enabling Environment (EE)	Policies and regulations, gender norms, and income equality

Illustration 1. Alternative SEM

Having the abovementioned connotation into account, the variables for this research were classified under only three categories: 1) Individual; 3) Service (SD) Delivery; and 3) Enabling Environment (EE). Particularly, they were framed as observed on *Table 14* for the results analysis in chapter 4.

Table 14. Results Categorization

	SEM	VARIABLES
1	Individual	Share of women among STEM graduates in tertiary education
3	EE	Global Gender Gap Index 2021 (0 - 1)
2	SD	Contributing family workers, female (% of female employment)
3	EE	Economic Fitness Metric (Legacy)
2	SD	Educational attainment, at least Bachelor's or equivalent, population +25, female (%)
2	SD	Educational attainment, at least Master's or equivalent, population +25, female (%)
2	SD	Employment in industry, female (% of female employment)
2	SD	Employment in services female (% of female employment)
2	SD	Firms with female participation in ownership (% of firms)
2	SD	Firms with female top manager (% of firms)
3	EE	GDP per capita growth (annual %)
2	SD	Gender Gap in Relative Academic Strengths
3	EE	GINI Coefficient - last year available
3	EE	Households and NPISHs consumption expenditure (annual % growth)
3	EE	Human Capital Index (HCI), Female (scale 0 -1)
2	SD	Multidimensional poverty, educational attainment (% of population deprived)
3	EE	Nondiscrimination clause mentions gender in the constitution (1=yes; 0=no)
3	EE	Overall Life Satisfaction score (Life Satisfaction OECD better life index) (0 - 10)
2	SD	PISA 2018. Relative Math Strength - Boys
2	SD	PISA 2018. Relative Math Strength - Girls
2	SD	PISA 2018. Relative Reading Strength - Boys
2	SD	PISA 2018. Relative Reading Strength- Girls
2	SD	PISA 2018. Relative Science Strength - Girls
2	SD	PISA 2018. Relative Science Strength -Boys
3	EE	Research and development expenditure (% of GDP)
2	SD	Vulnerable employment, female (% of female employment)
2	SD	Wage and salaried workers, female (% of female employment)

Chapter 4. Results & Analysis

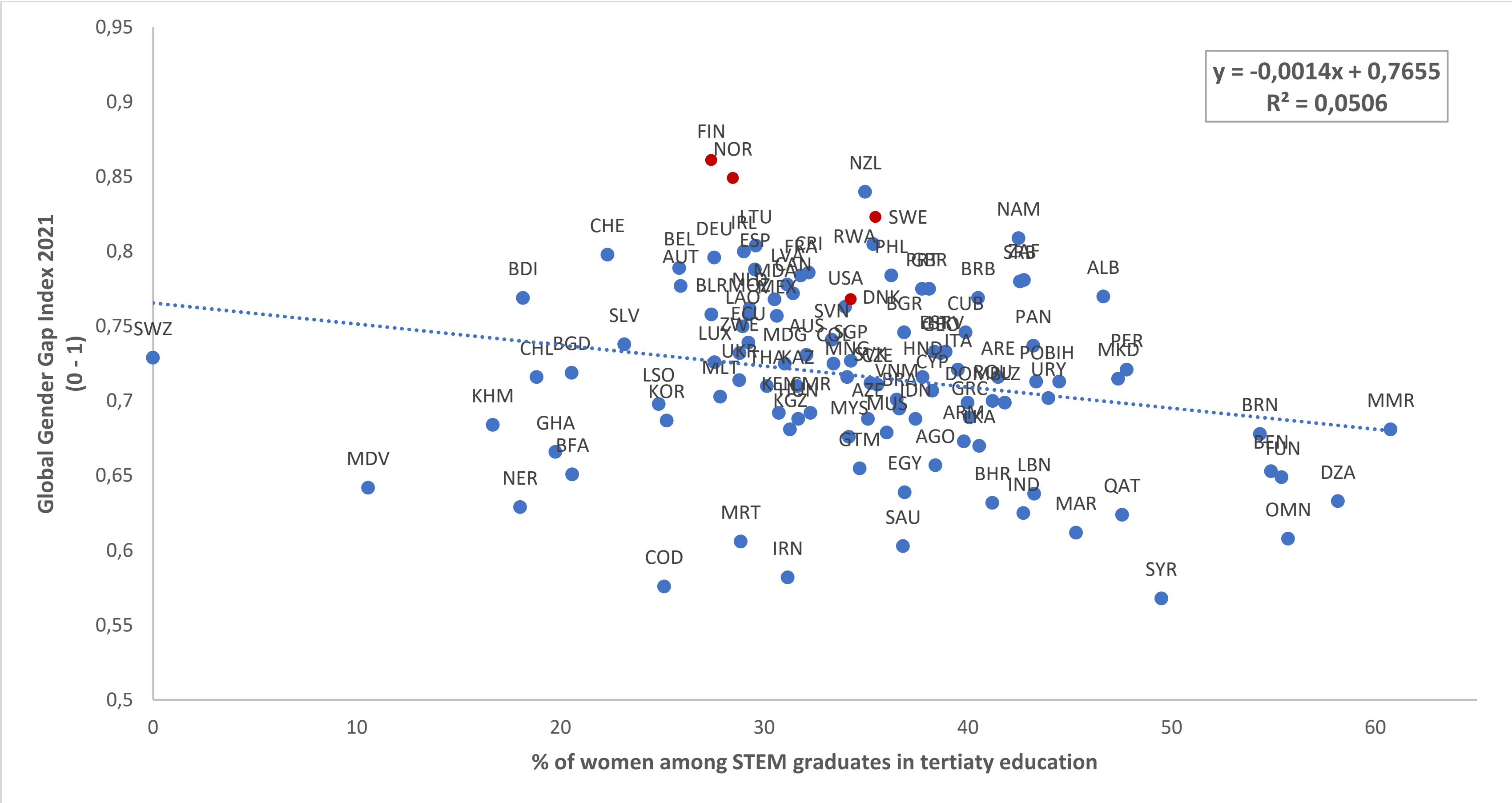
1. Step 1. Stoet & Geary analysis

Taking into account the information provided in chapter 3, different scenarios were runed to prove the Gender-Equality Paradox, with the same variables used by Gijsbert Stoet and David Geary. Those scenarios included: 1) 156 sampled countries; 2) 44 Asian countries; 3) 40 African countries; 4) 39 European countries; 5) 10 North European countries, separated from the previous group; 6) 28 countries from Latin America, the Caribbean, and North America; and 7) 5 countries from Oceania.

In that line, and as mentioned previously, in order to have a global perspective of the relationship between GGGI and women's participation in STEM areas, from the 156 sampled counties, a correlation was runed only among those 109 countries that had available data of share of women among STEM graduates in tertiary education. Accordingly, although a negative correlation could be observed (*Figure 1*) the correlation coefficient, as well as the determination coefficient were not significant enough to prove causation ($r = -0,22$ and an $r^2 = 0,0506$).

Later on, the same correlation was analyzed for the different regions mentioned above, and again no significant correlation coefficient was found. In that sense no significant tendency could be observed or proved on neither of the regions, except for the case of the Northern European countries.

Figure 1. Global tendency of GGGI vs. women's participation in STEM areas

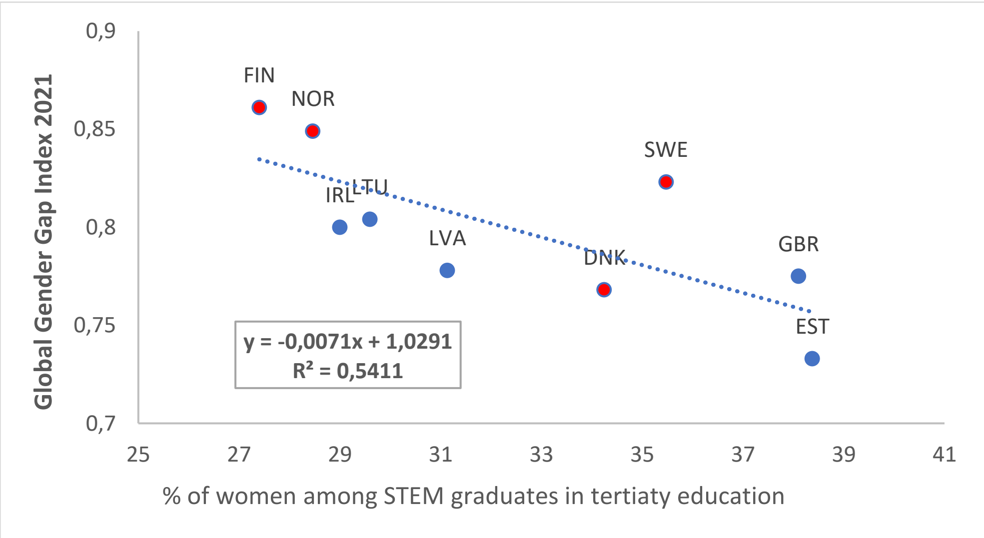


Following these results, and by taking into account that Stoet & Geary proved the Gender-Equality with the Nordic Countries, further analysis was intended to do with a broader spectrum of countries that included as well those original sampled countries. Accordingly, the Northern European region was selected as the sample to be analyzed in further detail.

The core objective of this selection was to prove the first hypothesis of this research: *"The Gender-Equality Paradox cannot only be proved in the Nordic countries, but also in all Northern European countries"*.

Accordingly, after running the regressions, the Paradox was proved for the 10 Northern European countries *(Finland, Norway, Sweden, Lithuania, Ireland, Latvia, United Kingdom, Denmark, and Estonia)*, proving as well the first hypothesis of the research, as can be observed on *Figure 2.*

Figure 2. GGGI vs. Share of Women in STEM areas



On that same line, this first data analysis showed a negative correlation between share of women among STEM graduates in tertiary education, and the

GGGI, with an $r = -0{,}74$ and an $r^2 = 0{,}5411$. Detailed information can be observed in *Table 15*.

Additionally, it can be observed that five independent variables showed a negative correlation that helped proving the Paradox, as was the case of: 1) GGGI, mentioned above; 2) PISA 2018 girls relative math strength ($r = -0{,}67$); 3) PISA 2018 girls relative science strength ($r = -0{,}57$); 4) PISA 2018 girls relative reading strength ($r = -0{,}67$); 5) average score for girls ($r = -0{,}66$); and 6) Overall Life Satisfaction Score (OLS) ($r = -0{,}28$). This last variable (OLS), was disregarded as its correlation coefficient was below 0,50.

On the other hand, eight independent variables showed a positive correlation with share of women among STEM graduates in tertiary education, as was the case of: 1) PISA 2018 boys relative math strength ($r = 0{,}70$); 2) difference in relative math strength between girls and boys ($r = 0{,}68$); 3) PISA 2018 boys relative science strength ($r = 0{,}56$); 4) difference in relative science strength between girls and boys ($r = 0{,}57$); 5) PISA 2018 boys relative reading strength ($r = 0{,}65$); 6) difference in relative reading strength between girls and boys ($r = 0{,}66$); 7) average score for boys ($r = 0{,}67$); and 8) gender gap in relative academic strengths ($r = 0{,}67$).

It's important to take into account that when collecting the data set for the Northern European countries, Iceland wasn't included as there was not available data regarding its share of women in STEM areas.

Table 15. Stoet & Geary Correlation

	Share of women among STEM graduates in tertiary education	*Global Gender Gap Index 2021*	*PISA 2018. Relative Math Strength by gender - Boys*	*PISA 2018. Relative Math Strength by gender - Girls*	*Difference in Relative Math Strength between Girls and Boys*	*PISA 2018. Relative Science Strength by gender - Boys*	*PISA 2018. Relative Science Strength by gender - Girls*	*Difference in Relative Science Strength between Girls and Boys*	*PISA 2018. Relative Reading Strength by gender - Boys*	*PISA 2018. Relative Reading Strength by gender - Girls*	*Difference in Relative Reading Strength between Girls and Boys*	*Average Score for boys*	*Average Score for girls*	*Gender Gap in Relative Academic Strengths*	*Overall Life Satisfaction Score*
Share of women among STEM graduates in tertiary education	1														
Global Gender Gap Index 2021	-0,74	1													
PISA 2018. Relative Math Strength by gender - Boys	0,70	-0,90	1												
PISA 2018. Relative Math Strength by gender - Girls	-0,67	0,89	-0,99	1											
Difference in Relative Math Strength between Girls and Boys	0,68	-0,90	1,00	-1,00	1										
PISA 2018. Relative Science Strength by gender - Boys	0,56	-0,52	0,57	-0,58	0,58	1									
PISA 2018. Relative Science Strength by gender - Girls	-0,57	0,53	-0,62	0,65	-0,64	-0,99	1								
Difference in Relative Science Strength between Girls and Boys	0,57	-0,52	0,60	-0,62	0,61	1,00	-1,00	1							
PISA 2018. Relative Reading Strength by gender - Boys	0,65	-0,69	0,85	-0,86	0,86	0,86	-0,90	0,88	1						
PISA 2018. Relative Reading Strength by gender - Girls	-0,67	0,70	-0,87	0,88	-0,87	-0,83	0,87	-0,86	-1,00	1					
Difference in Relative Reading Strength between Girls and Boys	0,66	-0,69	0,86	-0,87	0,87	0,85	-0,89	0,87	1,00	-1,00	1				
Average Score for boys	0,67	-0,76	0,88	-0,89	0,88	0,88	-0,92	0,90	0,99	-0,98	0,99	1			
Average Score for girls	-0,66	0,75	-0,88	0,90	-0,89	-0,86	0,91	-0,89	-0,99	0,99	-0,99	-1,00	1		
Gender Gap in Relative Academic Strengths	0,67	-0,75	0,88	-0,89	0,89	0,87	-0,91	0,90	0,99	-0,99	0,99	1,00	-1,00	1	
Overall Life Satisfaction Score	-0,28	0,67	-0,66	0,62	-0,64	-0,47	0,46	-0,47	-0,48	0,48	-0,48	-0,58	0,55	-0,56	1

The core findings to be highlighted can be observed in *Figure 2*, regarding the relationship between GGGI and the share of women among STEM graduates in tertiary education, in which the Gender-Equality Paradox can be fully observed.

For instance, Finland, being the country with the highest level of gender equality, with a $GGGI = 0{,}86$, showed the lowest share of women among STEM graduates in tertiary education equal to 27,40%. While on the other hand, Estonia showed the lowest $GGGI = 0{,}73$, and the highest share of women among STEM graduates, with a participation of 38,38%, above the regional (32,42%) and the global mean (34,72%).

Later on, regarding PISA 2018 girls' relative strength on math (*Figure 3*), science (*Figure 4*), and reading (*Figure 5*), similar findings could be observed. On the first hand, Finland and Norway where the top two countries in which girls showed high relative academic strengths in the three areas of study; however, they were as well the countries with the lowest share of women among STEM graduates in tertiary education. Interestingly, United Kingdom scored the girls' lowest result on the three areas of the PISA 2018; nonetheless, presented one of the highest participation of women among STEM graduates in tertiary education (38,10%).

Figure 3. PISA 2018 Girls' Relative Math Strength vs. Share of women among STEM graduates in tertiary education

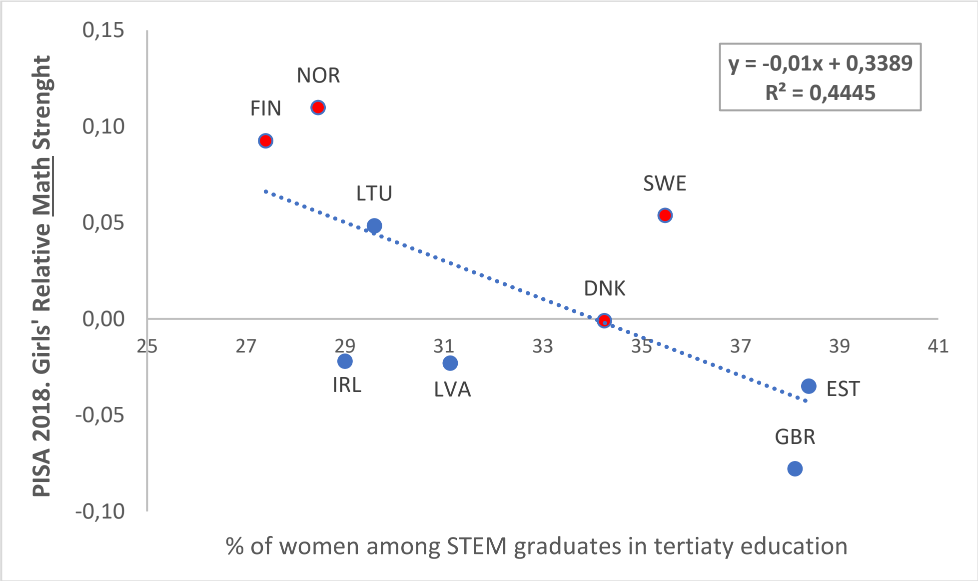


Figure 4. PISA 2018 Girls' Relative Science Strength vs. Share of women among STEM graduates in tertiary education

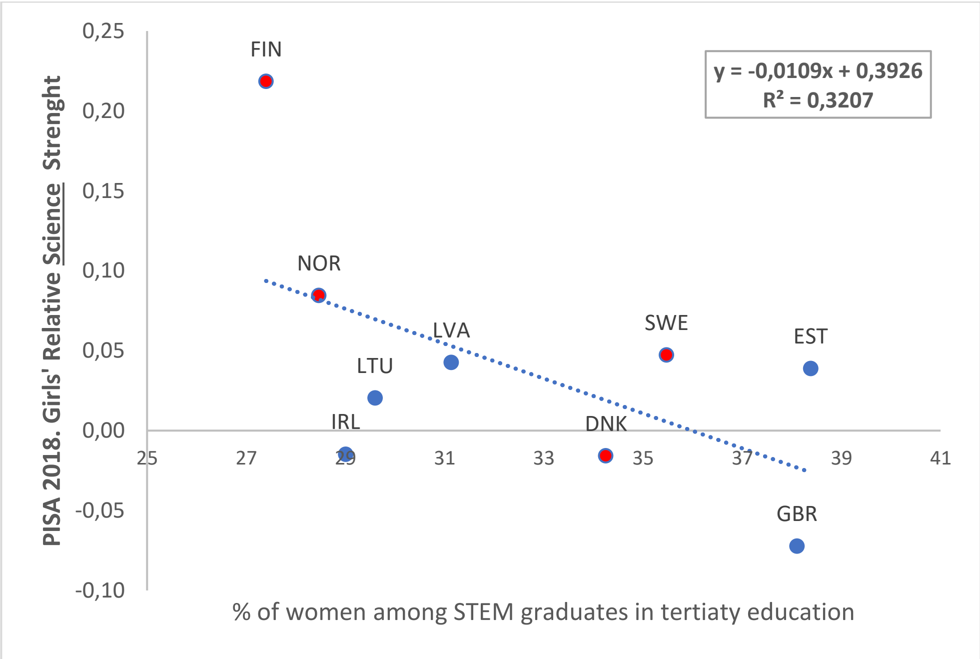
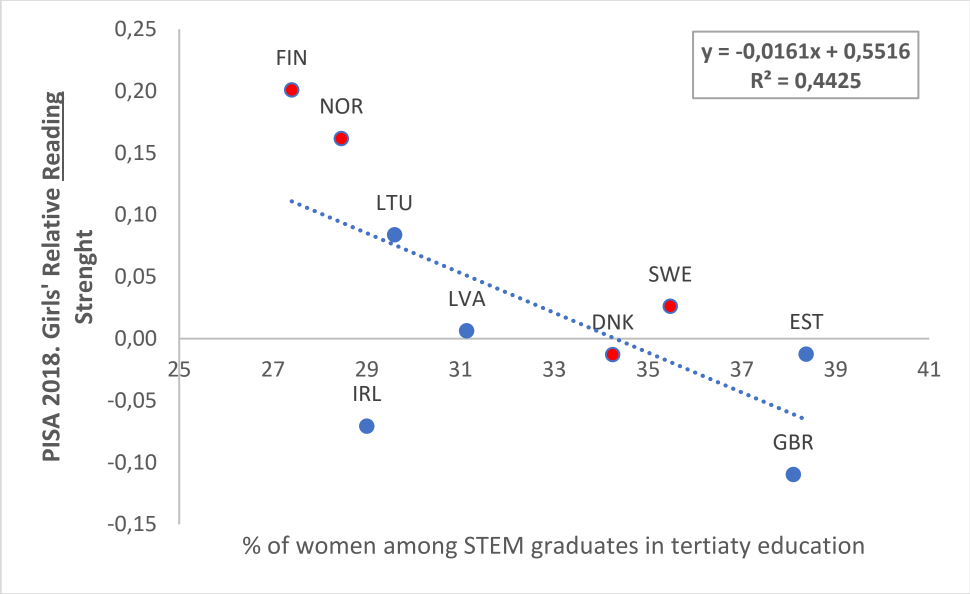


Figure 5. PISA 2018 Girls' Relative Reading Strength vs. Share of women among STEM graduates in tertiary education

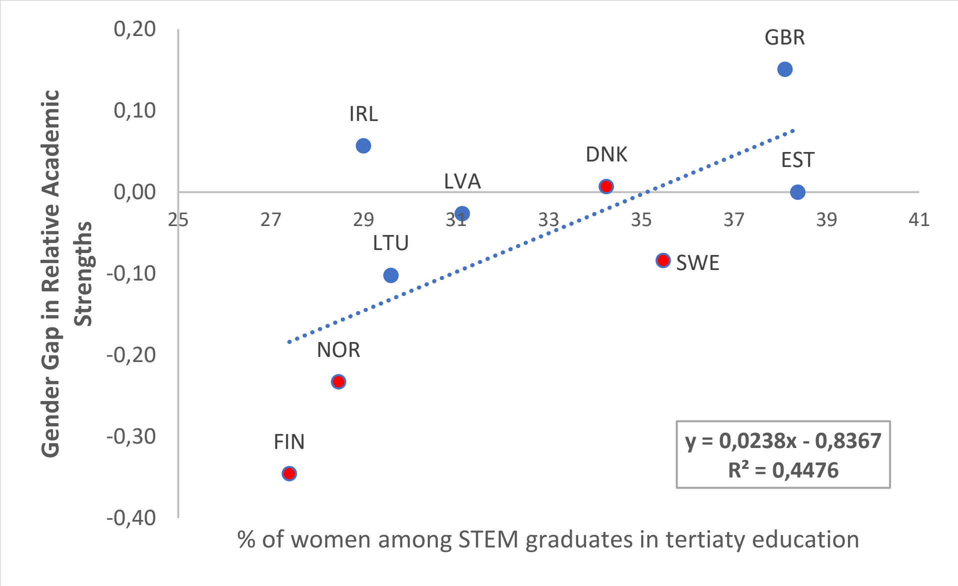


The abovementioned, although proved the Paradox, leave the unresolved question of what could be the main reason or reasons that explain this behavior in which girls, despite their high performance in areas like science and mathematics, are still reluctant to study in fields related to STEM areas in tertiary education.

On the other hand, when looking at the variables that showed a positive correlation, it was interesting to find the exact opposite tendency. Accordingly, boy's highest results could be observed in areas like mathematics and science in countries like United Kingdom and Estonia, while in Finland and Norway they presented the lowest results as can be observed on *Figures 3* and *4*.

Having the abovementioned into account, one interesting finding that could be highlighted and that goes hand in hand with this Paradox, was the obtained results regarding the Gender Gap in Relative Academic Strengths, as can be observed in *Figure 6*.

Figure 6. Gender Gap in Relative Academic Strengths vs. Share of women among STEM graduates in tertiary education



Particularly, countries with negative results showed that girls had highest average scores in the three areas, while the positive results implied the opposite scenario, in which boys were the ones with the higher average score. In that regard, it was once again reaffirmed that in countries like Finland and Norway, despite the positive results that girls presented in the PISA 2018 results, specifically in mathematics and science, their participation in STEM areas was still the lowest in the region, compared to United Kingdom, in which girls, despite their low PISA 2018 results, had still the highest participation in STEM areas in tertiary education.

Accordingly, by using a similar approach to the one used by Gijsbert Stoet and David Geary on their research, the Gender-Equality Paradox was proved. Additionally, and as a step towards proving hypothesis 2, the prevalent category of the Socio-Ecological Framework that could be observed in this analysis, regarding the core independent variables, was service delivery.

2. Step 2. New models

As mentioned before, the second step of this thesis was to explore new variables and countries that could guide this research towards the identification of those factors or elements that might explains women's decision-making process towards their involvement in STEM fields, and that accordingly could explain the Gender-Equality Paradox. In that regard, although six models where tested, only four of them resulted significant for this research.

2.1. *Model 1 results. Top 10 GGGI vs. Top 10 STEM*

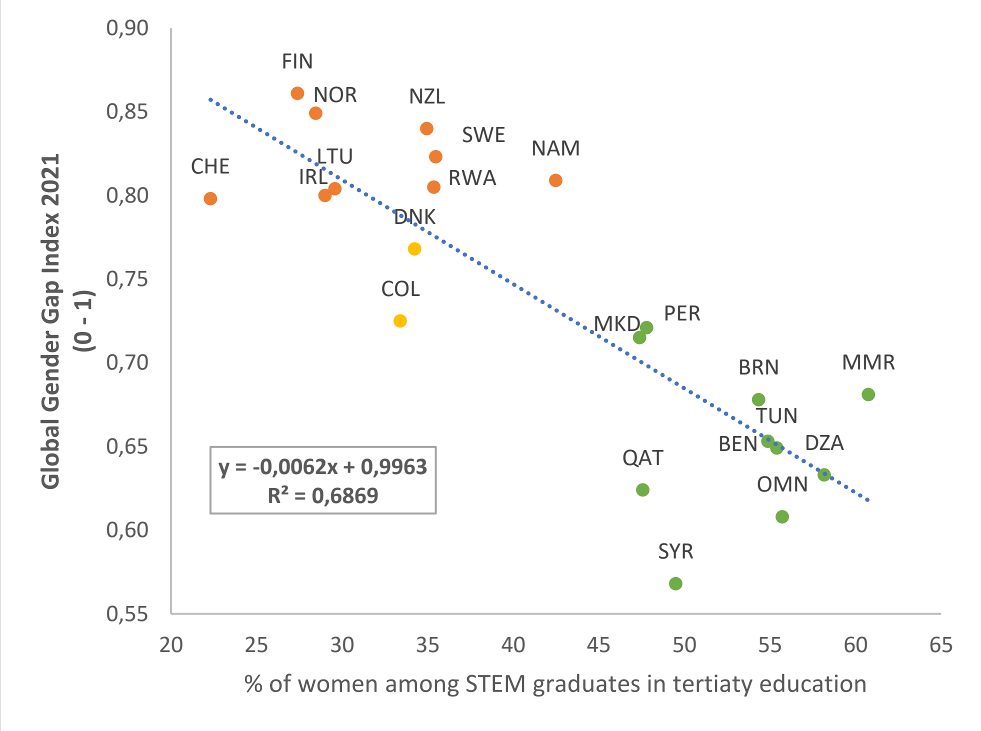
The first model that was tested, included 22 countries as showed in *Table 3*; the top 10 countries with the highest Global Gender Gap Index of 2021; the top 10 countries with the highest share of women among STEM graduates in tertiary education from the World Bank DataBank; plus, Denmark as the only Nordic country that was not on the top 10 GGGI, but still was in a very high position as being ranked in the eleventh place; and Colombia as a country of interest for this research.

In that regard, the first finding was that once again there was a negative correlation between the share of women in STEM areas and the GGGI. Interestingly, the comparison between these 22 countries, showed a higher correlation coefficient ($r = -0{,}83$), and a higher determination coefficient ($r^2 = 0{,}69$), compared to the one found when doing the Stoet and Geary analysis, as can be observed on *Table 16*, and *Figure 7*.

Table 16. MODEL 1. Top GGGI vs Top STEM Correlation

	Share of women among STEM graduates in tertiary education	*Global Gender Gap Index 2021 (0 - 1)*	*Multidimensional poverty, educational attainment*	*Educational attainment, at least Master's or equivalent, population +25, female (%)*	*Nondiscrimination clause mentions gender in the constitution (1=yes; 0=no)*	*Research and development expenditure (% of GDP)*	*Economic Fitness Metric (Legacy) - 2015*	*Human Capital Index (HCI), Female (scale 0 -1)*
Share of women among STEM graduates in tertiary education	1							
Global Gender Gap Index 2021 (0 - 1)	-0,83	1						
Multidimensional poverty, educational attainment	0,61	-0,56	1					
Educational attainment, at least Master's or equivalent, population +25, female (%)	-0,73	0,68	-0,73	1				
Nondiscrimination clause mentions gender in the constitution (1=yes; 0=no)	0,52	-0,52	0,45	-0,58	1			
Research and development expenditure (% of GDP)	-0,70	0,72	-0,51	0,73	-0,74	1		
Economic Fitness Metric (Legacy)	-0,64	0,44	-0,52	0,62	-0,47	0,78	1	
Human Capital Index (HCI), Female (scale 0 -1)	-0,71	0,65	-0,85	0,80	-0,60	0,74	0,57	1

Figure 7. Share of women among STEM graduates in tertiary education vs. GGGI (TOP 10 STEM – TOP 10 GGGI)



As observed in *Figure 7*, the Paradox was proved again when comparing the top 10 countries with the higher GGGI, and the top 10 countries with the higher share of women among STEM graduates in tertiary education.

For instance, it's interesting to observe the case of Syria being the sampled country with the lowest GGGI (0,57), ranked 152 of 156 countries according to the Global Gender Gap Report of 2021 (WEF W. E., 2021), and having as well a share of women in STEM areas of 49,51%. These results positioned Syria above the global average (34,72%), and this Model sampled mean (42,10%), in women's participation in STEM areas.

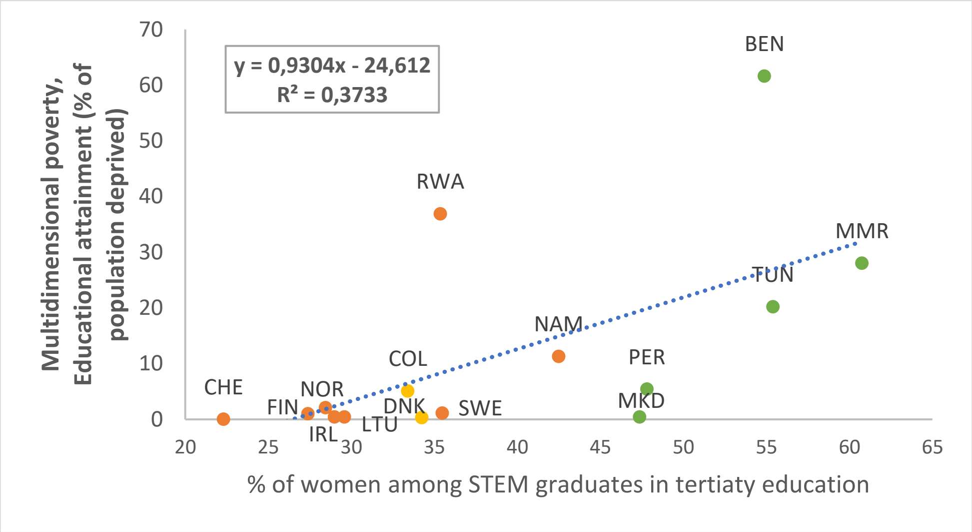
Similar tendencies can be observed for the case of Myanmar, having the highest participation of women in STEM areas (60,76%), and presenting as well the lowest results in the GGGI with a score of 0,68, ranked 109 of 156 countries (WEF W. E., 2021). The Colombian case seems to be isolated of the tendency, or in a neutral position in which its results neither regarding GGGI or women in STEM areas was high enough to track a tendency.

Similarly, other interesting findings were for instance that countries with a high percentage of women with at least a master degree or equivalent, were as well those countries with the lowest participation of women in STEM areas with an $r = -0{,}73$. Same patter occurs with countries with the highest investment in research and development ($r = -0{,}70$); countries with a high fitness metric ($r = -0{,}64$); and countries with female highest Human Capital Index ($r = -0{,}71$). Interestingly, it can be observed that countries with the best performance on those variables, that were categorized as part of the enabling environment in the Socio-Ecological Model, were as well the ones with the lowest participation of women in STEM areas.

Now, for Model 1, two variables showed a different tendency. Accordingly, positive correlations were found for percentage of the population that is deprived from educational attainment ($r = 0{,}61$), and the existence of a nondiscrimination clause that mentions gender in the constitution ($r = 0{,}52$).

As it can be observed in *Figure 8*, countries with the lowest access to educational attainment as is the case of Bennin (61,60%), Myanmar (28%) and Tunisia (20,20%), were as well countries with the highest participation of women in STEM areas; accordingly, these results can be interpreted in a twofold way. On the one hand, this could imply that as there is a low percentage of the population that has access to educational attainment, there is no proportionality when comparing percentages with countries like Finland or Norway, rather than the rough number of women in STEM areas.

Figure 8. Percentage of population deprived of educational attainment vs. Share of women among STEM graduates in tertiary education



On the other hand, this could imply that women, may be influenced in their decision-making process by characteristics framed under the category of service delivery of the Socio-Ecological Model, when there is a lack of access of any good or service, for this particular case, lack in the access to educational attainment.

Later on, the second variable that showed a different tendency was regarding the existence, or not, of a nondiscriminatory clause that mentions gender in the constitution. Interestingly, the only 3 countries that had "*no*" for an answer were Finland, Norway, and Denmark. Particularly, according to the definition of the indicator, it implies that:

> *"There is no nondiscrimination provision, or the nondiscrimination language is present in the preamble but not in an article of the constitution, or there is a*

provision that merely stipulates that the sexes are equal, or the sexes have equal rights and obligations." (WB, Metadata Glossary, 2022)

In that regard, this indicator may have various interpretations as it could imply that in these three countries there is no nondiscriminatory provision; or that there is a provision that stipulates that the sexes are equal. Accordingly, the results and their interpretation may differ significantly, as they may imply the complete opposite thing. Therefore, it's correlation was disregarded as significant for this research.

2.2. Model 2 results. Key 3 Nordic vs. Top 3 STEM (PISA 2018)

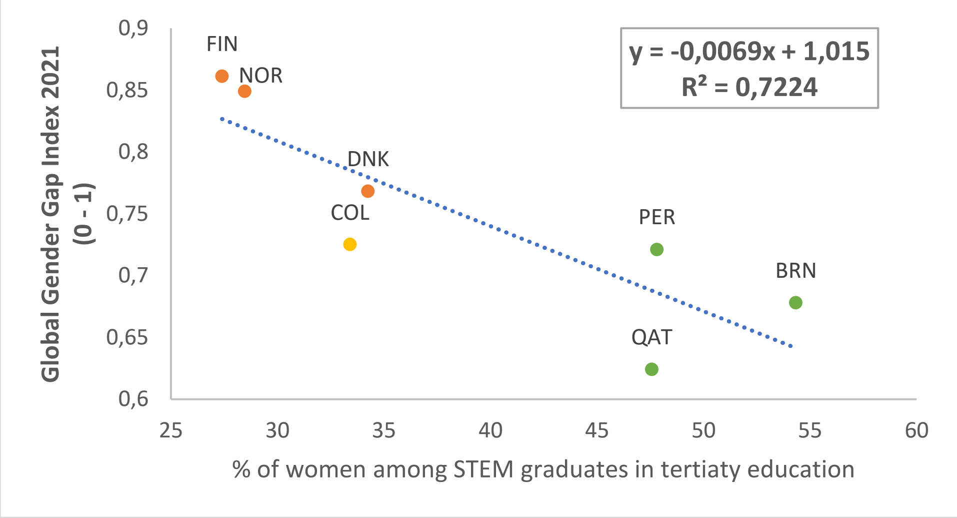
The second model that was tested had as its main goal to include the top 3 countries with the most significant correlation between GGGI and women's participation in STEM areas; the top 3 countries with the highest participation of women in STEM areas; and Colombia as a subject of interests, as can be observed on *Table 5*. Additionally, another characteristic that this model included was that the 7 sampled countries have to had participated in PISA 2018.

By using this new sample, once again the Paradox was proven when comparing GGGI and women´s participation in STEM areas with a correlation coefficient of $r = -0{,}85$, and a determination coefficient of $r^2 = 0{,}72$, higher than the ones obtained both on the Stoet and Geary analysis and Model 1, as can be observed on *Table 17* and *Figure 9*.

Table 17. MODEL 2. Key 3 Nordic vs. Top 3 STEM (PISA 2018) Correlation

	Share of women among STEM graduates in tertiary education	*Global Gender Gap Index 2021 (0 - 1)*	*GINI Coefficient*	*Multidimensional poverty, educational attainment*	*Nondiscrimination clause mentions gender in the constitution (1=yes; 0=no)*	*Research and development expenditure (% of GDP)*	*Economic Fitness Metric (Legacy)*	*Human Capital Index (HCI), Female (scale 0 -1)*
Share of women among STEM graduates in tertiary education	1							
Global Gender Gap Index 2021 (0 - 1)	-0,85	1						
GINI Coefficient	0,52	-0,71	1					
Multidimensional poverty, educational attainment	0,65	-0,71	0,89	1				
Nondiscrimination clause mentions gender in the constitution (1=yes; 0=no)	0,78	-0,84	0,93	0,96	1			
Research and development expenditure (% of GDP)	-0,76	0,79	-0,92	-0,99	-0,98	1		
Economic Fitness Metric (Legacy)	-0,63	0,62	-0,68	-0,88	-0,78	0,88	1	
Human Capital Index (HCI), Female (scale 0 -1)	-0,71	0,68	-0,94	-0,96	-0,93	0,94	0,72	1

Figure 9. Share of women among STEM graduates in tertiary education vs. GGGI (Key 3 Nordic – TOP 3 STEM [Pisa 2018])

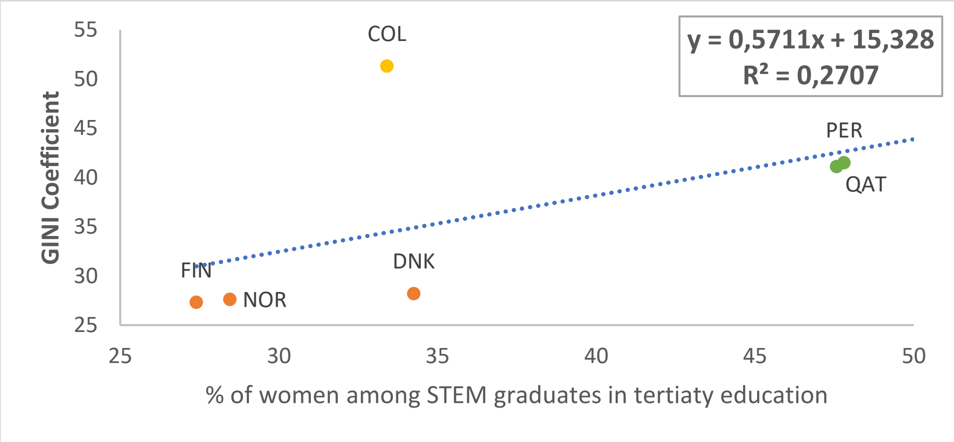


Additionally, equality that what happened on Model 1, the same independent variables showed a negative correlation when contrasted with women's participation in STEM areas. This was the case of investment on research and development ($r = -0{,}76$), economic fitness metric ($r = -0{,}63$), and female human capital index ($r = -0{,}71$). Accordingly, once again it could be observed that when having a positive tendency in variables categorized as part of the enabling environment of the SEM, the lowest participation of women in STEM areas could be observed.

Interestingly, although this model included countries that participated on PISA 2018 as a variable of analysis, no significant correlation was found regarding neither of its categories (*mathematics*, *science*, *and reading*).

On the other hand, a similar pattern compared to Model 1 occurred with those variables that showed a positive correlation, as was the case of low access in educational attainment ($r = 0{,}65$), and the nondiscrimination clause existence ($r = 0{,}78$). Nonetheless, one new variable appeared to be significant to prove the inverse positive correlation, as was the GINI coefficient ($r = 0{,}52$) as can be observed on *Figure 10*.

Figure 10. GINI Coefficient vs. Share of women among STEM graduates in tertiary education



Particularly, for the case of this independent variable it resulted interesting to observe the cases of Peru and Qatar, versus Finland, Norway and Denmark. While Colombia was the only country showing a different tendency.

For the case of the 3 Nordic countries, they showed the lowest GINI coefficient (*FIN=27,3; NOR=27,6; and DNK=28,2*) below the sampled mean (36,2), while on the other hand, Peru and Qatar, presented a GINI coefficient of 41,5 and 41,1 respectively, above the sample mean and the global average (38.38) (WorldPopulationReview, 2022); being as well the countries with the highest participation of women in STEM areas, 47,80% and 47,57% respectively.

It is important to take into account that the GINI coefficient measures the extent to which there is an equal distribution of income or consumption, so the lower the GINI coefficient, the more egalitarian scenario can be observed. In that sense, it was surprising to observe that the most egalitarian countries in terms of income and consumption as was the case of Finland, Norway, and Denmark, were as well those countries with the lowest participation of women in STEM areas.

Particularly, the GINI coefficient was also framed under the enabling environment category of the SEM, as it is related to income equality and shows as well "important background information for shared prosperity" (WB, Metadata Glossary, 2022). Accordingly, it can be assumed that those countries with higher prosperity, and higher equality are as well those with lower women's participation in STEM areas in tertiary education. Having this context in mind, it seems that the policies implemented by welfare states towards the achievement of equality are generating the opposite outcome regarding women's participation in STEM areas, and discouraging them to study or work on those fields.

These findings, gave an additional hint regarding hypothesis 2, by showing how the enabling environment may be as well a triggering factor in women's decision making regarding their involvement in STEM areas.

2.3. *Model 3 results. Key 3 Nordic vs. TOP STEM*

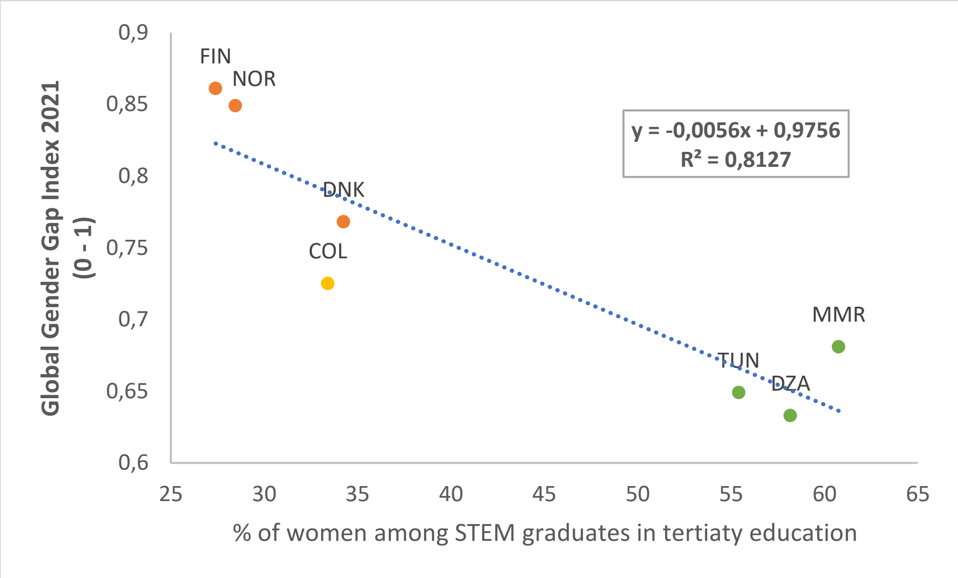
The third model used in this research included again 7 countries, that followed the same criteria of Model 2, with the differential element that PISA 2018 was not considered as a core variable of analysis. Accordingly, and as mentioned in chapter 3, this slight change, generated a significant variation regarding the variables that showed correlation with the share of women among STEM graduates in tertiary education, as can be observed on *Table 18*.

Table 18. MODEL 3. Key 3 Nordic vs. Top 3 STEM Correlation

	Share of women among STEM graduates in	*Global Gender Gap Index 2021 (0*	*Multidimensional poverty, educational*	*Contributing family workers,*	*Educational attainment, at least*	*Educational attainment, at least Master's or equivalent,*	*Employment in industry, female*	*Employment in services, female*	*Firms with female participation*	*Firms with female top manager (%*	*Households and NPISHs consumption expenditure*	*Nondiscrimination clause mentions gender in the*	*Research and development expenditure*	*Vulnerable employment, female*	*Wage and salaried*	*Economic Fitness*	*Human Capital Index (HCI),*
Share of women among STEM graduates in tertiary education	1																
Global Gender Gap Index 2021 (0 - 1)	-0,90	1															
Multidimensional poverty, educational attainment	0,98	-0,80	1														
Contributing family workers, female (% of female employment)	0,58	-0,35	0,81	1													
Educational attainment, at least Bachelor's or equivalent, population +25, female (%) (cumulative)	-0,66	0,73	-0,75	-0,74	1												
Educational attainment, at least Master's or equivalent, population +25, female (%) (cumulative)	-0,80	0,86	-0,85	-0,84	0,92	1											
Employment in industry, female	0,80	-0,86	0,71	0,11	-0,94	-0,94	1										
Employment in services female	-0,87	0,73	-0,99	-0,83	0,80	0,87	-0,65	1									
Firms with female participation in ownership (% of firms)	-0,56	0,37	-0,28	-0,03	-0,47	-0,27	-0,26	0,14	1								
Firms with female top manager (% of firms)	0,60	-0,36	0,71	0,98	-0,83	-0,89	0,00	-0,77	-0,05	1							
Households and NPISHs consumption expenditure (annual % growth)	0,54	-0,36	0,54	0,79	-0,39	-0,48	0,03	-0,60	-0,42	0,73	1						
Nondiscrimination clause mentions gender in the constitution (1=yes; 0=no)	0,79	-0,90	0,78	0,46	-0,95	-0,96	0,79	-0,77	0,04	0,53	0,24	1					
Research and development expenditure (% of GDP)	-0,75	0,82	-0,78	-0,55	0,94	0,98	-0,68	0,78	-0,08	-0,64	-0,23	-0,97	1				
Vulnerable employment, female	0,56	-0,56	0,68	0,82	-0,96	-0,98	0,28	-0,76	0,24	0,89	0,55	0,78	-0,84	1			
Wage and salaried workers, female	-0,56	0,57	-0,68	-0,81	0,97	0,97	-0,29	0,76	-0,26	-0,89	-0,54	-0,78	0,85	-1,00	1		
Economic Fitness Metric (Legacy)	-0,52	0,49	-0,54	-0,43	0,75	0,83	-0,35	0,49	0,06	-0,77	-0,03	-0,70	0,82	-0,67	0,66	1	
Human Capital Index (HCI), Female (Scale 0 -1)	-0,85	0,87	-0,90	-0,58	0,95	0,98	-0,82	0,90	-0,01	-0,57	-0,33	-0,96	0,93	-0,75	0,76	0,61	1

Accordingly, on the first hand, and as has been the case throughout this research, the first core finding of the model is that the Paradox is once again proved as can be observed on *Figure 11*, with the highest correlation coefficient found ($r = -0{,}90$), and a determination coefficient of ($r^2 = 0{,}81$).

Figure 11. Share of women among STEM graduates in tertiary education vs. GGGI (Key 3 Nordic – TOP 3 STEM)



Later on, the independent variables that showed a negative correlation when contrasted with women's participation in STEM areas were: 1) share of women above 25 years old with at least a bachelor or equivalent degree ($r = -0{,}66$); 2) share of women above 25 years old with at least a master or equivalent degree ($r = -0{,}80$); 3) share of women employed in the service sector ($r = -0{,}87$); 4) share of firms with female participation in ownership ($r = -0{,}56$); 5) investment on research and development ($r = -0{,}75$); 6) economic fitness metric ($r = -0{,}52$); and 6) female Human Capital Index ($r = -0{,}85$).

Interestingly, as can be noted from Model 1, 2 and 3, there are three independent variables that showed a negative correlation with women's participation in STEM areas: 1) investment in research and development; 2) economic fitness metric; and 3) female human capital index, which are all included on the enabling environment SEM category, as has been highlighted before.

On the other hand, the variables that showed a positive correlation with the share of women among STEM graduates in tertiary education, were: 1) percentage of the population deprived of educational attainment ($r = 0{,}98$); 2) percentage of women employees contribution to the family ($r = 0{,}58$); 3) share of women employed in the industry sector ($r = 0{,}80$); 4) firms with female in the top managerial positions ($r = 0{,}60$); 5) households and NPISHs consumption expenditure ($r = 0{,}54$); 6) nondiscrimination clause ($r = 0{,}79$); and 7) share of women in vulnerable employment ($r = 0{,}56$).

Having this context in mind, an additional finding to highlight was related to women's employment both in services and industry, as can be observed on *Figures 12* and *13* respectively. Particularly, it's interesting to observe that those countries with the best enabling conditions, as is the case of Norway, Finland, and Denmark, were as well those countries with the highest participation of women working in the service sector (ej. retail, restaurants, hotels, transport, storage, communications, and business services); while on the other hand, Algeria, Tunisia, and Myanmar, showed a higher participation of women in the industry sector (ej. mining, manufacturing, and construction).

Figure 12. Female employment in services vs. Share of women among STEM graduates in tertiary education.

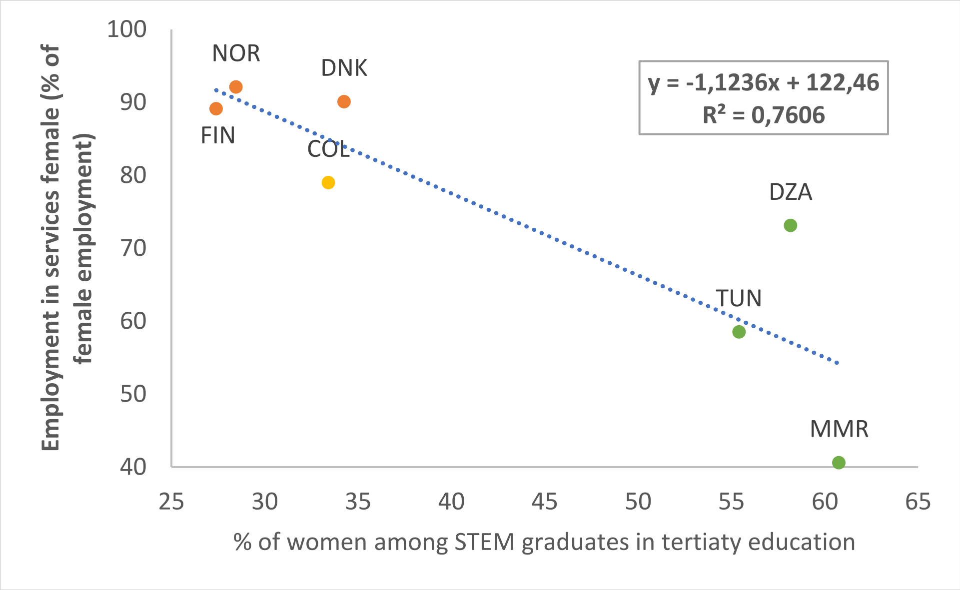
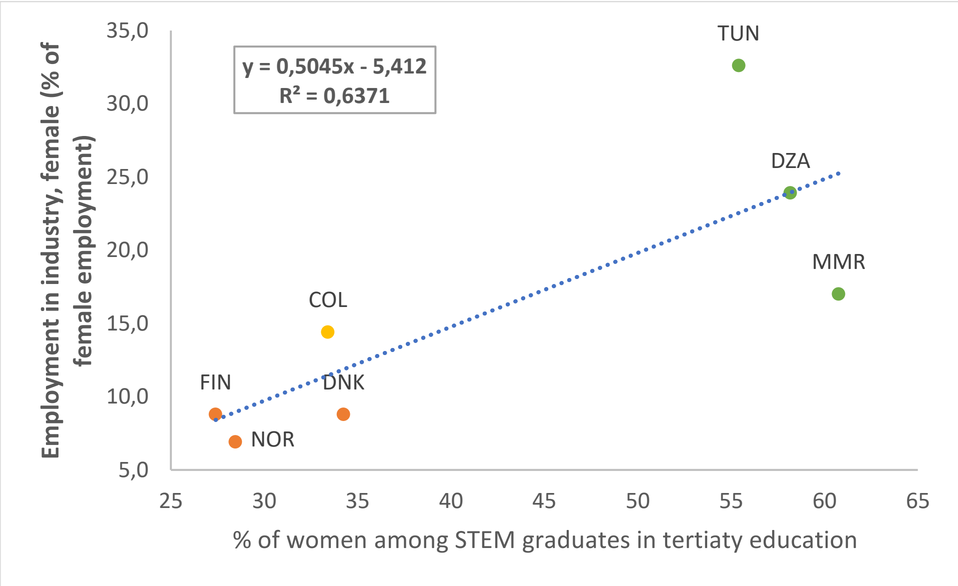


Figure 13. Female employment in industry vs. Share of women among STEM graduates in tertiary education.



In that sense, it could be suggested that in countries with the best enabling environment conditions, women prefer to work on service-related fields, while in countries with negative enabling conditions, women prefer to work on the industry sector, leading to some interesting findings related to the second hypothesis of this research.

2.4. Model 4 results. Nordic Countries

Finally, the last model used during this research included only the Nordic countries, as key referents of the welfare state, in order to observe strictly on that scenario what was the influence of the enabling environment, and the service delivery category of the Socio-Ecological Model. It's important to take into account that this model does not include Iceland, as no data was available regarding share of women among STEM graduates in tertiary education.

Now, on the first hand, when comparing the GGGI and the share of women in STEM areas for this Model, the Gender-Equality Paradox was again proved, with a correlation coefficient of ($r = -0{,}77$), and a determination coefficient of ($r^2 = 0{,}59$), as can be observed on *Figure 14* and *Table 19.*

Figure 14. GGGI vs. Share of women among STEM graduates in tertiary education

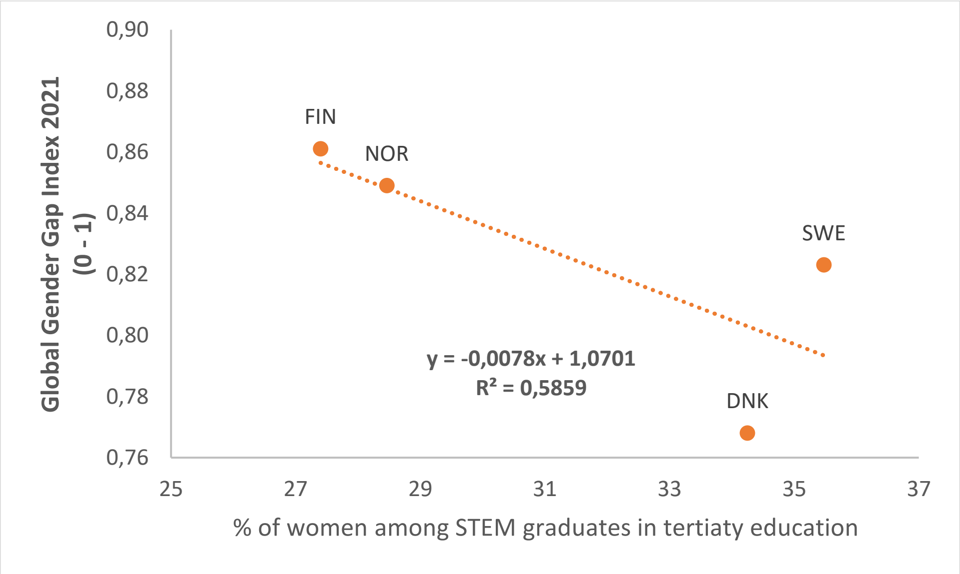


Table 19. MODEL 4. Nordic Countries Correlation

	Share of women among STEM graduates in tertiary education	*Global Gender Gap Index 2021 (0 - 1)*	*Overall Life Satisfaction score*	*PISA 2018. Relative Math Strength - Boys*	*PISA 2018. Relative Math Strength - Girls*	*PISA 2018. Relative Science Strength -Boys*	*PISA 2018. Relative Science Strength - Girls*	*PISA 2018. Relative Reading Strength - Boys*	*PISA 2018. Relative Reading Strength- Girls*	*Gender Gap in Relative Academic Strengths*	*GINI Coefficient - last year available*	*Multidimensional poverty, educational attainment*	*GDP per capita growth (annual %)*	*Research and development expenditure (% of GDP)*	*Vulnerable employment, female*	*Economic Fitness Metric (Legacy)*
Share of women among STEM graduates in tertiary education	1															
Global Gender Gap Index 2021 (0 - 1)	-0,77	1														
Overall Life Satisfaction score	-0,53	0,33	1													
PISA 2018. Relative Math Strength - Boys	0,89	-0,95	-0,26	1												
PISA 2018. Relative Math Strength - Girls	-0,80	0,97	0,18	-0,99	1											
PISA 2018. Relative Science Strength -Boys	0,79	-0,47	-0,74	0,44	-0,42	1										
PISA 2018. Relative Science Strength - Girls	-0,81	0,50	0,65	-0,48	0,47	-0,99	1									
PISA 2018. Relative Reading Strength - Boys	0,95	-0,67	-0,49	0,75	-0,72	0,88	-0,90	1								
PISA 2018. Relative Reading Strength- Girls	-0,96	0,67	0,47	-0,76	0,72	-0,85	0,88	-1,00	1							
Gender Gap in Relative Academic Strengths	0,92	-0,73	-0,56	0,77	-0,75	0,90	-0,93	0,99	-0,98	1						
GINI Coefficient	0,86	-0,63	-0,54	0,72	-0,62	0,26	-0,21	0,46	-0,47	0,47	1					
Multidimensional poverty, educational attainment	-0,53	0,04	-0,41	-0,20	0,23	-0,28	0,38	-0,50	0,52	-0,41	0,31	1				
GDP per capita growth (annual %)	-0,68	-0,56	-0,16	0,39	-0,42	-0,23	0,26	-0,19	0,20	-0,08	0,46	0,71	1			
Research and development expenditure (% of GDP)	0,75	-0,51	-0,07	0,74	-0,65	0,09	-0,10	0,49	-0,53	0,43	0,81	-0,20	0,11	1		
Vulnerable employment, female (% of female employment) (modeled ILO estimate) -2016	-0,52	0,45	0,94	-0,32	0,29	-0,85	0,80	-0,59	0,56	-0,67	-0,37	-0,26	-0,16	0,08	1	
Economic Fitness Metric (Legacy) - 2015	0,79	-0,77	-0,07	0,89	-0,85	0,06	-0,08	0,45	-0,48	0,44	0,83	-0,02	0,49	0,90	0,00	1

Interestingly, when running the regression for Model 4, the Overall Life Satisfaction Score, was for the first time a variable that showed a negative correlation with women in STEM areas. For example, Finland presented the highest OLS score (7,90), and the lowest participation of women in STEM areas (27,40%), even below the Nordic mean (31,40%); while on the other hand, Sweden presented the lowest OLS score of 7,3, and the highest share of women among STEM graduates in tertiary education (35,48%). Nonetheless, the OLS was an indicator that didn't showed much difference between its minimum and maximum values (7,3:7,9), therefore the difference among countries was not significant enough to conclude any tendency.

On the other hand, PISA 2018 indicators showed the same results in this Model, as the ones presented in the analysis of Stoet and Geary research, in which girls scores showed a negative correlation, while boys academic strengths presented the opposite tendency with women's participation in STEM fields.

Later on, three additional variables showed a negative correlation with women in STEM areas: 1) percentage of women deprived from educational attainment ($r = -0{,}53$; 2) annual growth of GDP per capita ($r = -0{,}68$); and 3) percentage of women in vulnerable employment ($r = -0{,}52$). On the contrary, the variables that showed a positive correlation were: 1) economic fitness metric ($r = 0{,}79$); 2) GINI coefficient ($r = 0{,}86$); and 3) investment in research and development ($r = 0{,}75$).

Surprisingly, for the case of percentage of women deprived from educational attainment; percentage of women in vulnerable employment; economic fitness metric; and investment in research and development, the correlation showed the opposite tendency in Models 1, 2 and 3, versus Model 4.

This implies on the first hand that when doing the analysis of the welfare states, a differentiation must be done when thinking about how the enabling environment, and the service delivery categories may affect women's decision-making towards their involvement in STEM areas.

For instance, the case of percentage of women deprived from educational attainment is still very low in the Nordic countries, compared to developing countries, with a mean of 0,90%, which could be a reason to disregard this indicator, as it might not be significant enough to explain any behavior regarding women's decision-making towards their involvement in STEM areas.

For the case of women in vulnerable employment, Finland presented the highest percentage (7,40%), and the lowest participation of women in STEM areas (27,40%); while Norway presented the lowest regional percentage of women in vulnerable employment (3,70%), and a really low participation of women in STEM areas as well (28,46). These results showed that no significant findings could be concluded from this two variables correlation, as no causation could be proved.

On the other hand, it was interesting to observe that the countries with the highest economic fitness metric like Sweden (2,50) and Denmark (2,30), were as well the countries with the highest participation in STEM areas 35,48%, and 34,25% respectively. The exact same behavior could be observed as well for the case of investment in research and development, in which Sweden (3,50%) and Denmark (3%), showed the highest expenditure of their GDP, even above the regional average (2,84%).

Finally, this could lead us to consider that when analyzing the context of the Nordic countries versus other countries; and the Nordic countries among themselves, a differentiation in the analysis must be done. The results of the data analysis led to a preliminary finding in which the correlation of the independent variables that were categorized as part of the SEM in the enabling environment, and service delivery categories, have opposite tendencies when the Nordic countries are analyzed as an indivisible group, and when they are compared among themselves. This might imply that when addressing the welfare policies as a homogeneous group of policies some preliminary results are found, but when a disaggregated analysis is done among those welfare states, the outcome may vary among themselves.

Taking into account all the results observed in this chapter, it can be concluded that the Gender-Equality Paradox does exists, and was proven in the analysis of Stoet and Geary research, as well as in the other four Models tested. Additionally, various independent variables were analyzed creating a general spectrum of the reasons that might explain women´s decision-making process towards their involvement in STEM fields. Finally, this led to interesting findings regarding how the enabling environment and the service delivery categories of the Socio-Ecological Model, are key determinants in women's decision making. Refer to *Table 20* to a broad summary of the results found in this research.

Table 20. Correlation coefficient (*r*) between share of women among STEM graduates in tertiary education and 31 independent variables for Stoet & Geary analysis, Model 1, 2, 3, and 4.

SEM	VARIABLES	Stoet & Geary *r >50%*	M1 *r >50%*	M2 *r >50%*	M3 *r >50%*	M4 *r >50%*
Individual	**Share of women among STEM graduates in tertiary education**	**1**	**1**	**1**	**1**	**1**
EE	**Global Gender Gap Index 2021 (0 - 1)**	**-0,74**	**-0,83**	**-0,85**	**-0,90**	**-0,77**
SD	Average Score for boys	0,67				
SD	Average Score for girls	-0,66				
SD	Contributing family workers, female (% of female employment)				0,58	
SD	Difference in Relative Math Strength between Girls and Boys	0,68				
SD	Difference in Relative Science Strength between Girls and Boys	0,57				
SD	Difference in Relative Reading Strength between Girls and Boys	0,66				
EE	**Economic Fitness Metric**		**-0,64**	**-0,63**	**-0,52**	**0,79**
SD	Educational attainment, at least Bachelor's or equivalent, population +25, female (%)				-0,66	
SD	Educational attainment, at least Master's or equivalent, population +25, female (%)		-0,73		-0,80	
SD	Employment in industry, female (% of female employment)				0,80	
SD	Employment in services female (% of female employment)				-0,87	
SD	Firms with female participation in ownership (% of firms)				-0,56	
SD	Firms with female top manager (% of firms)				0,60	
EE	GDP per capita growth (annual %)					-0,68
SD	Gender Gap in Relative Academic Strengths	0,67				0,92
EE	GINI Coefficient			0,52		0,86
EE	Households and NPISHs consumption expenditure (annual % growth)				0,54	
EE	Human Capital Index (HCI), Female (scale 0 -1)		-0,71	-0,71	-0,85	
SD	**Multidimensional poverty, educational attainment (% of population deprived)**		**0,61**	**0,65**	**0,98**	**-0,53**
EE	Nondiscrimination clause mentions gender in the constitution (1=yes; 0=no)		0,52	0,78	0,79	
EE	Overall Life Satisfaction score (Life Satisfaction OECD better life index) (0 - 10)					-0,53
SD	PISA 2018. Relative Math Strength - Boys	0,70				0,89
SD	PISA 2018. Relative Math Strength - Girls	-0,67				-0,80
SD	PISA 2018. Relative Reading Strength - Boys	0,65				0,95
SD	PISA 2018. Relative Reading Strength- Girls	-0,67				-0,96
SD	PISA 2018. Relative Science Strength - Girls	-0,57				-0,81
SD	PISA 2018. Relative Science Strength -Boys	0,56				0,79
EE	**Research and development expenditure (% of GDP)**		**-0,70**	**-0,76**	**-0,75**	**0,75**
SD	Vulnerable employment, female (% of female employment)				0,56	-0,52
SD	Wage and salaried workers, female (% of female employment)				-0,56	

Chapter 5. Conclusion

1. Discussion

This research, intended to prove the Gender-Equality Paradox, and find the core issues that trigger women in their decision-making process to engage, or not, in STEM fields. This was to provide insights from an academic perspective, that could be useful for policy-makers, to formulate policies to achieve the Sustainable Development Goal number 5 related to gender equality, of the 2030A, as well as future post-2030 initiatives that could go beyond the current policies that lead the gender-equality agenda.

In this regard, this research collected and analyzed the core literature related to the Gender-Equality Paradox; demonstrated its existence in different scenarios; and showed its correlation with other variables established within the Socio-Ecological Model, particularly related to the enabling environment, and the service delivery categories.

Accordingly, one of the first interesting findings was that women are influenced in their decision-making process by characteristics that fall under the service delivery category of the Socio-Ecological Model, when there is a lack of access of any good or service. In this sense, it was found that women's participation in STEM areas increases when there are negative indicators of the service delivery category.

On the other hand, when there was a positive trend in variables categorized as part of the enabling environment, the lowest participation of women in STEM areas could be observed. In this context, it can be assumed that the countries with higher wealth, and higher equality indices are also the countries with lower participation of women in STEM areas in tertiary education. Accordingly, as mentioned above, it seems that the policies implemented by welfare states to achieve social equality produce the opposite result in terms of women's participation in STEM areas, discouraging them from studying or working on these fields. An example of this, is that in countries with the best enabling environmental conditions, such as the Nordic countries, women prefer to work on service-related fields, while in countries with negative enabling conditions, women prefer to work on the industry sector.

A surprising finding observed specifically in the analysis of Model 4, was that the correlation of the independent variables classified as part of the SEM in the "enabling environment", and "service delivery" categories, showed opposite trends when the Nordic countries were analyzed as an indivisible group, rather than when they were compared among themselves.

In addition, there were three independent variables that showed a significant correlation with women's participation in STEM fields in Models 1, 2, 3 and 4, namely the economic fitness metric; the percentage of the population deprived from educational attainment; and investment in research and development; all of which fall under the enabling environment category of the SEM. Interestingly, and related to what was previously mentioned, these variables showed an opposite tendency in Models 1, 2 and 3, than the one observed in Model 4. For example, economic fitness metric and investment in research and development showed a negative correlation in Models 1, 2 and 3, and a positive correlation in Model 4. On the other hand, the percentage of the population deprived from educational attainment showed a positive correlation in Models 1, 2, and 3, and a negative correlation for Model 4.

Other variables that were included in the category of enabling environment, and that were also relevant for this research, were the female human capital index, which showed a significant negative correlation with women in STEM areas for Models 1, 2 and 3; and the nondiscrimination clause, which showed a positive correlation in the same models, although it was disregarded due to its possible different interpretation.

The variables that showed correlations in two different models at the same time, were specifically related to the service delivery category, such as the variables related to PISA 2018 scores, master's degree or equivalent, GINI coefficient, and vulnerable employment.

In conclusion, the variables that fall under the enabling environment, are more significant than those related to the service delivery category when trying to explain the Gender-Equality Paradox.

2. Limitations

One obstacle in this research was the lack of available data for some indicators. The case of Iceland is an example of that, where no data was available regarding women's participation in STEM areas, on the World Bank DataBank. Although some information could be found on OECD.STAT, the results were not comparable between the different data bases.

Another limitation of this research was that it relied on previous studies on the Gender-Equality Paradox; in this sense, the different models used throughout the research only explained the trend for the extreme cases, such as top 10 GGGI and the top 10 STEM. However, the intermediate cases, such as Colombia, were not easily explained by the models, the variables, and the SEM categorization. In this regard, further efforts need to be done in order to track a tendency of this intermediate cases.

In addition, the variables selected for this research were all framed under the enabling environment and service delivery categories. In this regard, there is a lack of additional explanations of other factors that could explain women’s behavior or decision making, that could be categorized as “individual”, “interpersonal/relationship”, or “community” categories of the Socio-Ecological Model.

Finally, there are other macro-variables that are difficult to demonstrate on a numerical data base like the social norms, cultural constraints, and gender stereotypes. In this regard, further research needs to be conducted on very specific cases to determine how these elements might influence women’s decision making regarding their involvement in STEM fields.

3. Conclusions

The Gender-Equality Paradox exist and was demonstrated through the analysis of Stoet and Geary research, as well as in the other four Models tested. In addition, several independent variables were analyzed to create a general spectrum of the reasons that might explain women´s decision-making process regarding their involvement in STEM fields. This led to interesting findings on how the enabling environment and the service delivery categories of the Socio-Ecological Model are key determinants in women’s decision making.

In this sense, policy-makers should take these socio-ecological characteristics into account when designing policies to achieve gender-equality. For example, although the 2030A is already the roadmap for achieving Sustainable Development, there is still a decade ahead towards its fulfilment, as well as the construction of the next framework post-2030, and in that regard, having this framework in mind might be a useful tool towards effective policy implementation.

As was mentioned in Chapter 1, women's participation in STEM fields is generally consider as an indicator of gender-equality; however, this research shows a different perspective. Through its core findings, it was observed that the most egalitarian countries have the lowest participation on these areas, an in that regard policymakers should focus on policies that seeks to address those macro-variables, such as the ones framed under the enabling environment and service delivery categories, and their impact on gender-equality.

Women's participation in STEM fields are indeed an indicator of women's access to education, and participation in specific fields, which are divided into three main categories: 1) engineering, manufacturing and construction; 2) natural sciences, mathematics and statistics; and 3) information and communication technologies; and their involvement in these fields is indeed significant for education, as well as for economic growth, as more people of the economically active population will work on the S&E workforce. Nonetheless, this should not be misconstrued with educational attainment per-se, as perhaps policymakers should consider education attainment as a broader indicator that enables women to study the field they prefer, and not necessarily the fields related to STEM.

Finally, policymaking should address the constraints associated with gender-equality and change the perspective from which it is formulated and measured. This could open up a new perspective, different from the one used since the Beijing Declaration and Platform for Action, and in this regard, accelerate efforts to achieve gender equality as a global goal. Nevertheless, it is important to emphasize that correlation does not necessarily imply causation; and in this regard, it should not be assumed that, for example, cutting social benefits in Nordic countries will increase women's participation in STEM fields, or that gender equality efforts in countries such as Myanmar or Algeria should not be undertaken to maintain higher levels of women's participation in STEM fields.

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Abstract in Korean

직관적으로, 여성의 역량 강화는 성 평등과 관련된다. 우리는 교육, 노동, 정치 및 의사 결정 과정에서의 여성 참여도가 가장 평등한 국가에서 가장 높을 것이라고 믿는다. 공학, 수학, 기술, 과학 분야에서 여성 참여는 종종 발전과 성 평등의 지표로 간주되며, '지속 가능한 개발 목표 5(성 평등의 성취와 여성 역량 강화)'를 향한 좋은 발걸음으로 여겨진다. 그러나 또 다른 시나리오를 제시하는 증거들이 있다. '성 평등 역설' 이론은 성 평등 지표와 여성의 STEM(과학, 기술, 공학, 수학) 분야 참여도 사이에 부적 상관관계가 있음을 암시한다. 본 연구는 이러한 상관관계를 증명하고, 이 역설을 촉발할 수 있는 요인을 제시하고자 한다.