UNIVERSITAT DE BARCELONA

Facultat d'Economia
i Empresa

Final degree project

WOMEN AND TECHNOLOGY, OPPOSITE POLES?

The influence of tertiary education systems on women's choice

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Business Administration and Management

2019-2020

SUMMARY AND KEY WORDS

This project is a study of the existing problematic in tertiary technical studies, which have an alarming small share of women. The report is divided in two parts: a situation analysis and an empirical evidence, each of which will have different objectives. Throughout the project, we see how women's and men's interests in studies only differ in four areas: Health, Education, ICT and Engineering, and how these interests are caused by cultural aspects. For this reason, four variables are proposed to be analyzed through a linear regression: PIB per capita, household spending on tertiary education, share of women in tertiary studies and share of total students in technical degrees, in order to test if they are significant or not and, thus, if they have an effect on women's choice to study technical degrees. Finally, the conclusions posed make a statement on how the problematic could be fixed based on the numerical results.

Econometrics, Regression, Tertiary Education, Policies, Engineering, ICT, Women, Sexes, Choice

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Contents

CHAPTER I: INTRODUCTION

1. MOTIVATION

As the title states, the main focus of this project is women in technical studies. More precisely, the conditions of a tertiary education model incentivizing or disincentivizing women to choose this type of degrees.

This topic is especially important because of different reasons. First of all, it is focused on a current issue: the lack of equal opportunities between sexes, which not only affects the obvious half of the society that is in disadvantage, but also the society as a whole by not profiting from a potential source of enrichment and progress. Further from that, this project is a study with a feminist perspective of how education systems and public policies can disincentivize women to embrace studies typically "more difficult" or "more costly", even in the most advanced countries.

It is an evidence that women have been, in the past, limited to domestic work, which means that they have been poorly trained for a long time. In fact, the first woman to ever graduate from college was Catherine Brewer in 1840, nearly two centuries ago. Although, it was not until some decades ago that universities started to show the same proportion of men and women in their classrooms. In fact, now a days, we can even find a slight predominance of female students in most countries around the world, which would be great news, except that there are notable differences between branches of study. In the totality of the 36 countries of the OECD, women represent less than a 25% in engineering studies and less than a 20% in technological degrees.

Why is that so alarming? Well, since the world is evolving and taking huge steps in technological progress, the labour market is also experiencing changes. It is expected that in the next few decades a lot of the current work positions will be replaced. Daron Acemoglu (2016, p. 4) "Computers replace, they take over tasks previously performed by labor (e.g., assembly tasks, switchboard operation, mail sorting, packing, stock trading, dispensing cash, operating machines, etc.)" but Acemoglu and Restrepo (2016, p. 24). "as new machines replace labor in some tasks, new tasks in which labor has comparative advantage will be created." This is what Keynes described in 1930 as technological unemployment, which is the loss of job positions because of technological development. It is not that there will be unemployment *per se* but there will surely exist polarization

of employment. This means that in the near future, there will be less demand for medium-skilled jobs and more for people with technological-related studies. The fact that women are not engaging this type of degrees, will make them, once more, less prepared for the job positions available. In other words, it will be a huge drawback towards equality between sexes, the inclusion of women in the labor market and the reduction of the gender gap.

2. OBJECTIVES AND HYPOTHESIS

The aim of the project is to measure numerically if something can be done from the government perspective, with respect to the tertiary education models, to promote the increase of women in technical degrees or if they are really not choosing these studies because they are not as interested. Therefore, the specific objectives are: First, to classify the different models of tertiary education there exist; Second, analyze how they work; Third, identify which variables have an effect on the proportion of women in technical studies.

The hypothesis behind these objectives are two: on one hand, some studies carried out by researchers like [1]Renate Schubert, Martin Brown, Matthias Gysler and Hans Wolfgang or [2]Nancy Ammon and Alexandra Bernasek or [3]Sylvia Maxfield, Mary Shapito, Vipin Gupta and Susan Hass, suggest that women are more risk adverse, especially in financial decision making, which we think would make them choose more common degrees, easier degrees and ones not so time engaging. This poses a first set of questions: are women more disincentivized than men to engage in these types of studies in countries where the technology market is not as strong?

On the other hand, the second hypothesis is that the decision of women about what type of studies to enroll in, is influenced by the economic possibilities of the family. In a world where females are not encouraged to get good work positions and to earn more money (because that is the man's role), families might assume that the boy of the family has to study something that will give him a good professional future while the girl should only do so if it is economically possible or if she really wants to do it, it is more accepted for

[1] Economic Inpury, Are woman more risk averse?

[2] Gender and Economic Transactions, Financial Decision Making, Are women really more risk averse?

[3] Gender and Risk: women, risk taking and risk aversion

her to do more vocational studies that may not evolve in great professional careers. So are, in fact, university taxes and monetary level of families influencing the choice of female students?

3. REALIZATION OF THE PROJECT

The project is structured in four chapters. The first one being the current one, the **Introduction**, where we are introducing the topic, objectives, and hypothesis.

The second chapter is the **theoretical framework**. This part will synthesize a set of data of the OECD countries to get an idea of the main problems in tertiary education and why this project took place. In this part of the project we want to show the situation of post-secondary education and to detect the biggest differences between countries

The third chapter is the central part of the project, the **practical framework**. This chapter is divided in two parts. (1) The **analysis of the tertiary education models** and the classification of the countries in the sample, which will explain how this classification was done and an ex-post analysis will be performed by providing macroeconomic information that explains the results of the classification. The objective in this first part is to detect what are the differences between models to select the variables to be analyzed in the second part; and (2) **the econometrical regression**, where we will be analyzing each variable considered as "explicative" of the proportion of women in technical degrees with the objective of determining if these variables are, in fact, significative enough and independent form one another.

Finally, in chapter four, after the analysis of both practical parts. We will put in common both results and state some **conclusions**. What we intend, is to being able to suggest some solutions that could be proven to promote the young female student's choice of studying technical degrees.

In the process of answering all of this, we will be collecting recent worldwide data about tertiary education, more specifically, data from the 36 countries forming the OECD (Organization for Economic Cooperation and Development). By doing so, we will be able to treat the data by excel and compare countries' results in the different aspects we explained before and develop a big picture of the current situation on tertiary education worldwide. All of the graphs and tables shown, unless specified otherwise, are from own making and based in the OECD data base.

Throughout the project we will always be talking about tertiary education, which englobes short-cycles, bachelor, master, and doctorate level. All of the data has been extracted from the data base of the OECD, which means the geographic area are the 36 countries in this Organization, so all the continents except from Africa (and most part of Asia) are represented. Moreover, data is divided by sex (man and women) and the time span is from 2013 to 2017, which are the last 5 years available. Not all the parts on the project will be using data from all 5 years, the specific explanations will be made in each case.

On the other hand, there are 10+2 groups of fields of study, which are listed below. To ease the comprehension of the reader, we will be naming them with shorter titles

1. **Agriculture** (Agriculture, Forestry, Fishery and Veterinary)
2. **Arts and Humanities**
3. **Business and Law** (Business, Administration and Law)
4. **Education**
5. **Engineering** (Engineering, Manufacturing and Construction)
6. **Health** (Health and Welfare)
7. **ICT** (Information and Communication Technologies)
8. **NS** (Natural Sciences, Mathematics and Statistics)
9. **Services**
10. **SS** (Social Sciences, Journalism and Communication)

*11. Generic programs. They only exist in Bachelor and Short-Cycle.

*12. Unknown programs.

The fields that are going to be central in our study as "technical studies" are Engineering and ICT, which are the ones showing significative differences. Further explanations will be made later on about this aspect.

4. DISSERTATION ACKNOWLEDGEMENTS

On the very outset of this project, I would like to extend my sincere and heartfelt obligation towards all the people who have helped me in this project. Without their active guidance, opinion, and encouragement it would not have been possible the realization of this report.

First of all, I would like to thank my tutor, Esteve Sanromà, for his enormous help and guidance throughout the project as well as his share of wide knowledge and good judgment, with a full dedication.

I would also like to acknowledge Professor Samuel Calonge for inspiring my interest in econometrics and the desire to give explanation to economic phenomena, a part from the cession of use of the complement of excel *MicroEconomia-Regresión* which was a very important tool for the project.

Moreover, I want to give a special mentioning to my job peers in the Generalitat de Catalunya, who helped me a lot during the search for the topic. Especially Carmina and Marina, helped me with the brainstorming and provided me with their opinion and knowledge on the area.

Finally, I want to thank my family and friends for their time and attention every time I needed to explain a problem that I hit or an encouraging discovery. Especially to my mother and brothers, who provided some especially useful points of view throughout the whole process.

CHAPTER II: SITUATION ANALYSIS

5. DESCRIPTIVE ANALYSIS OF THE PROBLEM

5.1 OECD DESCRIPTIVE ANALYSIS

As we already mentioned before, nowadays there is a slight predominance of female students in the tertiary education, with a 52.7% of women in 2017 opposed to a 47.3% of men. As shown in Figure 1, this difference between sexes has remained stable for the last 5 years even though both sexes have experienced an increase of enrolments of a 5.4% and 4.8% respectively.

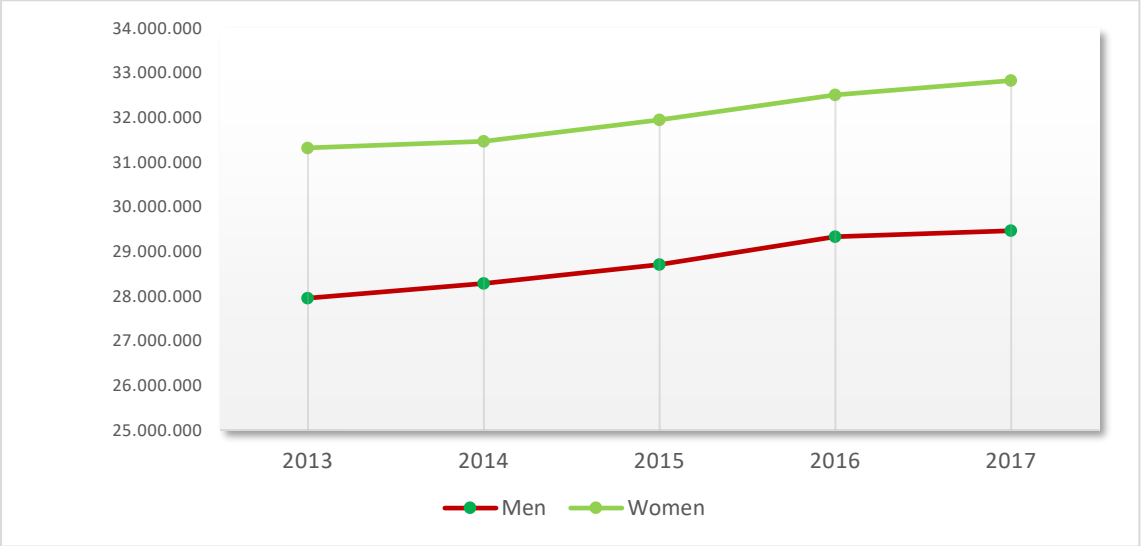

Figure 1: Nº of Enrolments by sex

Source: Own creation

Although, this is not the reality of all the fields of study, in fact there are notable differences between them. If we make the three obvious groups: Pure Sciences (Mathematics, Statistics, Engineering, Health, Agriculture, ICT…), Social Sciences (Business, Law, Communication, Journalism…) and Arts and Humanities, we get the following proportions shown in Figures 2, 3 and 4.

In figure 2, we can see how women and men's proportions invert and there is now 7% more men than women, opposed to 5% more women in the totality of all fields.

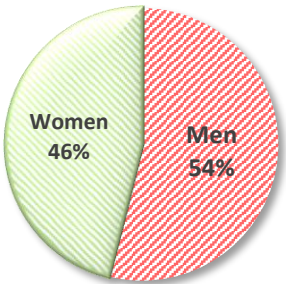

Figure 4: Pure Sciences enrolment

Source: Own creation

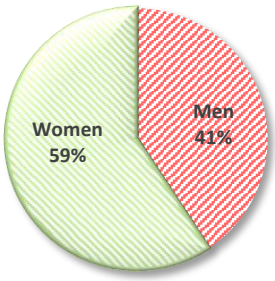

Figure 4: Arts and Humanities enrolment

Source: Own creation

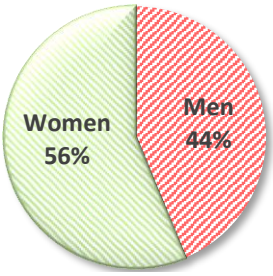

Figure 4: Social Sciences enrolment

Source: Own creation

This would not be entirely a problem, except that women's presence decreases a lot more when the Health studies are extracted from the calculation (see Figure 5).

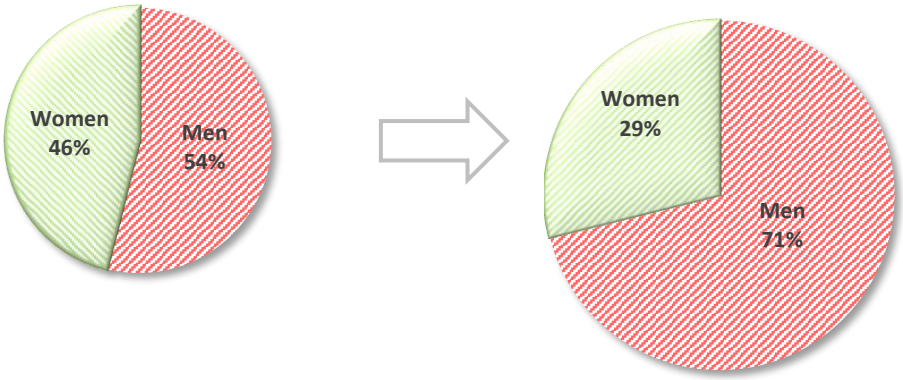

Figure 5: Pure Sciences w/ Health vs Pure Sciences w/o Health enrolment

Source: Own creation

This proves that women represent a much lower proportion in studies of technical sciences, except for health studies, which is not surprising given the feminine role in society. Women account for less than a 30% of Pure sciences while more than half of tertiary students are women. In Table 1 below, this information is broken down into each field, to take a closer look:

Table 1: Field of study by sex from 2013 to 2017

Field of study	*Men*	*Women*
Education	25,34%	**74,66%**
Health and Welfare	26,78%	**73,22%**
Social Sciences, Journalism and Information	39,09%	**60,91%**
Arts and Humanities	40,89%	**59,11%**
Business, Administration and Law	49,90%	50,10%
Services	50,77%	49,23%
Natural Sciences, mathematics and statistics	50,79%	49,21%
Agriculture, forestry, fisheries an veterinary	53,78%	46,22%
Engineering, Manufacturing and Construction	77,46%	**22,54%**
Information and Communication Technologies	80,11%	**19,89%**

Source: Own creation

In accordance to this information, the project will be focusing in the groups of Engineering and ITC, given that these are the two fields showing a significative difference between men and women, with proportions of female students of 22,54% and 20% respectively.

When looking at absolute numbers (see Figures 6 and 7) we can see how both sexes follow a similar pattern for all fields except for ICT, Engineering, Education and Health. From these graphs below we can extract some conclusions:

ICT, is not quite a common field, given that it is the 7th most chosen field for men. Although, it has not much lower numbers than fields from 4th to 9th. While for women, not only is it the lowest one, but also it is notably lower than the rest of fields. In the case of engineering, the situation is worse when comparing men and women. For men it is the 2nd most chosen field, while for women it is in the 7th position.

We could assume that this is because men and women have different interests and there would be nothing wrong about it. Except that the only fields appearing in the upper positions for female students that are not chosen by men are Health and Education, which

are the ones linked with the "feminine role" in society. In fact, the rest of fields are exactly in the same order of preference. So, would it be misguided to assume that women tend to choose more these fields (Education and Health) than men because of cultural background influences? And if that were true, wouldn't it be possible also that they are not choosing ICT and Engineering because of the same cultural factors?

What is left for us to do is to discover which those factors are. Moreover, in these graphs we can see how the order of preference gives a picture of how society in the first world countries, where agriculture is not as important as business and law. We can assume that the choices students make, are highly affected by cultural factors.

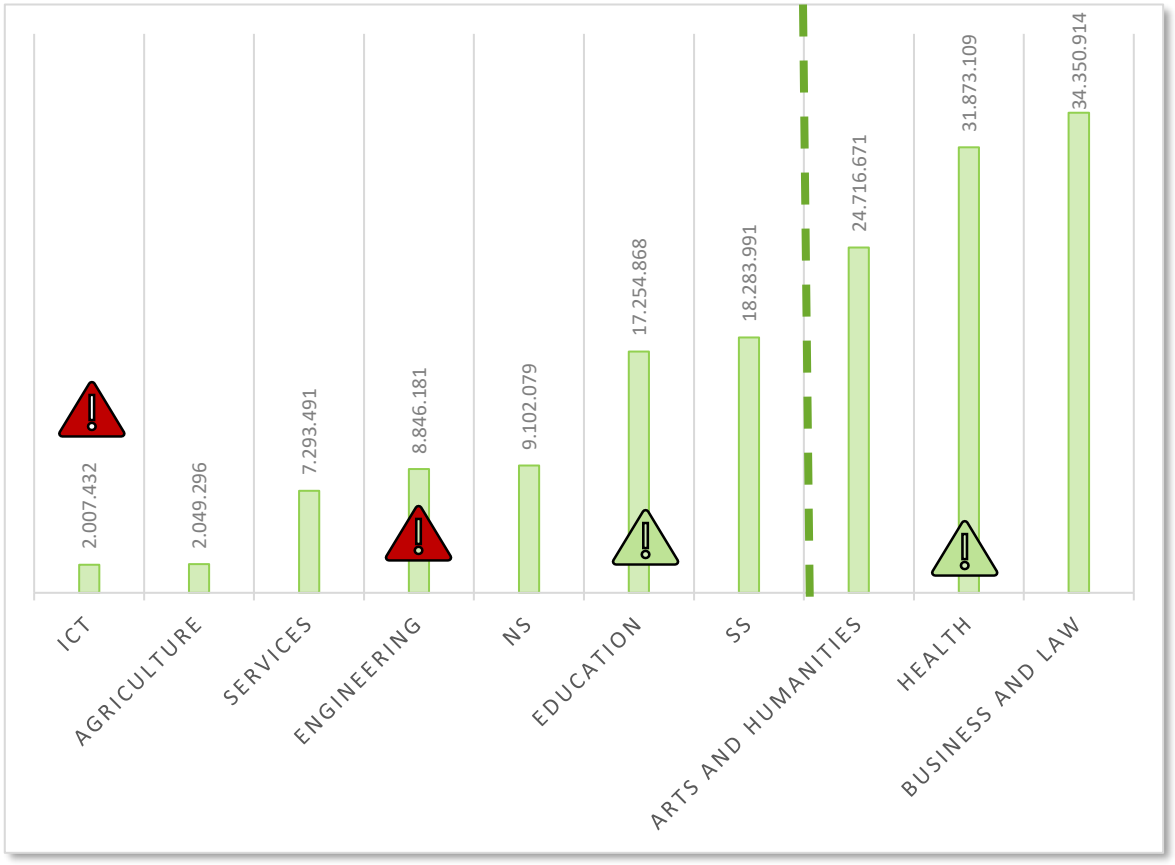

Figure 6: Nº of women enrolled by field. Source: Own creation

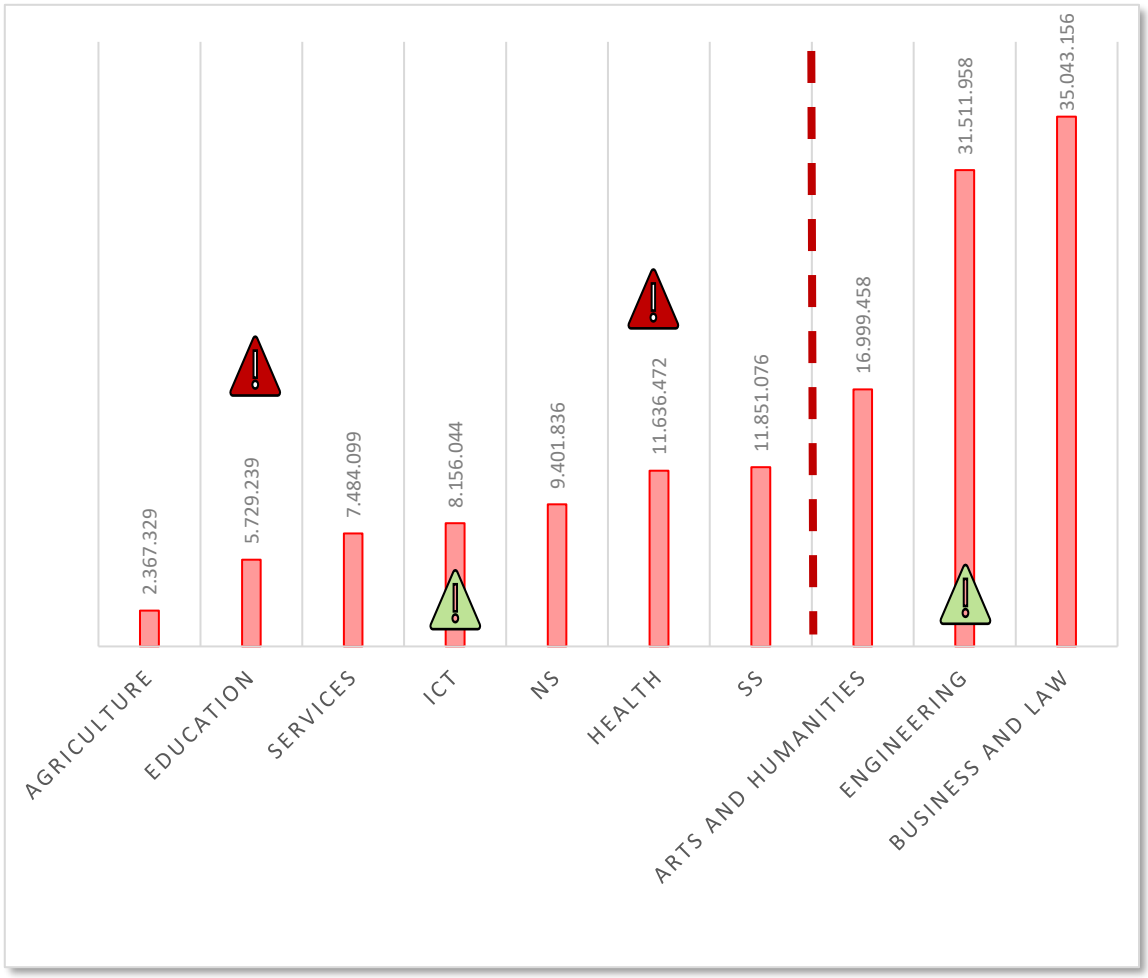

Figure 7: Nº of men enrolled by field. Source: Own creation

When we take a look at the two central fields (Engineering and ICT), we get a whole range of female presence different for both fields. In the case of Engineering (Figure 8) we can see that the range goes from 35.61% of female engineers in Poland to 13.19% in Japan.

Being the mean of that field similar to the median 24.18% and 24.37%, we can assume that there are no outliers influencing the mean. The countries in the central part of the distribution are Austria and Norway

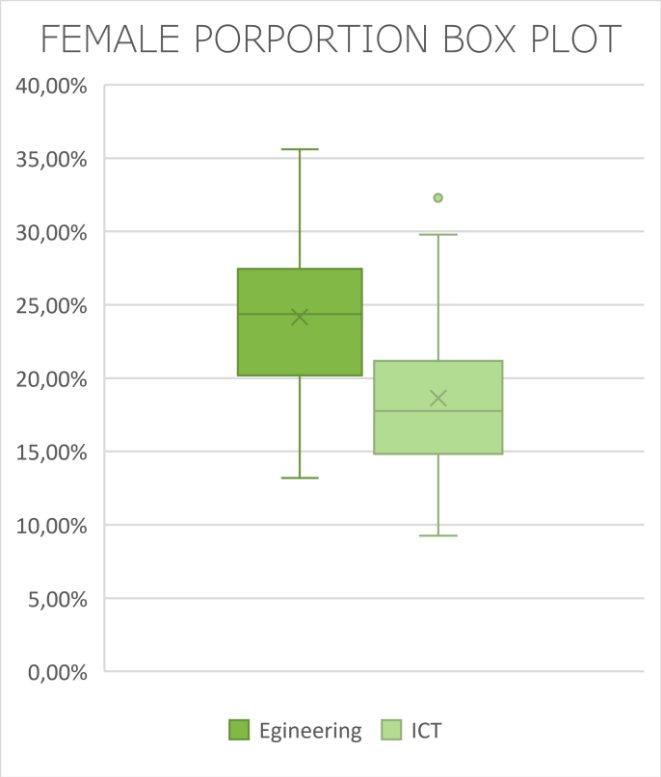

Figure 8: Box-Plot- Female proportion by country

Source: Own creation

On the other hand, ICT shows in general lower proportions of women. The range goes from 9.26% of female students in the field for the Netherlands, to a 29.78% in Mexico, with the presence of an outlier, Greece, with a 32.30% of women. That is why the mean is higher than the median, it is influenced by the outlier and becomes not enough robust. The median is 17.76% while the mean is 18.64%. This time Japan is not considered because of lack of data, but actually not many countries follow the same patterns on both fields.

In table 2 below, we can see the distribution the proportion of women in technical studies by country. In this table the proportion is the sum of women in both Engineering and ICT in relation to the totality of students in these fields.

Although, there are differences between one field and another within the same country, this is why we divided the countries in four groups for each field from lower to higher share of women in the field, so that we can appreciate when a country has inconsistencies between the two fields. This is done so that even when the general proportion is high, we can notice if it has low percentage of women in one of the two fields. (being 1 the group with highest percentages and 4 the lowest). The objective of the table is to be able to choose the "better" and "worst" countries and take a general look at their data about tertiary studies.

In the case of Japan, Luxembourg and the Netherlands, (red countries) we can see they have low proportions of women in technical studies, plus, their proportions in both Engineering and ICT are also low (they are in groups 3 or 4 in both areas).

In the case of the countries with higher proportions (green countries), they pose some problems, given that countries like Italy and Poland have high proportion of women in tech, but they are inconsistent between areas given that they have very low percentages

in ICT (group 3 and 4). Therefore, the countries that we are going to analyze are going to be Sweden, Denmark, and Iceland. Given that they show high proportions of women in technical studies too and are also consistent in both fields because they do not change more than two points between fields.

Table 2: % of Women in technical studies

Source: Own creation

	%W_TECH	GROUP ENG	GROUP ICT
Japan	13%	4	4
Luxembourg	16%	4	3
Netherlands	16%	4	4
Korea	16%	4	2
Ireland	17%	4	2
United States	17%	4	1
Switzerland	18%	4	4
Chile	18%	4	4
Belgium	19%	3	4
Finland	19%	3	3
Germany	20%	4	2
Canada	21%	3	1
Lithuania	21%	3	4
Australia	21%	3	2
United Kingdom	21%	2	3
Hungary	22%	3	2
Norway	22%	3	2
Austria	23%	2	3
Latvia	23%	3	2
Spain	23%	2	3
Slovenia	24%	2	3
Turkey	24%	3	1
France	25%	2	3
New Zealand	25%	2	1
Czech Republic	25%	1	3
Slovak Republic	26%	1	4
Portugal	26%	2	2
Israel	27%	1	1
Mexico	27%	2	1
Estonia	27%	1	1
Greece	27%	2	1
Iceland	**28%**	**1**	**2**
Denmark	**29%**	**1**	**1**
Italy	29%	1	3
Sweden	**30%**	**1**	**1**
Poland	31%	1	4

5.2 GREEN COUNTRIES

When analyzing these three countries, the first fact that stands out is that proportion of women in tertiary education is higher than the general of the OECD:

- Sweden 60%
- Denmark: 57%
- Iceland 62.5%

*Remember: OECD 52.7%

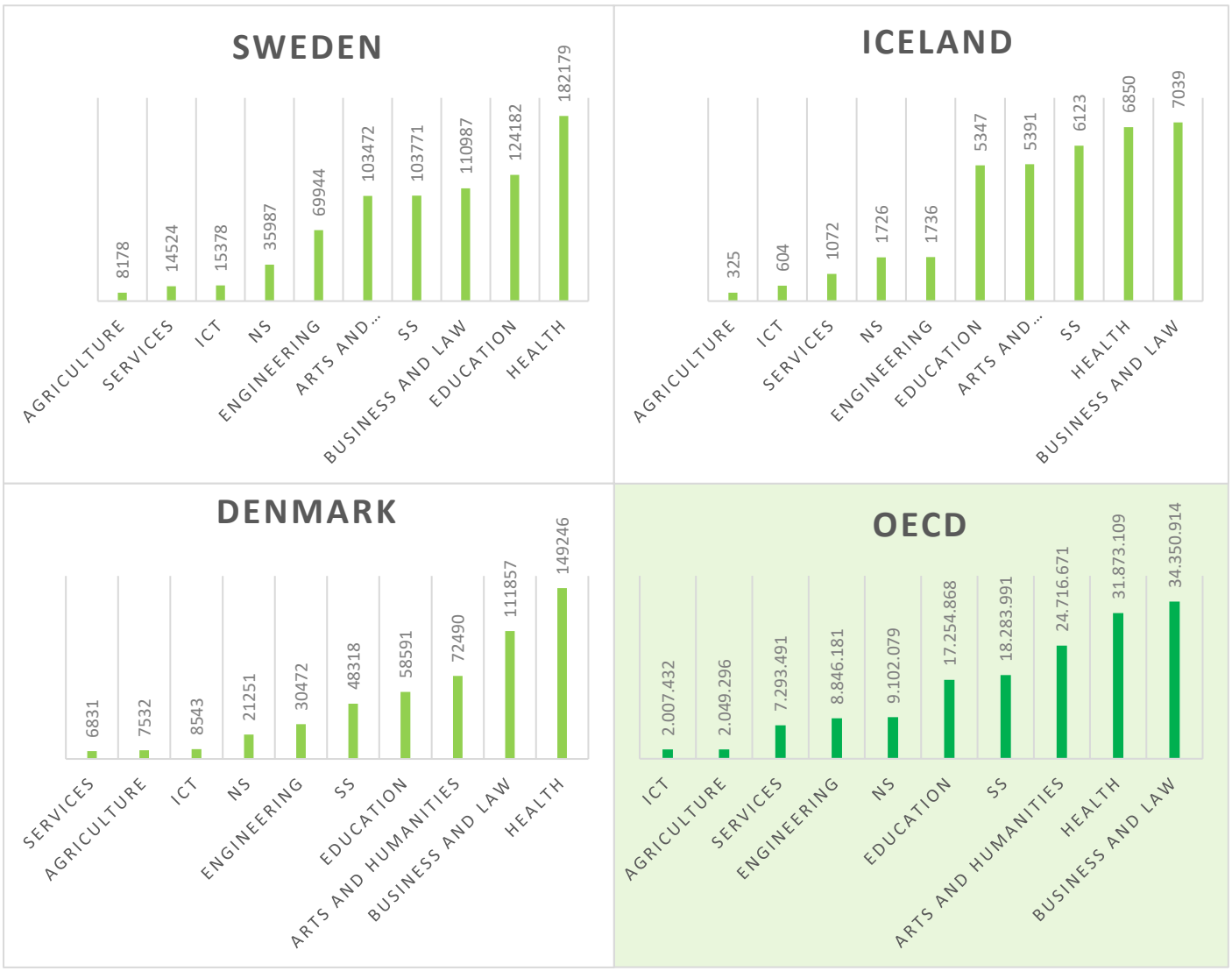

Figure 9: Nº of enrolled women by field in green countries vs OECD

Source: Own creation

Which means that in the three cases the difference between male and female students at these levels of education is approximately a 20% difference. The explanation of these three groups being similar in terms of women presence in technological studies might be their cultures. The three are Nordic countries, which in general means more feminist countries in terms of useful policies in women's favor with lower education systems for households.

Actually, household spending in tertiary education over the total spending on tertiary education (Public, Private and Household) accounts for a 0% in Denmark, 0.5% for Sweden and 7.5% for Iceland, in a range going from 0% to 55% for the totality of the sample. Moreover, countries like Sweden have strong policies to promote tertiary studies enrolment, like a "salary" given to students that also work part-time. This kind of policies make it possible for students to work less hours with much higher salaries and still be able to carry a bachelor's degree.

When looking at the distribution by field, (see figure 9) we can see how ICT in these countries occupies 7th place of preference by women, opposed to last place for the OECD mean. Engineering also goes up a couple of positions, from 7th to 6th or 5th position. However, neither go up to the top 5 preferred fields. It is also interesting to see that the fields that are normally more preferred by women than by men (Education and Health), in two out of the three countries (Sweden and Denmark) also go up from 2th position of preference to 1st in the case of Health, and from 5th to 4th and 2nd position in the case of Education.

So, the countries that have better percentages of women in technical studies (green countries) also show higher number of enrolments in these two other fields (education and health) the ones "typically" chosen by women. So, they still show the "problematic" we were posing. We could assume the that these countries are just showing higher percentages of women in technical studies because they have, in general, a lot more women than men in tertiary studies. This means one of the variables that we need to analyze is if the fact that countries have more women in tertiary education is affecting the number of women in technical studies, the regression will help us to know that.

5.3 RED COUNTRIES

Just like with the green countries, when analyzing the red ones, the first data that stands out is the proportion of women in tertiary education:

- Japan 46,9%
- Luxembourg 51.18%
- Netherlands 51.77%

*OECD: 52.7%

Even though, these numbers are closer to the 50-50, in the three cases we can find a lower proportion of women with respect to the OECD in general. It does not seem a coincidence that the green countries are showing such high numbers in this aspect and the red countries are below OECD's mean.

Even though green countries are showing notable higher proportions of female students in tertiary education, these three countries do not present a much lower proportion of female students in general, compared to the mean in the OECD, whereas in the area of tech there is a much more notable difference of women share compared to the mean.

As to the preferences between fields (see Figure 10) we cannot make any general conclusions given that there are no clear patterns that the three have in common. As to why women are not choosing tech degrees, the cultural factor would not be enough to explain it, given that culture in these three countries is very different, especially Japan. So, *a priori* we cannot give any explanation to this phenomenon, at least if we wanted to provide some explanation that applied to the three of them.

Although, a fact that stands out and that they do have in common, is the proportion of total students (male and female) that choose engineering and ICT. These account for 11% of total students for Luxembourg and the Netherlands and a 15% for Japan, in a range that goes from 6% to 30%, so all of them are in the lower tail of the distribution. We cannot be sure if these low percentages are a cause or a consequence of women not choosing tech studies.

But the hypothesis we pose is that women follow "trends" because they are more risk adverse, so in countries where tech studies are not as "trendy", women will be more disincentivized to enroll and will engage other areas of studies that are more typical or normal in the country.

In a more detailed analysis, if we wanted to give some cultural explanations as to why women do not choose technical studies, we can make a specific analysis for each country: First, in the case of Japan and Luxembourg, women are choosing more Arts and Humanities and Education (see Figure 10) which are clearly more vocational studies rather than ones with higher "professional" objectives like Business (normally the most preferred option). This makes sense if we look at the type of work women have. In Japan, women account for the 82% of part-time workers, and in Luxembourg for the 88%, compared to the 76% in the OECD. From this, we could assume that in these two countries women are even less incentivized to work or that their salaries are not the important ones in the household. This would explain why they are not choosing technical degrees and prefer more vocational studies. We could suppose that in Japan and Luxembourg women are not as ambitious, or at least it is not expected from them to be because of their culture, and this is why they do not engage in technical studies. This would be in accordance with the fact that business and law (which is normally the most preferred for women) in Japan decreases until the 3rd preferred option.

Also, in the case of the Netherlands (and not as much but also in Japan), Health is an especially important area for women, which makes sense and would also explain the low proportions in technical activities. Women that are in fact more scientific or that really want to engage in good professional careers choose health studies rather than ICT and Engineering.

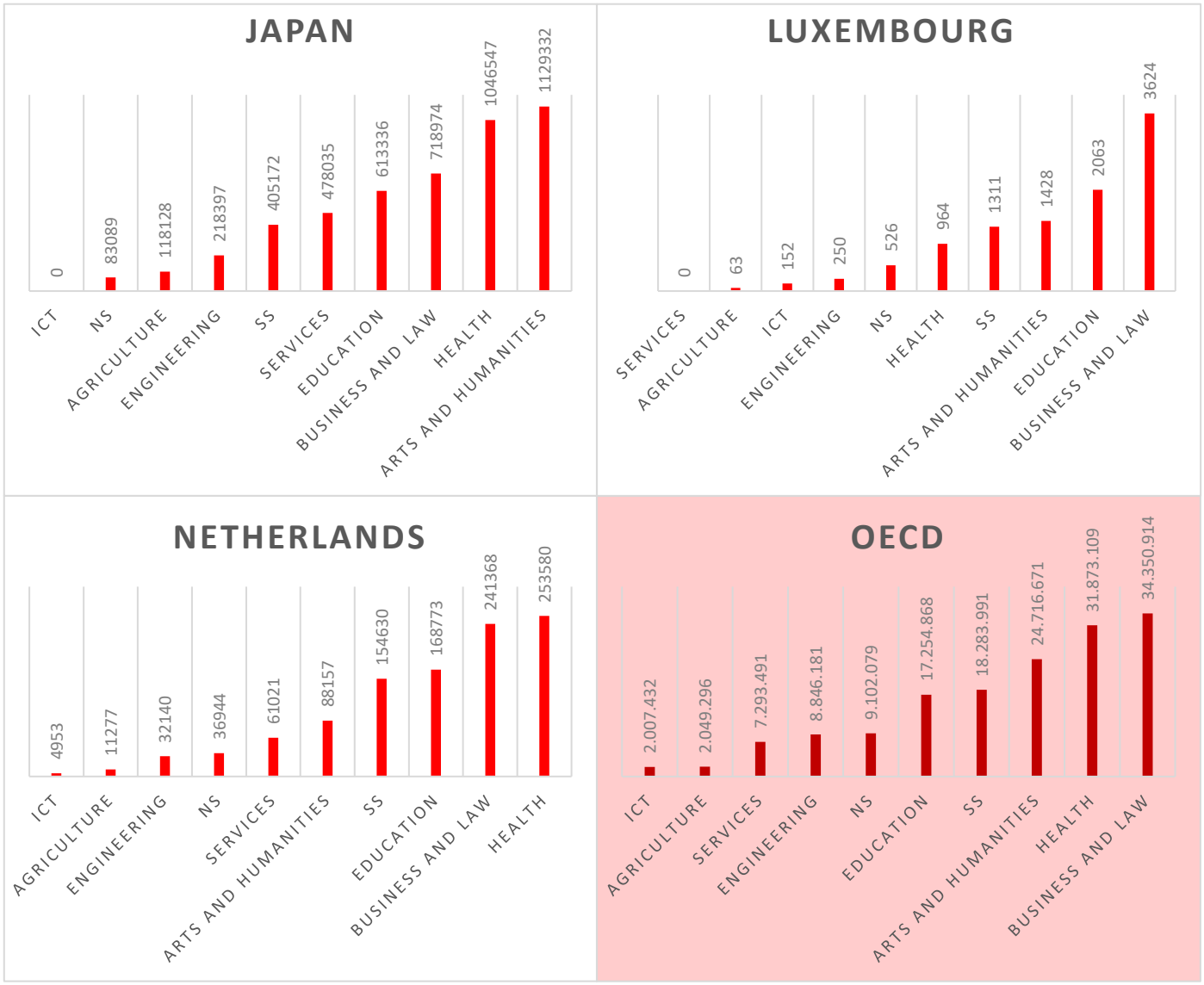

Figure 10: Nº of women enrolled by field in red countries vs OECD

Source: Own creation

6. DATA BASE

The data base used for the practical framework of this project was extracted from the OECD Data. The sample chosen were the counties forming the OECD except for Switzerland given that one of the main variables for the study was not available.

So, the geographical range is 35 countries of the OECD, in which the continents of America (4 countries), Europe (28 countries), Asia (2 Countries) and Oceania (1 Country) are represented. The latest data available for most of the variables was 2015 while the first available data was 2013. Thus, the time span chosen is from 2013 to 2015. Choosing this time span we could include a wider geographical range.

The variables that will be used for the study are: (1) Percentage of women choosing tertiary technical studies, with respect to the total of women engaging in tertiary education, (2) GDP per capita delayed 5 years, (3) Percentage of tertiary public spending, with respect to the total spending of tertiary education, (4) Percentage of people choosing tertiary technical studies, with respect to the totality of tertiary students, (5) Percentage of women engaging tertiary studies, with respect to the totality of tertiary students.

A more detailed explanation of these variables and the reason they were chosen will be given later on in the respective section.

7. TERITARY EDUCATION MODELS

7.1 METHODOLOGY

Once we stated that cultural factors may be affecting women's choice, it was of our interest to be able to differentiate different types of tertiary education, so that we could make some assumptions as to how the economical costs of tertiary education can affect women's decision too. Not all of the countries work the same way and especially public spending levels in education vary between countries.

In this section we are doing a classification of countries with respect to the level of public spending on tertiary education. The percentage is calculated over the total spending (Public, Private and Households) in this same level of education. We are choosing this variable because we want to see if there are similarities in education between countries that present similar levels of public spending.

Table 3: *% of public spending on tertiary education to the total spending on tertiary education (Public + Private + Household) by country. Source: Own creation*

Japan	33,92%
Korea	34,37%
United States	35,42%
United Kingdom	35,67%
Chile	35,91%
Australia	39,69%
Canada	48,90%
New Zealand	51,51%
Israel	53,95%
Portugal	55,95%
Italy	63,33%
Hungary	64,60%
Czech Republic	64,64%
Spain	67,39%
Netherlands	67,83%
Latvia	69,26%
Estonia	69,39%
Mexico	69,94%
Lithuania	72,93%
Greece	73,53%
Ireland	75,21%
Turkey	75,37%
Slovak Republic	76,08%
France	77,55%
Poland	78,56%
Slovenia	83,25%
Germany	83,53%
Sweden	85,26%
Belgium	85,29%
Iceland	88,42%
Denmark	91,66%
Luxembourg	93,87%
Austria	94,27%
Finland	95,21%
Norway	96,10%

7.2 RESULTS ANALYSIS

We can appreciate a range from 34% of public spending in Japan, to a 96% of public spending in Norway. The mean is around 68% while the median is almost 70%, they are remarkably close because there are no outliers. In general the data is continued and has no abrupt jumps, therefore, we put the color cuts when data changes by 2 or more points. Although, when doing an ex-post analysis, we considered cultural factors and made new groups (black lines) and four groups appeared.

We can see how the first group is formed by Anglo-Saxon countries and the two Asian countries in the sample. Both these types of countries are known to be more liberal, so the state has lower level of intervention. One curious factor in this group is Chile, which is neither Anglo-Saxon nor Asiatic but this country has a lot of influence of Chicago's university given that it was during Pinochet's government (1973-1990) that under the influence of the "Chicago boys", neoliberal economists, the new regime implemented the economic liberalization.

In the second group we can find a little mix: On one hand, there are the Southern countries of the EU (Spain, Portugal and Italy) plus Mexico which would make sense if we have into account the mix of cultures in this country with a significant "Latin culture" influence, and on the other hand Balkan countries and some of the Eastern Europe. This group of countries is characterized also by the free economy and liberal states but with a higher incidence for Welfare State, especially European countries, thus the higher spending on education compared to the first group, given that education is an important factor for Welfare.

The percentages go from 53% to 70% which means that at least half of the cost of tertiary education is assumed by the government. This group is similar to the third one with respect to cultural aspects given that most of the countries in these two groups are under the scope of the European Union. Although, the one country that stands out is Ireland which is an Anglo-Saxon country, number 6th freest in the world according to [4]Heritage Foundation. Although, in the group of the 10 freest countries in the world, Ireland is the third with highest public spending, so it makes sense a high spending also in Education.

Finally, in the last group we can find both Nordic countries and Central-European countries but, in fact, the European countries stand out for being Germanic ones, which would explain the fact that they are found in the same group than the Nordic ones. These countries stand out for being the ones with notable incidence towards Welfare State. Even with a free economy market, they have a system that ensures health and education services for everyone.

When comparing this to the list we got in the previous section about percentage of women that choose technical studies, we cannot appreciate, *a priori*, a correlation between these two factors. It is true though, that countries like Japan, with low public spending have low percentage of women in tech studies, but also does Luxembourg, which is the fourth country with more public spending on tertiary education. Although, we do notice that the three countries chosen as "green countries" because of their highest percentages on both ICT and Engineering are all placed in the fourth group, the one with higher public spending. These inconclusive results force us to take the next step, the regression, so that we can perform a more numerical analysis rather than a descriptive one. Moreover, in the light of the above, we decided that public spending might not be entirely a good variable to put in the regression given that it might not reflect entirely the cost to families of tertiary education of their children, this is why we will be introducing a new variable: household spending on tertiary education, to reflect the part of the cost that families assume of their children's education.

[4] Governed by an independent Board of Trustees, The Heritage Foundation is an independent, nonprofit institution that promotes public policies of the conservative movement.

8. EMPIRICAL EVIDENCE

8.1 METHODOLOGY

The objective in this part of the project is to know if there are some variables that are affecting the fact that women are not choosing the technical fields. In order to do so, we decided to carry a regression in which four variables are tested. With this objective we used an excel complement that performs the regression with the set of data given by us.

The model is the one that follows:

$$WOMENINTECH = \beta_1 + \beta_2 GDP/CAP^{RET} + \beta_3 PUBLICSPENDING + \beta_4 WONENINTERTIARYED + \beta_5 STUDENTSINTECH + U_l$$

Dependent variable: WOMENINTECH. It is the percentage of women that choose tertiary technical studies (Engineering or ICT) with respect to the totality of women. What we want to know is whether the independent variables have something to do or not with the choice women do in this aspect.

Independent Variables:

We wanted to test four different variables, two that represented the economic aspects and two reflecting more "cultural" aspects.

A) **Economical independent variables:**

- GDP per capita, retarded 5 years. It represents the **spending capability** of each family to give access to tertiary education to their children. The variable was retarded 5 years because it was considered that the decision to take one path or another is normally done some years before. 5 years before is normally the time when students enter secondary education.

- Household spending: It is the percentage of household spending in tertiary education with respect to the total spending (public, household, and private) on tertiary education. This variable represents the **cost of tertiary education for families**. Actually, the ideal data to test would have been prices (taxes) on tertiary education but given the lack of data and the variability within tertiary education levels of

different countries, we used household spending as a proxy. The more the households spend, the more part of tertiary education cost are families assuming.

The assumption under these two variables is that given high prices families tend to pressure more the boys to get an education that will provide them with a good professional career (technical in this case, which is normally more costly and longer to finish) because normally it is the men in the families the ones that are expected to work and have higher salaries to sustain the family. Also the demand factor can have something to do with it, given that companies might prioritize the hiring of men because of the female role in family caring and birth, so returns of studying this type of degrees might be higher for men nowadays.

B) Cultural independent variables:

- Women in Tertiary Education. It is the percentage of female students in tertiary education with respect to the totality of tertiary students. It represents the **facility women have to access tertiary education**. Obviously, the assumption is that countries with more female students (so, more feminist and education developed) are supposed to have more women in technical studies.

- Total of students in Technical Studies: It is the percentage of students in tertiary technological studies (Engineering and ICS) with respect to the totality of tertiary students. It represents how **trendy or common it is to choose technical studies** in a country. The previous assumption to this variable is that in a world where women are not educated to be leaders or find more difficulties to do so, in countries where technical studies are not normal or not as strong in presence, women will be even more disincentivized than men to choose them.

Descriptive statistics:

Table 4: Descriptive Statistics of the sample

Variables	N	Minimum Value	Mean	Median	Maximum Value
GDP/CAPITA-5	99	14.532,00	34.214,25	34.355,00	86.592,00
%HH_SPENDING_TERTIARY_ED	99	0	20.30%	16.13%	54.94%
W%_TERITARY_ED	99	40.08%	54.64%	56.12%	62.88%
T%_TECH_STUDIES	99	6.23%	18.65%	18.42%	29.25%
W%_TECH_STUDIES	99	2.57%	8.02%	7.76%	16.32%

Source: Excel complement MicroEconometria-Regresión

The sample in this part of the project is 99 observations, these are 33 out of the 36 countries of the OECD (Switzerland, Germany and Hungary lacked data) in years from 2013 to 2015.

In the table 4 we can see the distribution of data. It is important to remark that all of the variables except for GDP per capita are percentages.

All the variables have been analyzed separately in the previous sections, but special mentioning should be made about the student's decision to choose technical studies for both sexes and only women. We can observe that for most of the countries engineering and ICT are not common. They go approximately from a 6% to a 30% of students. As we already knew, the numbers are even lower for female students: from a 2.5% to a 16% of women choose to technical studies.

8.2 RESTULTS ANALYSIS

Overall significance

Table 5: Analysis of overall significance

Dependent Variable: W%_TECH_STUDIES			Number of Observations: 99		
Variation	SC	gl	SC/gl	F	Prob > F
Explained	0,085178	4	0,021294	126,70	< 0,0001
Not Explained	0,015798	94	0,000168		
Total	0,100976	98			
$\sqrt{}$ECM =	0,012964	**R^2 =**	**0,8435**	R^2 corr =	0,8369

Source: Excel complement MicroEconometria-Regresión

1. Signification test **F-test**: when F < 0.05 (significance level) the model is statistically significative; thus, the variables do explain "something". We got an F-test < 0.0001 so it is statistically significant

2. R squared: It is the square correlation between the reality and the prediction made. The higher the R^2, the more explicative the model is.

   In this case, R^2 = 0.8435 → 84.35% which means it is a good model. The model we estimated explains in an 84.35% the total variability of the dependent variable (%Women in technical studies).

Parameter's individual significance

Table 6: Parameter's analysis of significance

Variable	Parameter	Standard Error	t-value
b1(Const.)	0,010576	0,022556	0,469
b2(PIB/CAPITA-5)	**-4,04213E-07**	1,20042E-07	-3,367
b3(%HH_SPENDING_TERTIARY_ED)	-0,029807	0,009518	-3,132
b4(W%_TERITARY_ED)	0,000751	0,031597	0,024
b5(T%_TECH_STUDIES)	0,478072	0,029915	15,981

Source: Excel complement MicroEconometria-Regresión

To test the significance of the variables, we are performing the T-test. We need to compare the t-value of each variable with the t-value for our confidence interval (α=0.5) and degrees of freedom (99-5= 94). Our t-value was calculated by excel using the formula of the T distribution of two tails, and it is= ±0.61824. What we are doing here is test the hypothesis that the parameters are equal to zero (Ho: ß2=ß3=ß4=ß5 = 0). If we accepted the hypothesis, we would be saying that parameters are not statistically significant.

In this case three out of four variables are proven to be significant given that their t-values are out of the range (-0.6184, 0.6184) (see table 6) what, in turn, means they are explicative variables of our dependent variable.

B5: T%_TECH_STUDIES

This variable was statistically significant which means that the fact that the country has more students in general, and in turn, it is more powerful in technological knowledge, will incentivize women to engage in this type of studies. While countries where tech is not "trendy" women will not have the initiative to

enroll in these degrees. This could be proving the hypothesis that women are more risk adverse, so when the technical market is not powerful in a country, female students prefer other degrees. Although, we need to have into account that the percentage of students in technical degrees has in itself the percentage of women in technical studies, this is why it is especially significant. Thus, it will be necessary to analyze multicollinearity in this variable.

B4: W%_TERTIARY_ED

This variable turned out to be not significant. This means that, opposed to what we concluded in the descriptive part with the green countries, not because more women are continuing their studies after secondary education will they necessarily engage more in technical studies.

B3: %HH_SPENDING_TERTIARY_ED

The variable of percentage of household spending in tertiary education was statistically significant. Thus, the cost families must assume influences the choice of girls to study technical degrees. The fact that technical studies are normally longer in years, or students tend to fail more and takes more years for them to finish, make the costs for this type of studies even higher. As we can see the parameter is negative, so the relation between these two factors is inversely proportional, the higher the cost families assume, the less women engage in technical studies.

B2: PIB/CAPITA-5

This variable was statistically significant, but the parameter is negative which *a priori* does not make sense. An inverse relation between these two variables says that countries where people have more economical capability are the ones with less women in technical degrees, which is not what we would expect and it's conflicting with the household spending result. Given this result, multicollinearity will have to be tested.

Multicollinearity

We find it important to test multicollinearity between variables given that we are using data that is very mixed between variables and some could be correlated. Also, the negative parameter of B2 could be caused by multicollinearity.

To do so, we are looking at the factor of inflation, which when higher than 10, indicates multicollinearity. We can see that in this case no collinearity is shown (see table 7)

Table 7: Factor of inflation of the parameters

Variable	F.I.V
PIB/CAPITA-5	1,566
%HH_SPENDING_TERTIARY_ED	1,331
W%_TERITARY_ED	1,247
T%_TECH_STUDIES	1,542

Source: Excel complement MicroEconometria-Regresión

For the variable of PIB per Capita, we still need to find some explanation as to why the parameter has an inverse proportion with the percentage of women in technical studies. Therefore, we performed a scatterplot:

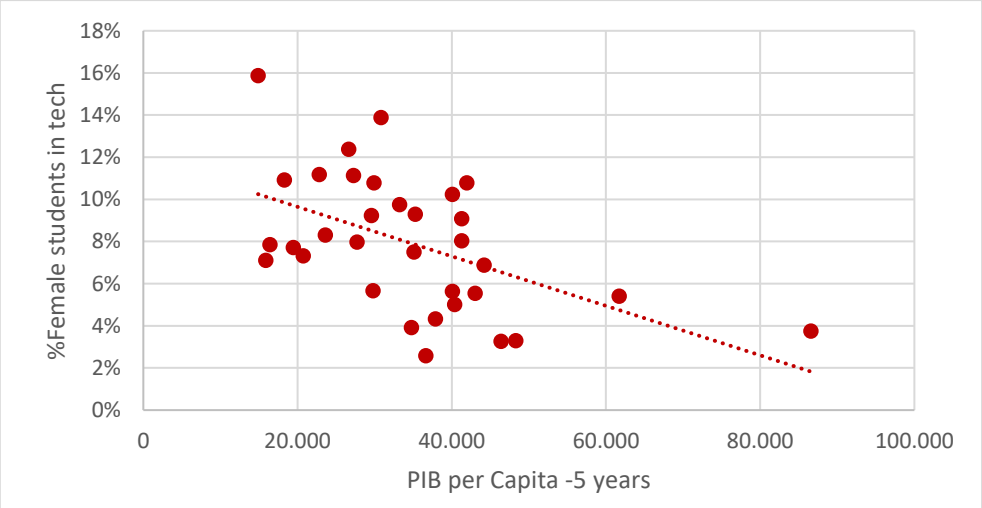

Figure 11: Scatterplot between PIB per capita and women in tech %

Source: Own creation

As we can see here, there is kind of a correlation between the PIB per capita of a country and the percentage of women that choose technical studies. The correlation, although is inverse. The higher the PIB of the country, the smaller the share of women in tech which it is not what we would expect to happen. Although, we need to have into account the countries in the sample. The observations we have are countries of the first world, so all of them are more or less considered rich countries. If we where to make that same study of all the countries in the world, we would surely get a different correlation between these two variables. Moreover, we should have into account the nature of this PIB per capita given that there are some countries which are successful and rich because of other markets not related to tech, like Luxembourg with banks, which means that there are very prosper countries in which the dominant market is not tech, so it is reasonable that not as much women study these type of degrees.

Efficiency

When testing efficiency of the model, we use the variance given that a small variance indicates more efficiency of the model

$$o^2 = \frac{\sum ei^2}{N-K} = 0.01699 \ / \ 100 = 0.00017$$

We could say that it is an efficient model

Although, if we observe the errors, we can see that the variance of the errors is not entirely constant, there is a slight cone shape in the tendency, which means that there might be heteroscedasticity. This could mean that the model is not entirely consistent across all values.

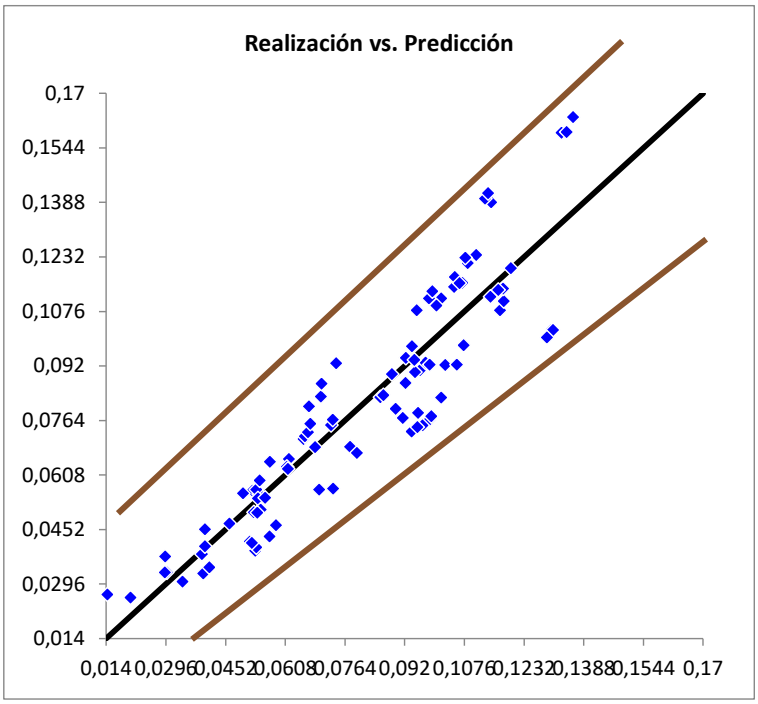

Figure 12: Dispersion of the variance errors

Source: Excel complement MicroEconometria-Regresión

CHAPTER IV: CONCLUSION

The project was structured in two parts, in the first one, the situation analysis, we proved the problematic on tertiary studies. Women are heavily discouraged to participate in technical studies while engaging notably more than men in studies like education and health (the ones more "typically" associated with the feminine caring role). This is not a problem in itself; men and women are not the same so it could be expectable that they show different interests. But a closer look showed us that, in fact, both sexes have exactly the same interests and in the same order of preference except for the four areas we mentioned (ICT, Engineering, Health and Education). In addition, the distribution of preferences between fields reflected a lot the cultural factors nowadays, showing Business and Law studies as the more preferred and Agriculture in the last preferred. This is clearly a reflection of how society in countries of OECD is highly focused in the third sector of economy (services) and much less in the first sector (agriculture). So, given that preferences order in the rest of areas can be explained by cultural factors we arrive to the conclusion that these differences between men and women should be cultural too so they need correction because they imply unequal opportunities and a disadvantage for women.

Moreover, in this first part, we made a first analysis of the variables that could be affecting this problematic and we could appreciate how higher levels of public spending proved to be a general common pattern in countries with more female presence in tech studies, giving importance to the economical/monetary aspects. While the low tendency for both male and female students to engage in technical studies could also be affecting even more the female part of students to not engage in these degrees, giving importance again to the cultural aspects. In order to prove this numerically, we engaged in the second part of the project, the empirical evidence. In this second part we proved that three of the four variables tested were statistically significant. But one of the three had no logical economical explanation for it so we concluded that the sample was too small for that variable.

So, the two factors that proved to be affecting women's choice to study technical degrees are: household spending on tertiary education (the share of cost that families assume of their children's education) and the percentage of total students studying technical degrees. This significance of the variables is strongly related to our hypothesis: (1) women are more risk averse, so in countries where tech market is not as developed, they

will be more discouraged that men to engage in these studies, they will not be the first ones to make that choice. This first hypothesis is not entirely proven, given that we would need further studies, but it is a first step. (2) Women's choice is, in fact, affected by the economical possibilities of the family, the cost for families is directly related to women's choice.

It is obvious that the fact of having a strong technological market in a country will encourage more students to study these degrees, but that is something that could be difficult to change in the short-term. Although, some policies can be put in practice in relation to monetary aspects, to encourage women to study technical degrees. We need to have into account that even though positive discrimination towards groups in disadvantage is accepted, we should look for policies that are proportionate and still incentivize women's choice. From this point of view what we propose is an application of a scholarship program for degrees related to tech, with a 50% share between sexes. By doing so, we ensure that more share of women is getting a scholarship and so, their families assume lower amounts of the cost of the studies. Moreover, given that the scholarship would be also for men by a 50%, it would incentivize also some men to get into this type of studies so that tech studies are developed and maybe turning also the "trend" and developing the tech market in the country.

As a conclusion, and giving answer to the main question of this project: can something be done from a public perspective to encourage women to study tech? The answer is not only that, in fact, yes, something can be done, but also that something should be done, given that women's choice is strongly affected by historical cultural factors, and not biological ones or at least not exclusively and this needs to be corrected in order to ensure equity between men and women and thus, equal opportunities.

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