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THE GENDER GAP IN PISA 2018 TEST SCORES IN THE EUROPEAN UNION AND THE TRANSMISSION OF GENDER ROLE ATTITUDES

Ana Chivite Monleón

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Javier Hualde

Análisis económico

EXECUTIVE SUMMARY

The gender gap in test scores exists in countries all over the world. Systematically, girls tend to underperform (outperform) boys in mathematics (reading). This paper has focused on analysing such gender gap in the 2018 PISA test for the European Union (EU). The study has provided further evidence supporting the social gender stratification hypothesis, as it was proved that girls perform better in mathematics in more gender-equal societies, thus closing the gender gap. Regarding the transmission of gender role attitudes from parents to children, it was found that the father's occupation improved more the boys' test scores in mathematics than that of the girls, pointing to a transmission of gender role attitudes from fathers to sons. Oppositely, it was found that having a mother with university studies improved more the test scores of girls than that of boys, indicating a transmission of gender role attitudes from mothers to daughters.

RESUMEN EJECUTIVO

La brecha de género en las pruebas escolares existe en países en todo el mundo. Sistemáticamente, las niñas tienen peor (mejor) desempeño que los niños en matemáticas (lectura) en los test de PISA. Este trabajo se ha centrado en analizar dichas diferencias en la Unión Europea en 2018. El estudio apoya la hipótesis de la estratificación social de género, ya que se ha demostrado que, en sociedades más igualitarias, las niñas obtienen mejores resultados en matemáticas, cerrando así la brecha de género. En cuanto a la transmisión de roles de género, la ocupación de los padres parece mejorar en mayor medida los resultados matemáticos de los niños que de las niñas, mientras que son los estudios universitarios de la madre los que tienen un mayor impacto en los resultados en matemáticas de las niñas, apuntando así a una transmisión de roles de género de padres (madres) a hijos (hijas).

KEY WORDS: PISA Test, Gender Gap, Social Gender Stratification, Intergenerational Transmission of Gender Roles.

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1. INTRODUCTION

The present paper focuses on the study of the test scores differences between girls and boys in the 2018 PISA tests in the European Union (EU), as well as on assessing whether there is any intergenerational transmission of gender roles from parents to children. Although one of the top priority areas of the EU is to promote gender equality, advances towards a more gender-equal society have been slow during the past decade. In fact, signs of gender inequality can already be observed at an early stage of life. PISA tests, which are undertaken by 15-year-old students, reveal a persistent gender gap between boys and girls.

PISA, which stands for Programme for International Student Assessment, is a project which was started in 2000 by the OECD (Organization for Economic Cooperation and Development). Its objective is to evaluate the educational systems all over the world by measuring the performance of 15-year-old students in different subjects such as mathematics, reading or science. Since its beginning, the results have shown a clear pattern where boys perform better than girls in mathematics but worse than them in reading. This pattern has been persistently displayed throughout the years in countries all over the globe. There exists previous literature pointing to the hypothesis of social gender stratification as an explanation, by which these differences are caused by the different roles imposed to girls and boys by the society.

The objective of this study is to examine the gender gap between girls and boys in the EU countries in 2018 for both mathematics and reading. Furthermore, an analysis will be conducted to assess whether a more gender-equal society helps to close the gender gap. Finally, in order to assess whether it exists intergenerational transmission of role attitudes form parents to children, the effect of parents' occupation and education on boys' and girls' test scores will be studied.

The structure of this paper is the following. First, the background on the topic, as well as the objectives of this study, will be presented. Next, we will explain the methodology followed to conduct the analysis. Then, a brief review of what the PISA database offers, along with the performance of the EU during the whole period 2000-2018 will be shown. Afterwards, the main analysis is conducted. It is divided into two different sections. The first one is the study of gender gaps in EU countries and the impact that a more gender-equal society has on them. The second part of the analysis focuses on examining the existence of intergenerational transmission of role attitudes from parents to children. Finally, some conclusions will be presented.

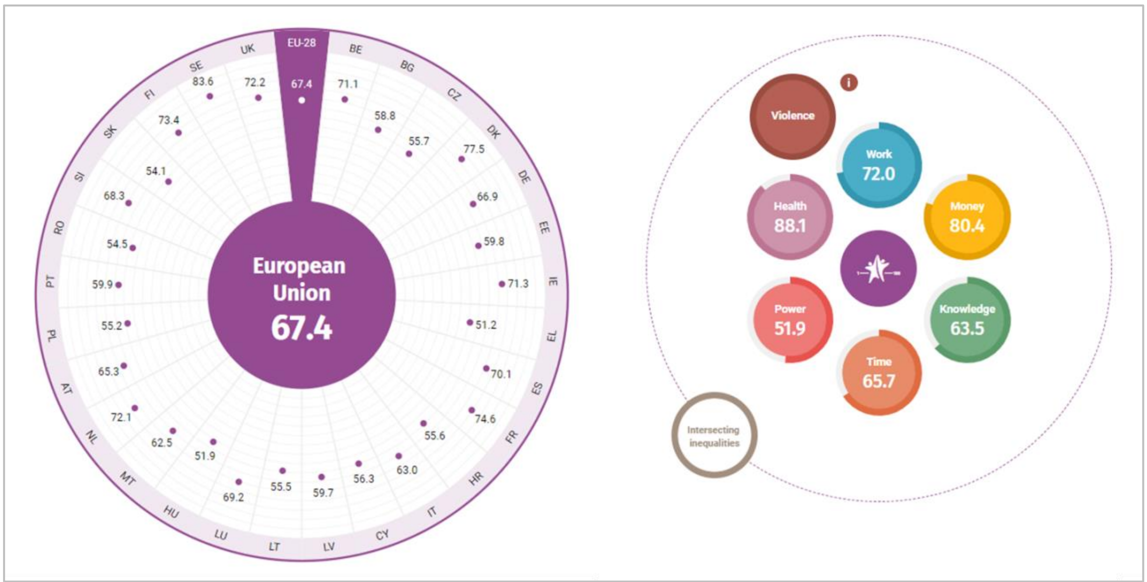
2. BACKGROUND AND OBJECTIVES

The objective of this section is to motivate the topic of study, showing the importance of achieving gender equality. For that purpose, the study will be mainly devoted to examine the existing gender gap in test scores and it will show the importance of understanding what the origin of the gender gap is in order to reach equality between genders. Furthermore, this section also aims to provide a quick overview of the study that has served as the starting point to carry out the present paper, as well as its objectives.

2.1 Background: gender inequality

Achieving gender equality has become one of the top priorities of every society nowadays. According to the European Institute for Gender Equality, the European Union has been moving towards gender equality at a worryingly slow pace. More precisely, the Gender Equality Index for the EU has only increased by 5.4 points since 2005, scoring currently 67.4 points out of 100, which revels there is still a big room from improvement. This progress towards equality has been unevenly distributed among countries, being Sweden and Denmark the most equal societies, whereas Greece and Hungary are the least equal ones. (European Institute of Gender Equality , 2019)

Figure 1. Gender Inequality Index for EU countries.



Source: European Institute of Gender Equality. Retrieved from: https://eige.europa.eu/gender-equality-index/2019

One of the measures that has systematically been used as an indicator of gender inequality at an early state of life has been the gender gap in test scores obtained in school by girls and boys (González de San Román & De la Rica Goiricelaya, 2016). More specifically, a pattern that has been observed worldwide is that girls underperform boys in mathematics, whereas the former outperform boys in reading. There are two main different schools of thought regarding which is the cause behind those differences in test scores between genders. The first one states that these differences are caused by nature, which means that they are originated by biological differences between males and females. Alternatively, the other school affirms that those differences are not a matter of biology rather than the product of roles set by the society (nurture). This is called social gender stratification (Baker & Jones, 1993).

There is a very famous quote which summarized perfectly the last school of thought and it says the following: "One is not born but rather become a woman" (De Beauvoir, 1949). To completely understand what this sentence tries to say, it is necessary to distinguish between two different concepts, sex and gender. On the one hand, sex is based on biological differences of human beings, which makes them being male or female. On the other hand, gender is a concept socially constructed and it refers to the adequate social role, position behaviour or identity of a person. It is gender what makes a human being be either a man or a woman. What Simone de Beauvoir states is that the social discrimination between genders produces in women moral and intellectual effects so profound that they appear to be caused by nature. In this line, it can be argued that the gender gap in test scores is not the result of a different ability of boys versus girls but rather it is a culturally acquired difference.

This gender gap in test scores is of vital relevance to understand educational and job segregation. Women are taught by society to support the paid and unpaid care labour. As a result, they tend to choose studies, and therefore careers, that imply care work, such as secretaries, teachers or nurses. It is not that women are better than men at care work because of a biological reason, it is that the former are imposed such role in the society, so they learn earlier how to do it. In the same way, it is not than women tend to have worse mathematical skills than men; it is that society imposes mathematics as a science for men, which end up harming the non-cognitive skills of women, making them actually worse at this science. On the contrary, men tend to choose more technical careers such as engineering, piloting or mechanics. The implication of this phenomenon is not just educational and job segregation between women and men, is that those careers chosen by women are worse paid than those commonly chosen by men. (Bowles, Edwards, & Rooselvelt, 2005). In consequence, a labour market gap appears.

As justified above, studying the differences in test scores between sexes is of vital relevance, as it is the effect of social gender stratification, which ends up provoking deep economic consequences in the labour market. To further study the gap in test scores in the zone of the EU, this paper relates to a report called "Gender Gaps in PISA Test Scores: The Impact of Social Norms and the Mother's Transmission of Role Attitudes", conducted by Sara de la Rica and Ainara González in 2012. The well-known PISA test, which stands for Programme of International Student Assessment, is a worldwide study conducted to evaluate the skills of 15-year-old students in the fields of mathematics, reading and science. The participating countries are the members of the OECD as well as its partners. (NCES , 2019). This test has been conducted every three years since 2000, being the last year 2018. As PISA makes public the results, it is a perfect data base to analyse the existing differences between boys' and girls' performance globally.

Before moving on to explain what the objective of this paper is, it will be useful to summarize the main conclusions drawn by the aforementioned study of PISA. The study conducted by Sara de la Rica and Ainara González in 2012 analysed the results obtained in the tests of 2009 for all the participating countries. The purpose of this study was to give empirical support to two different theories, the social gender stratification and the intergenerational transmission of gender roles. With regards to the first one, their study reaffirms the hypothesis of social gender stratification, by which the difference in scholastic achievements of sexes is a consequence of the roles established by society, as it was explained above. Moreover, they contribute to the research of the transmission of gender role by examining whether the mother's participation in the labour market is valid to explain subsequent underperformance of girls with respect to boys in mathematics skills.

The main conclusions extracted from the study were the following. In the first place, female students underperform (outperform) males in mathematics (reading) test scores in almost every country. It was also proven that in those societies where gender equality is enhanced, girls performed relatively better than boys, reducing the test score gap in mathematics and widening the one in reading, which is a clear indicator that social norms have a serious impact on gender differences. Secondly, they also found substantial evidence supporting intergenerational transmission of gender role attitudes, especially from mothers to daughters. It was proven than the performance of girls (not boys) improved when the mother participated in the labour market, as mothers were breaking somehow the role of women set by society.

2.2 Objectives of this study

The objective of the present paper is to analyse the gender inequality in the European Union, in particular, the systematic gap that exists in the test scores between males and females in the PISA results, focusing on mathematics and reading tests. To achieve such goal, a similar analysis to the one conducted by Sara de la Rica and Ainara González will be carried out. Our analysis will serve to provide further support on the mentioned hypothesis of social gender stratification and intergenerational transmission of gender roles for the particular case of the EU.

This paper will follow the core methodology of the described study, yet with its own particularities. In the first place, as it has been said, this paper aims to study the gender inequality in the European Union. Accordingly, only member countries of the EU will be taken into account. Furthermore, the previous study was only conducted for year 2009. The present paper intends to analyse the most recent data available, which is the one for the test conducted in 2018.

The study will be divided in two main subsections. The first one will be devoted to examine the existing gender gap in test scores between girls and boys in 2018. This subsection will also study the relationship between the mentioned gender gap and the extent of gender equality in a given society, analysing the impact that several gender equality measures have in the performance of students. The second subsection of the study will concentrate on analysing the intergenerational transmission of gender roles from parents to children. In order to perform this analysis, two variables have been chosen, which are the occupation and the level of studies of parents.

3. METHODOLOGY

The purpose of this section is to explain the methodology followed throughout this paper to achieve the established objectives. The main goal of this study is to explore the gender gap in the PISA wave of 2018 for the European Union. Furthermore, the paper also aims to analyse how these gender gaps are affected by different measures of the gender equality in a society, as well as to examine whether there is any intergenerational transmission of gender role attitudes from parents to children.

The present study has been conducted for a total of 23 countries, which are all the EU members that have participated in the PISA test of 2018. The number of students who have undertaken this test is of 182,945 in the case of mathematics and 147,002 in the case of reading, as Spain did not participate in this one. Moreover, the data base is composed of 49.6% of female students and 50.4% of male students. Additionally, it includes data on several variables regarding student, family and school characteristics that has been used as control variables at several steps of the analysis.

To achieve the aforementioned objectives, the first part of the study focuses on computing gender gaps in each of the EU countries in mathematics and reading and on analysing the size and the direction of the gap. Throughout the whole paper, the gender gap is defined as the difference of the girls' test scores minus the boy's test scores. Subsequently, we focus on examining to what extent a more gender egalitarian society has an impact on the gender gaps in mathematics and reading. To do so, several gender equality measures of society are identified. Later, two different analyses are carried out. In the first one, the impact of the gender equality measures on gender gaps is analysed at the country level. In the second one, a more complex analysis is performed, where the test scores of students are estimated at the individual level.

Finally, the last section will assess whether there exists intergenerational transmission of gender roles attitudes from parents to children in the EU countries. To do so, the objective is to examine the impact that the family has on students' performance base on two variables, which are the occupation and the level of education of parents.

4. A REVIEW ON THE PISA DATA

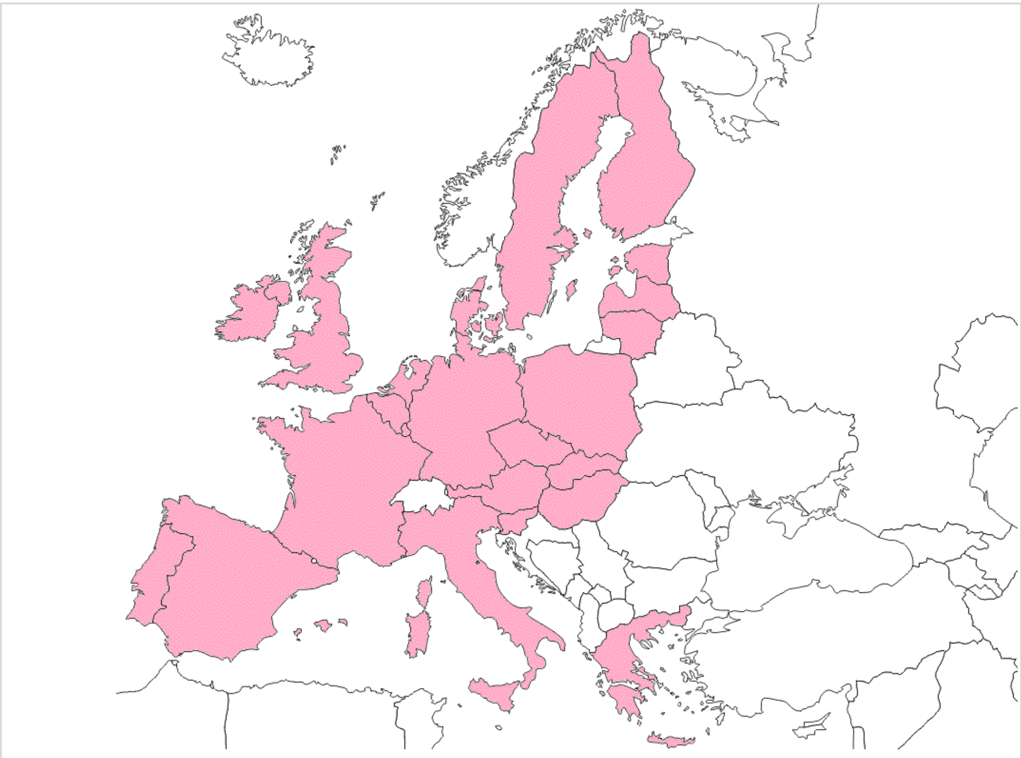
The section will show a brief description of what the PISA data base offers, as well as an overview of the performing of the European Union countries on mathematics and reading throughout the period 2000 to 2018.

PISA has a wide data base which gathers information regarding test scores of 15-year-old students for the OECD countries and its partners. The assessment tries to find out if students can apply what they have learned in class to real-life situations and it covers three subjects: mathematics, reading and science. Furthermore, it also collects information through questionnaires at student and school levels, which provide detailed information on children, family and school characteristics. The project started in 2000 and it has been conducted every three years since that moment. Over these years, more than 90 countries and 3 million students have participated in the tests.

Countries volunteer to take part in the test. Once they have been approved by the governing board of PISA, the sample is stratified at two stages. First, individual schools within that country are selected according to rigorous criteria in order to be a representative sample of all fifteen-year-old students in that country. Then, students within those schools are randomly selected to perform the test (OECD, 2016). Students do not get individual scores for their tests. Instead, their scores count towards a national mean score. There is no minimum or maximum score in the PISA test. The results are scaled to fix approximately normal distributions with mean 500 and standard deviation 100, $Score \approx N(500, 100)$. The vast majority of students get a score between 400 and 600 points. 2% of them get a score higher than 700 and just a bunch of students worldwide get a score over 800 points (OECD , 2020).

Although the data base of PISA offers countless possibilities, the focus has been put on the results for the EU countries in 2018. The EU is currently made up of 27 countries, of which 22 members participate in PISA tests and 5 of them have never done it. The EU members which have never enrolled in a PISA test are Bulgaria, Croatia, Cyprus, Malta and Romania. Besides, although United Kingdom is no longer part of the EU, it has been taking into account, as for the year studied, 2018, it was still a member. Therefore, the total number of countries studied is of 23, which can be seen in the map below. In 2018, all of them participated in the mathematics test and all of them except from Spain participated in the reading test.

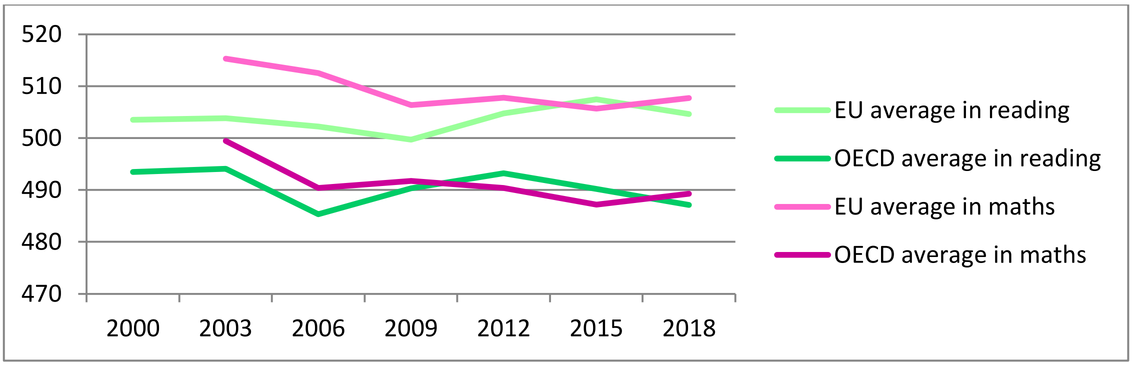
Figure 2. EU countries forming part of the analysis.



Source: Own elaboration.

Here, a description of the performance of the European Countries over the whole period that PISA has been conducted is presented. Overall, the difference in performance between European countries is not as wide as it is for the whole countries. Additionally, the EU has in mean better results than the OECD. Yet, the difference of average test scores is around 100 point between the best and the worst EU performer. The mean score in mathematics between 2000 and 2018 for the EU has ranged from 506 to 515 points, whereas the OECD has ranged from 487 to 499. In the case of reading, the EU average have varied from 500 to 507, whereas the OECD lags again behind with an average ranging from 485 to 494. The variation in the averages of the EU and the OECD are displayed in the figure 3.

Figure 3. EU and OECD average score in maths and reading from years 2000 to 2018.



Source: Own elaboration.

With regards to reading, there are two countries which have been outperforming the other EU members over the years, which are Finland, with average scores between 547 and 520 points and Ireland, with average scores ranging from 496 and 527 points. However, this pattern changed in 2018 when Estonia outperformed both of them with an average score of 523 points, being 33 points above the EU average. On the other hand, although the worst performing countries have been varying over the years, the three last PISA tests ended up with the same two countries in the latest positions, which are Greece and Slovak Republic. For the year 2018, their average scores were 457 and 458 points respectively, being 33 and 32 point behind the EU average.

With respect to the mathematics tests, the results are quite different. The best maths performers until 2009 were Finland, with scores from 541 to 548 points, and Netherlands, with scores from 526 to 538 points. From that year on, Netherlands achieved to keep its position and Estonia went up to the top two in the ranking. In the last year, Estonia got an average score of 523 points and Netherlands 519 points, being 27 and 23 points above the EU average. Regarding the worst performer, Greece has kept the lowest position in the ranking every year, with average scores varying from 445 to 466 points. In 2018, its average score was of 451, being 45 points below the EU average.

In the case of Spain, it lags behind both the EU and the OECD average every year in mathematics and reading, except for two years. Spain scored 493 in the reading test in 2000, being exactly the average of the OECD and two points above the EU one. The country achieved to score above both averages in 2015, with a score of 496 points, being four points above the EU average and 6 points above the OECD one.

5. GENDER DIFFERENCES IN TEST SCORES ACROSS UE COUNTRIES

The aim of the present section is to study the existing differences between the test scores of girls and boys in the PISA tests within the European Union as well as exploring the link between the mentioned gender gap and the extent of gender equality in a given country. The section will start by displaying the differences is test scores between genders across countries, next we will describe several indexes to measure gender equality in a society and finally we will analyse to which extent these measures affect the observed gender differences in test scores.

5.1 Gender gaps in test scores

The first goal of this section is to compute and analyse the existing differences in test scores between genders in mathematics and reading within the European Union in the year 2018. To do so, the regression model specified above has been run for each of the 23 countries, where the dependent variable is the test score of each student in a given country and f_i is a dichotomous variable which takes value "1" if the student is female and value "0" if the student is male.

$$y_i = \beta_0 + \beta_1 f_i + u_i$$

It can be proven that the estimated coefficient of β_1, i.e. $\widehat{\beta_1}$, is equivalent to the gender gap in test scores between girls and boys, being this gender gap the sample mean of the girls' test score minus the sample mean of the boys' test score. Table 1 below presents the estimated gender gaps, $\widehat{\beta_1}$, for each country in mathematics and in reading. The stars of each coefficient represent the level of significance, being "***" 1%, "**" 5% and "*" 10%.

The table above shows two clearly different patterns for each of the subjects. On the one hand, the most part of the EU members have a negative gender gap in mathematics, which means that boys outperformed girls in this subject. This result holds in 17 out of 23 countries and it is statistically significant in 15 of them. On the other hand, it can also be appreciated that in the vast majority of countries girls outperformed boys in reading. This holds, and it is statistically significant, in 20 out of the 22 countries. Besides, the gender gap in reading is larger than the gender gap in mathematics, meaning that girls outperformed boys by more points than boys outperformed them in mathematics. These results are consistent with the prior literature, specifically, with the results of De la Rica and Gonzalez (2012) of the 2009 PISA wave.

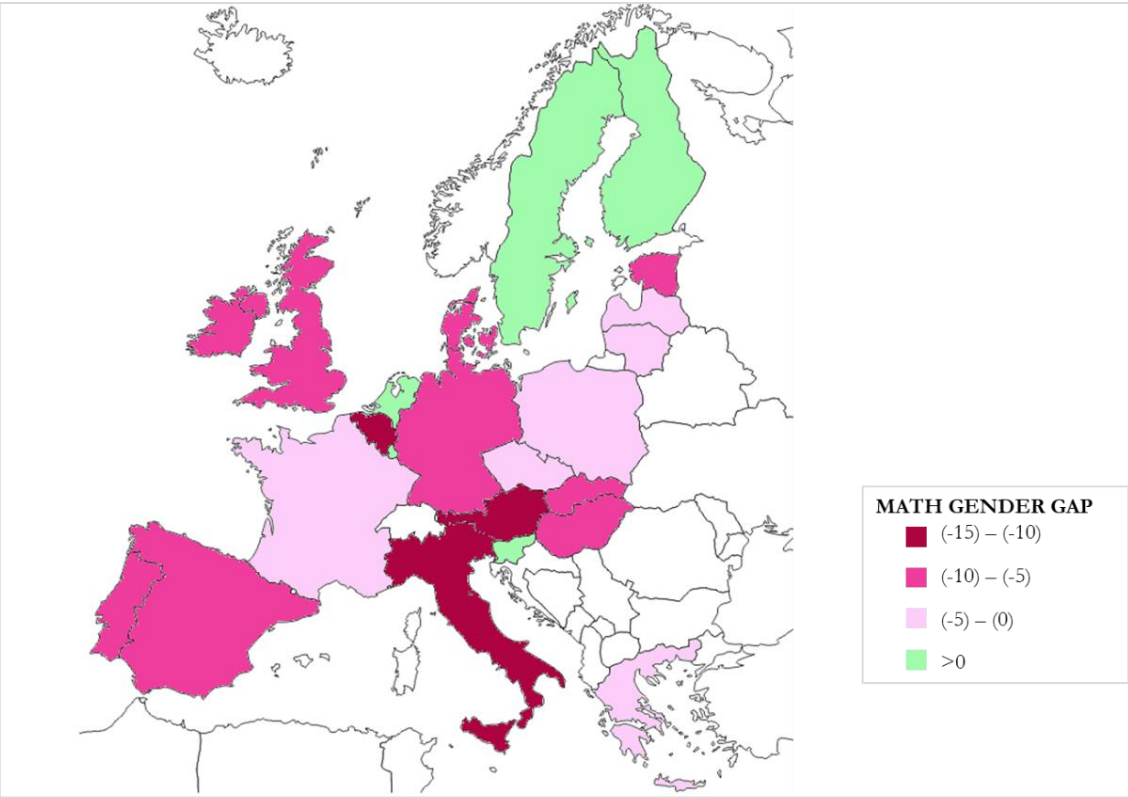
Table 1. Estimated gender gap and significance for EU countries in 2018.

COUNTRY	Gender gap in maths	Gender gap in reading	Nº. of observations
Austria	-11,892*** (2.315)	30,655*** (2.362)	6802
Belgium	-13,084*** (2.049)	21,6749*** (2.209)	8475
Czech Republic	-4,983** (2.273)	35,9305*** (2.360)	7019
Denmark	-5,687*** (1.942)	26,7568*** (2.132)	7657
Estonia	-8,746*** (2.212)	32,5238*** (2.533)	5316
Finland	5,475** (2.202)	50,8047*** (2.556)	5649
France	-4,5003* (2.440)	26,8565*** (2.635)	6308
Germany	-8,6400*** (2.561)	25,4278*** (2.846)	5451
Greece	-0,0952 (2.180)	41,5985*** (2.354)	6403
Hungary	-9,6100*** (2.480)	27,3098*** (2.678)	5132
Ireland	-7,5567*** (2.082)	22,5457*** (2.400)	5577
Italy	-13,4997*** (1.652)	26,7652*** (1.724)	11785
Latvia	-3,8780* (2.179)	33,9909*** (2.415)	5303
Lithuania	-3,1091 (2.166)	-36,2237*** (2.230)	6885
Luxembourg	8,1252*** (2.672)	-28,2750*** (2.912)	5230
Netherlands	0,1139 (2.747)	28,6467*** (3.051)	4765
Poland	-0,7026 (2.391)	32,3495*** (2.533)	5932
Portugal	-8,1703***	26,1720*** (2.462)	5932
Slovak Republic	-9,9228*** (2.545)	33,1550*** (2.557)	5965
Slovenia	0,8417 (2.147)	46,9067*** (2.270)	6401
Spain	-8,6228*** (0.920)	-	35943
Sweden	1,2355 (2.463)	34,2019*** (2.835)	5504
United Kingdom	-8,3935*** (1.527)	22,6181*** (1.664)	13818

Source: Own elaboration.

The table above displayed the gender gap in mathematics and reading for all the EU participating countries in PISA. To more clearly analyse the gender gap in mathematics test scores, Figure 4 shows a map classifying EU countries in four different categories according to the size of their mathematics gender gap.

Figure 4. EU Countries classified according to their mathematics gender gap.



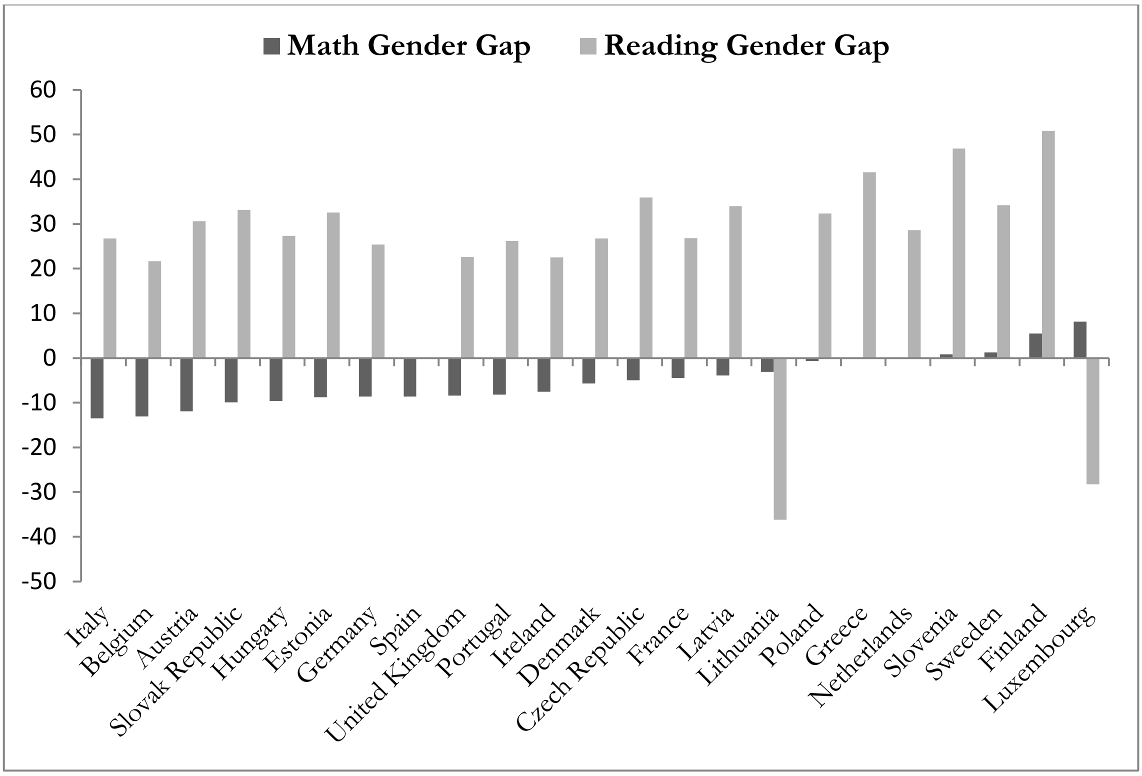
Source: Own elaboration.

There are 17 countries in which girls underperformed boys, i.e. which have a negative gender gap in mathematics. These countries are subdivided in three categories according to how large the gender gap is. These categories are (1) between -15 and -10 points, (2) between -10 and -5 points and (3) between -5 and 0 points. The fourth category, higher than 0, indicates countries where the gender gap in mathematics were positive, i.e., where girls outperformed boys in this science.

The countries with the largest negative gender gap in mathematics are Italy, Belgium and Austria. Spain falls inside the second category, in which the gender gap is between -10 and -5 points, together with Portugal, Ireland, United Kingdom, Germany, Denmark, Estonia, Slovak Republic and Hungary. Lastly, those with a negative gender gap between -5 and 0 are France, Latvia, Lithuania, Czech Republic, Poland, and Greece, being the last two pretty close to zero. Furthermore, there are 5 countries for which the mathematics gender gap is positive, that is, where girls outperformed boys. These countries are Netherlands, Luxembourg, Finland, Sweden and Slovenia.

Figure 5 displays the mathematics and reading gaps of each country, where these are ranked in ascending order by their gender gap in mathematics.

Figure 5. Gender differences in reading and mathematics.



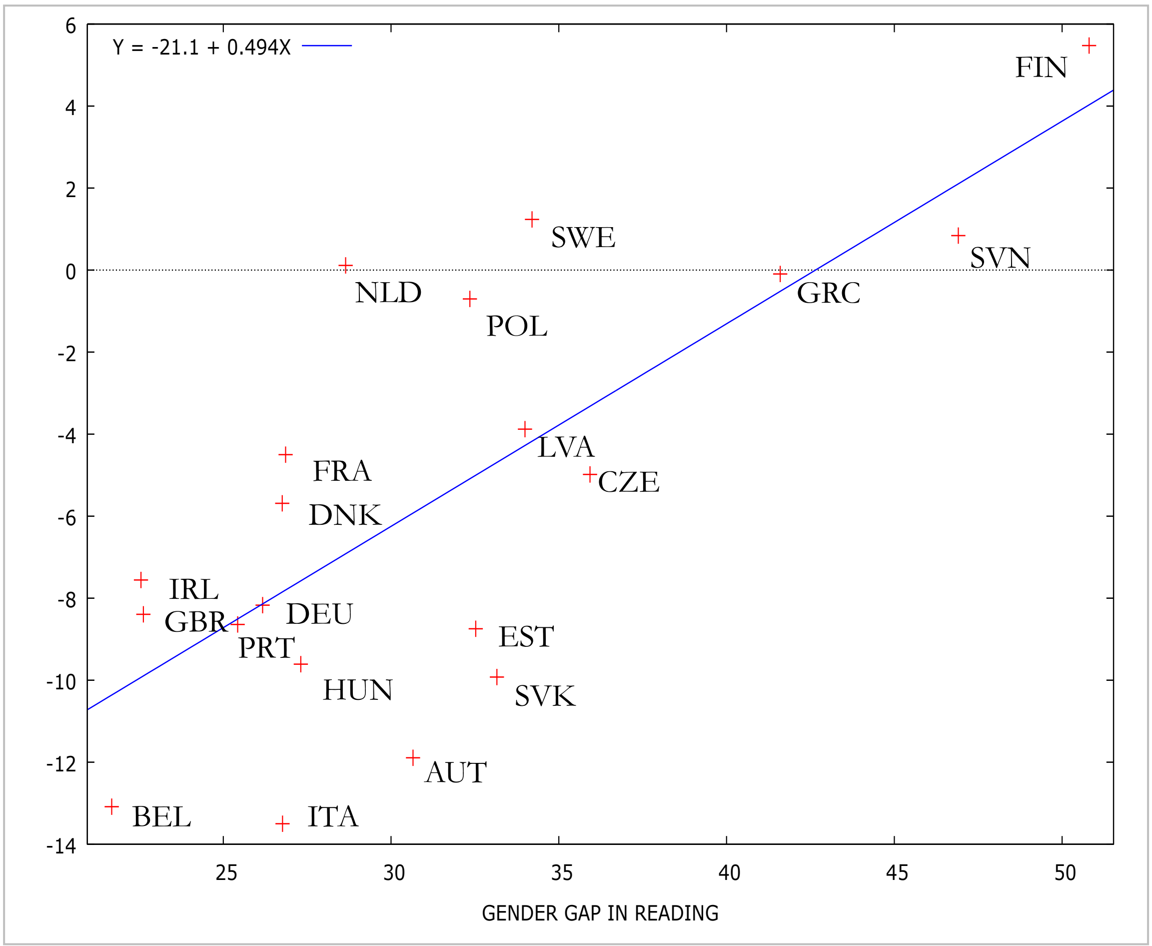
Source: Own elaboration.

In average, the test scores of girls in mathematics are 6.401 points lower than those of boys. Nevertheless, the results vary considerably from country to country. The largest gender gap was obtained by Italy, with -13.500 points, followed by Belgium, with -13.084 points, whereas in Luxembourg, Finland and Sweden girls outperformed boys by 8.125, 5.475 and 1.236 points respectively. If we compare these results with those obtained in De la Rica and González (2012), it can be seen that Finnish and Swedish girls already outperformed boys in 2009 and Belgium was already one of the countries with a largest negative gender gap. Nevertheless, although Italy has slightly closed its mathematics gender gap, it has not been enough to improve its position in the ranking, which was before France, Spain and Belgium in 2009 and now occupies the last position.

Regarding reading, the gender gap reverses, that is, in reading are girls who outperform boys. In fact, test scores in reading are in average 30.553 points higher for girls than for boys, being this gap wider than the mathematics one. Nevertheless, results vary again widely from country to country. Finland is the country with the highest positive gender gap in reading, where girls outperformed boys by 50.805 points, whereas Lithuania and Luxembourg have a negative gender gap, where girls underperformed boys by 36.224 and 28.275 points respectively.

Figure 7 represents the correlation between the gender gaps in mathematics and reading for each country. There are three countries that are excluded, which are Lithuania and Luxembourg because they could be considered outliers and also Spain because it did not take part on the reading test in 2018.

Figure 6. Correlation between gender gaps in mathematics and reading.



Source: Own elaboration.

For the countries analysed, the correlation between genders gaps is of 0.73005. This correlation is slightly lower than the one found by De la Rica and Gonzalez in 2009, which was 0.7764. This implies that in countries where girls have the largest advantage in reading, they also have better results in mathematics, closing the mathematics gender gap with respect to boys.

To finish the description of the gender gaps in the EU, it has been considered of interest to display the existing gender differences along the distribution range of test scores. Table 2 shows the average gender gaps for mathematics and reading in the European Union for several percentiles throughout the corresponding distributions.

Table 2. Main statistics and percentiles of EU gender gaps.

	Mean	Std. Dev.	5th	10th	25th	50th	75th	90th	95th
Maths									
Girls	493,12	87,63	344,43	377,07	434,12	496,36	555,19	603,39	631,77
Boys	499,52	93,09	342,76	376,65	435,37	502,53	565,90	618,21	647,83
Gender gap	**-6,40**		**1,67**	**0,42**	**-1,24**	**-6,17**	**-10,72**	**-14,82**	**-16,06**
Reading									
Girls	505,98	94,86	344,37	380,10	441,15	509,04	573,64	626,77	656,30
Boys	475,45	102,18	303,67	339,16	403,15	477,42	549,15	607,80	639,32
Gender gap	**30,53**		**40,71**	**40,94**	**38,00**	**31,62**	**24,49**	**18,97**	**16,97**

Source: Own elaboration.

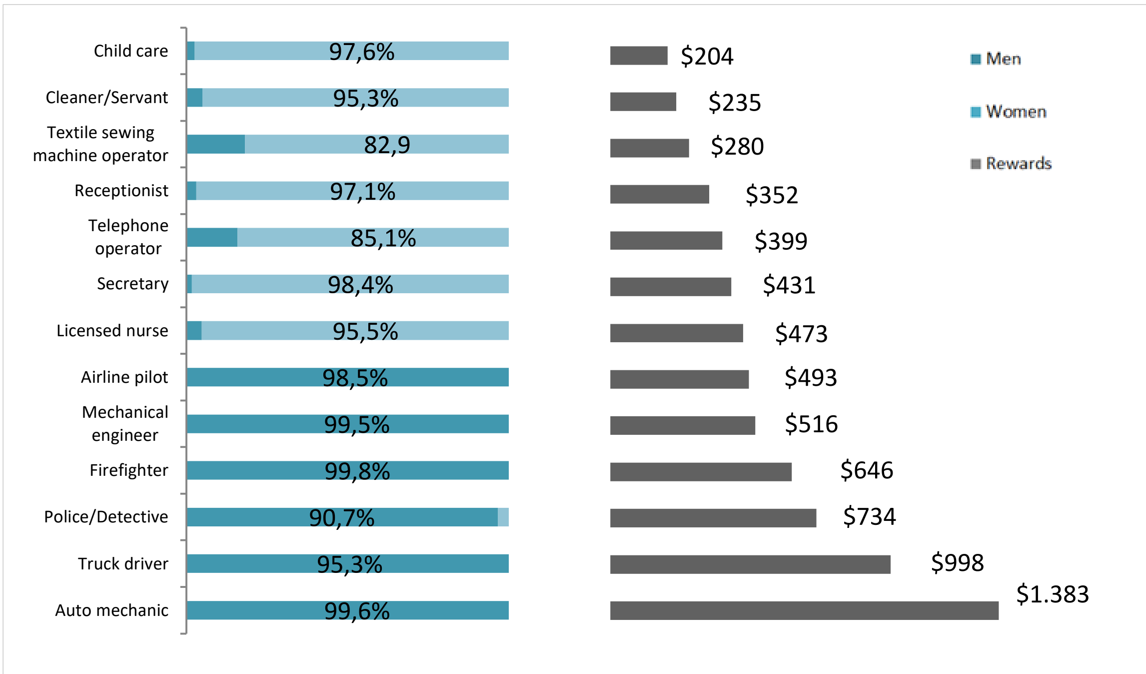
The table reveals that although the mean gender gaps in mathematics and reading are -6.40 and 30.53 points respectively, they vary widely throughout the test scores distribution. On the one hand, the negative gender gap in mathematics, i.e. girls underperforming boys, is low or even becomes positive, that is, girls outperforming boys, on the left tail of the distribution. However, as we advance towards higher percentiles of the distribution, this gender gap in mathematics becomes larger at every step. This implies that among low-performer students, girls and boys obtain similar scores in mathematics, whereas if we focus on the top-performer students, boys clearly outperform girls.

On the other hand, the opposite situation happens with the gender gap in reading. It can be observed that the gender gap is larger in the first percentiles, meaning that among low-performer students, girls have a big advantage over boys. Yet, in the highest percentiles, that is, among the top-performer students, girls lose advantage over boys in reading, considerably closing the gender gap.

The same pattern that has been described here was observed by De la Rica and Gonzalez (2012) at the international level for the gender gaps in mathematics and reading in the wave of 2009. There is previous literature supporting that these results can have long-lasting implications in older stages of life of the students, resulting in the persistence of gender inequality.

As mentioned in the background section, some pieces of literature hold that the performance of girls being worse than boys in mathematics is not due to fact that girls have worse skills than boys in this subject rather than a consequence of the role of women established by society. According to these authors, the role of women imposed by society is the one of bearing the burden of carework, whereas mathematics is supposed to be a men's science. This ends up harming the non-cognitive skills of women, making them actually worse at maths. In consequence, women lean towards worse paid professional careers such as teachers or secretaries, whereas boys tend to choose technical careers which are better paid. (Bowles, Edwards, & Rooselvelt, 2005). Evidence on these facts is shown in Figure 7.

Figure 7. Occupations stratified by gender and its rewards.



Source: Bowles, S. et. al. (2005). *Gendered occupations and unequal rewards.*

Same evidence is provided in another study, where it is said that these differences in test scores can harm girls' future earnings through their chosen careers, as these ones are highly correlated with maths scores at school (Klassen 2002).

5.2 Measures of gender-equal societies

This subsection is devoted to describe and analyse several indicators of gender equality in societies that have been gathered. The first two indicator measures gender role attitudes of countries towards women whereas the last is related to the women's decision to participate in the labour market. A higher value in any of these measures indicates a better position of women in society.

Data on three different indicators has been collected, which are the Gender Gap Index (GGI), the Political Empowerment Index (PPI) and the Female Labour Force Participation Rate (LFPC). Here follows a brief description of each of them.

- **Gender Gap Index (GGI).** Over the last 14 years, the World Economic Forum has annually published the Global Gender Gap Report. In it, countries are ranked according to their gender gap between women and men. The indictor is composed by four different key dimensions to assess the position of women in a given country, which are Economic Participation and Opportunity, Educational Attainment, Health and Survival and Political Empowerment. The ranking allows effective comparisons among countries and is intended to create global awareness of the challenges and opportunities derived from the existing gender disparities.

- **Political Empowerment Index:** This is one of the subindexes of the GGI, which measures the gender gap in the highest level of political positions based on three indicators: ratio of women to men at ministerial, ratio of women to men at parliamentary positions and the ratio of years of women to men being prime minister or president for the last 50 years. (World Economic Forum, 2019)
- **Female Labour Force Participation Rate +15 (FLFP).** This ratio indicates the percentage of women in the age group of 15 to 54 who are working or actively seeking employment in the labour market in 2018. This data is available at the World Bank and comes from the International Labour Organization (ILO) database.

The sample statistics for each of the indicators described above is displayed in table 3. All the indicators contain data for the full set of countries studied.

Table 3. Sample statistics of the gender equality indicators.

	Mean	Std. Dev.	Min.	Max.	Obs.
GGI	0,740	0,052	0,592	0,822	23
PPI	0,299	0,132	0,045	0,519	23
FLFP+15	0,541	0,058	0,411	0,708	23

Source: Own elaboration.

To assess whether these gender-equality indicators are correlated to each other, table 4 presents the correlation matrix. All the correlations shown are positive and statistically significant.

Table 4. Correlation matrix between gender-equality indexes.

GGI	PEI	FLFP+15	
1.000	0.781	0.738	GGI
	1.000	0.524	PEI
		1.000	FLFP+15

Source: Own elaboration.

The fact that the three measures are positively correlated means that if one of them increases, the others increase too. This implies that when women achieve a better position in society in terms of gender in any of the gender equality measures, the other gender equality measures will improve too.

5.3 Gender-equal societies and gender differences in test scores

The previous subsection has been devoted to provide a description of the gender-equality measures that wil be used throughout this analysis as well as displaying their main statistics and the correlations between them. The aim of this section is to asses to which extent these indicators affect the gender gap observed in mathematics and reading.

To carry out such analysis, two different approaches will be followed. In the first one, a cross-country analysis will be performed. For that purpose, the unit of analysis will be the country, meaning that the gender gap of each country will be the average gender gap. As this analysis contains few observations to reach robust results and it may suffer of heterogeneity problems, we compute a second analysis at the student level. In this analysis the impact of the gender-equality measures will be estimated for the full set of observations for 2018 PISA wave, that is, for every student.

5.3.1 Cross-country analysis

In this first analysis, the aim is to analyse the existing correlation between the gender-equality measures and the gender gap in test scores taking the country as the unit of analysis. To do so, the following OLS regression model has been run. Separate regression models have been run for mathematics and reading and for each gender-equality measure.

$$y_i = \beta_0 + \beta_1 GEI_i + \beta_2 GDPpc_i + u_i \ ,$$

where:

- y_i : Gender Gap in country "i"
- GEI_i : Gender Equality Indicator in country "i"
- $GDPpc_i$: Gross Domestic Product per capita in country "i"

The dependent variable, y_i, is the gender gap of the "i" country in either of the two subjects studied, mathematics or reading, and it depends on two regressors. The first one, GEI_i, corresponds to any of the three gender-equality measures presented above for the "i" country and the second one, $GDPpc_i$, represents the Gross Domestic Product per capita in 2018 for the "i" country.

It could happen that in most developed countries, the gender gap was bigger and more favourable to women, as in these countries girls tend to have a bigger advantage in reading and tend to close its disadvantage in mathematics. In brief, the extent of development of a country could affect the gender differences in test scores. By introducing the second regressor into the model, we make sure that any increase in the gender gap of a country is due to an increase in the corresponding gender-equality measure and it is not due to other variables, in this case the GDP pc of a country.

Table 5 displays the estimated coefficients for each of the gender-equality measures for the gender gap in mathematics and reading respectively. The coefficients of each gender equality measures are obtained from a different estimation. The coefficient is shown together with its robust standard error and, in case it is significant, its level of significance.

Table 5. OLS estimation for the gender gaps in mathematics and reading.

GENDER-EQUALITY MEASURES	Maths	Reading	Maths	Reading	Maths	Reading
GGI	46,300*** (-15,703)	38,744 (-52,891)				
PEI			8,672 (-8,241)	25,063 (-26,285)		
FLFP+15					37,923*** (-12,744)	31,492 (-51,668)

Source: Own elaboration.

The purpose of this analysis is to assess whether these gender equality measures are significant in explaining the gender gap in test scores. As it can be seen in the table, the coefficients are positive and significant for two out of the three proposed gender quality measures in mathematics and they are not significant in the case of reading. From this exercise, we can say that in more gender-equal societies, according to gender-equality measures GGI and FLFP+15, girls obtain better results in mathematics. Regarding reading, no conclusion can be reached.

Nevertheless, these results are not solid enough as the presented analysis has clear weak points. The model only contains observations for the gender gap in mathematics and reading of the 23 countries of the EU which participated in the PISA test of 2018. This number of observations is not enough to reach robust results. However, the model can be a starting point to carry out the more-precise study of the following section, in which rather than doing the analysis at the country level with the corresponding gender gaps, the analysis is made at the student level, estimating the test score of each individual who participated in the 2018 PISA wave.

5.3.2 Pool of countries: an analysis at the student-level

To obtain more robust results, we take advantage of the PISA data base which provides the test scores for each participating individual. This second analysis concentrates on assessing the impact of the gender-equality measures at the student level, rather than at the country level as done in the previous section. To do so, the regression model shown below has been run.

$$y_i = \beta_0 + \beta_1 f_i + \beta_2 f_i GEI_i + \beta_3 f_i GDPpc_i + \beta_4 CV1_i + \cdots + \beta_n CVn_i + u_i,$$

where:

- y_i : Score of student "i" in either mathematics or reading.
- f_i : Female indicator, (=1, female =0, male).
- $f_i GEI_i$: An interaction between female and the corresponding gender-equality measure for the country of student "i".
- $f_i GDPpc_i$: An interaction between GDP pc in the country of student "i" and the female indicator.
- $CV1_1 - CV1_n$: Control variables.

This model estimates the individual scores of students, dependent variable, in either mathematics or reading, based on several regressors. The regressor of relevance to the present study is the second one, $f_i GEI_i$, whose coefficient indicates the impact that a certain gender equality measure has on the final test score of the female student "i". In order to make sure that any improvement in the test score of a female student is due to an increase in the gender-equality measure, more regressors are added into the model. These ones are (1) the interaction between the dichotomous variable of female, f_i, and the GDP per capita, which ensures that the improvement in the test score is not due to the extent of economic development of the student's country and (2) a set of control variables.

These control variables are included as they have been reported to affect the performance of the student. They can be classified into four categories: country, student, family and school characteristics.

- Country. These enables to include in the model country fixed effects. Austria is taken as the country of reference.
- Student. In this category, two control variables are included, which are whether the students is on the modal grade in the country or in a different one, and the

immigration status of the child, which reports whether the student is native of the country where the test is being taken or not.

- Family. Here, both the occupation and the education level of both parents are included. The education is classified according to the ISCED scale[1].
- School. The control variable included here has been whether the student attends to a public or a private school.

Table 6 shows the estimated coefficient for the interaction between female and each gender-equality indicator, where each coefficient comes from a different estimation. These coefficients measure the impact that a certain gender equality measure has on the test scores of girls. Moreover, the table does not just display the average estimation but also the 25th and 75th percentiles, to observe whether the gender-equality indicators affects students differently in different points of the distribution of test scores, that is, low-performer students vs. high-performer ones. The figure also indicates the level of significance and the robust standard error in brackets. Robust SEs are chosen due to its validity if there is heteroskedasticity.

Table 6. The impact of the gender-equality measures in the test scores of girls.

	25TH QUARTIL		**AVERAGE**		**75TH QUARTIL**	
	MATHS	**READING**	**MATHS**	**READING**	**MATHS**	**READING**
Female * GGI	46,605*** (10,175)	39,763*** (10,691)	53,824*** (7,298)	29,762*** (7,865)	57,361*** (9,586)	28,243*** (9,607)
Female * PEI	9,698** (4,475)	10.432** (4.983)	10,706*** (4,045)	2.447 (3.643)	12,596*** (4,218)	-2.616 (4.595)
Female * FLFP+15	32,6487*** (9,88)	14.1002 (10.939)	37,0437*** (8,628)	4.0465 (7.750)	39,4046*** (9,103)	-1.62708 (9.926)

Source: Own elaboration

The table above reveals several facts regarding the impact of these gender equality measures in girls test scores. First, this impact differs from mathematics and reading. On the one hand, it can be seen at first glance that all the gender equality measures for mathematics are positive and significant at every stage of the distribution of the test scores. This means that a more gender-equal society entails an improvement in girls' test scores in every case.

Furthermore, if we analyse the effects at the average and in both tails of the distribution, the same pattern can be observed for the three gender equality measures. The impact of a

[1] The ISCED (International Standard Classification of Education), designed by the UNESCO, is used to classify education at an international level. It goes from ISCED 0, no education, to ISCED 6, maximum level of education

more gender-equal society increases as we advance in the distribution, that is, it is higher at the average than at the 25th quartile and, at the same time, it is higher at the 75th quartile than at the average. This pattern implies that the more equal a society is, the better girls perform in mathematics and this improvement is stronger for the high-performer girls. Besides, Table 2 showed that the gender gap between girls and boys in mathematics was higher in the right tail of the distribution, that is, for the top-performer students. Given this fact, a more gender-equal society, which implies a stronger improvement of high-achieving girls in mathematics, will help to close the gender gap throughout the distribution of mathematics test scores.

On the other hand, the results for reading coefficients are not always significant. The only gender equality measure which is significant at every stage of the distribution is the GGI. The coefficients of the interaction between this indicator and the "female" variable are in all cases positive and significant, which means that a more gender-equal society entails an improvement of girls test scores in reading. Nevertheless, in the tails of the distribution, the effects of this measure go in the opposite direction to the effects in mathematics. In this case, the improvement in the reading test scores is stronger for low-performer girls. The PEI coefficients show that at the average and at the 75th quartile the effect of a more gender-equal society is not significantly different from zero. However, the effect is positive and significant at the 25th quartile, which means that a more gender-equal society that is reflected in an increase of the PEI coefficient improves the maths test scores of the low-performer girls. The impact of the FLFP indicator is not significant in the case of reading.

In conclusion, this model which estimates the PISA test scores for every individual in the EU countries for the wave of 2018 has provided more robust results that those shown in the cross-country analysis. The main findings regarding the effect of the different gender equality measures in the performance of girls have been the following. First of all, these measures have in the majority of the cases a positive and significant coefficient, which implies that a more egalitarian society in terms of gender entails an improvement in both mathematics and reading for girls, being this improvement larger in mathematics than in reading. Secondly, if we focus on the distribution of test scores, the effect of the gender equality measures differs in mathematics and reading. For the former, the effect of a more egalitarian society is large at the right tail of the distribution, that is, for high-performer female students, whereas in the case of reading, the effects are stronger in the left-tail of the distribution, that is, for low-performer female students.

6. INTERGENERATIONAL TRANSMISSION OF GENDER ROLES.

The previous section focused on analysing the impact that several gender-equality measures of a society have on the average test scores in PISA of boys and girls. Nevertheless, this section leaves behind those gender-equality measures and focus on the impact that the family of the students have in their PISA test results. To do so, this section will analyse the impact that two different variables have on the students' results, which are the occupation and the level of education of the mother and father of the student.

6.1 The impact of parents' occupation.

The purpose of this part is to analyse the impact that the parents' occupation have on the test scores of their children. The section will analyse the impact on boys and girls for both subjects, mathematics and reading, separately.

Prior to start with the analysis, it can be of interest to explain the results that Sara de la Rica and González (2012) obtained in their analysis of the PISA results in 2009 for the whole set of participating countries. They run a model to assess whether the fact that parents participated in the labour market or not had an impact on the students' test scores, that is, they only took into account whether the mother or the father worked or was looking for a job, not what type of occupation they had in case they were working. The results of the analysis were the following. In the case of the student's mother participating in the labour market, results differ for girls and boys. It was observed that girls performed better if their mother was actively participating in the labour market, whereas in the case of boys, they obtained on average the same scores whether their mother participated or not. On the other hand, they found that students who had a father participating the labour market, more specifically, working full-time, had better results. However, in this case, they did not found any significant difference between genders, which means that both the performance of boys and girls improved similarly if they had a full-time working father.

One interpretation for the presented results is the *gender identity,* a hypothesis stating that genders, male and female, are strongly related with gender roles imposed by society, which indicates what is appropriate for men and women to do (Ghosh, 2015). This hypothesis is consistent with previous literature already mentioned in this paper. According to this literature, girls perform worse than boys in mathematics because this subject is said to be a men's skill by the society. What seems to happen here is that working mothers break somehow with the traditional view of being the father who works and the mother who should stay at home. Those mothers who work seem to transmit this break of the traditional gender role of women in society and empower their daughters to break their barriers and perform better in mathematics.

In this section, the intention is to go a step further. Rather than analysing the effect of parents participating in the labour market or not, we want to analyse how the parents' occupation in the labour market affects the students test scores of the EU countries in the 2018 wave of PISA. First, we will analyse the impact of the mother's occupation. To conduct this analysis, the following OLS regression model has been constructed.

$$y_i = \beta_0 + \beta_1 f_i + \beta_2 OccM0_i + \cdots + \beta_{13} OccM9_i + \beta_{14} f_i OccM0_i + \cdots + \beta_{25} f_i OccM9_i + \beta_{26} CV1_i + \cdots + \beta_n CVn_i + u_i,$$

where,

- y_i: Test score in either mathematics or reading for student "i".
- f_i : Female indicator, (=1, female =2, male).
- $OccM0_i - OccM9_i$: Dummies for the variable which indicates the mother's occupation of student "i". The classification of occupations is displayed below and the variable taken as reference is "9703: Housewife".
- $f_i OccM0_i - f_i OccM9_i$: Interaction between the variable female and each of the dummies for the variable which indicates the mother's occupation of students "i".
- $CV1_i - CVn_i$: Control variables of country, student and school. These control variables are the same that the ones used in the previous model.

The parent's occupation is classified according to the ISCO-08 standards, shown in Table 7. ISCO stands for International Standard Classification of Occupations and it is a tool developed by the ILO (International Labour Organization) to organize jobs into clearly defined sets according to the performed tasks and duties in the job (ILO, 2012).

Table 7. Classification of occupations according to ISCO-08.

Category	Description
0000	Armed forces
1000	Managers
2000	Professionals
3000	Technicians and associate professionals
4000	Clerical support workers
5000	Service and sales workers
6000	Skilled agricultural, forestry, and fishery workers
7000	Craft and related trade workers
8000	Plant and machine operators, and assemblers
9000	Elementary occupations, excluding 9701, 9702 and 9703
9701	Housewife
9702	Student
9703	Social beneficiary

Source: Own elaboration.

The following table shows the coefficients obtained for the variable of the mother's occupation in the model that have just being described. To recall, the variable taken as reference is the one of "housewife". Therefore, these coefficients represent the impact that the mother's occupation has on the student's test scores, for mathematics and reading separately, with respect to the mother being a housewife.

Table 8. Impact of mother's occupation in students tests scores.

MOTHER'S OCCUPATION	MATHEMATICS	READING
0000	26.523** (11.312)	26,717 (30,454)
1000	32.450*** (1.508)	42,117*** (3,704)
2000	40.558*** (1.080)	50,797*** (2,363)
3000	32.717*** (0.976)	42,689*** (2,661)
4000	35.264*** (1.325)	51,981*** (2,777)
5000	13.896*** (1.080)	23,222*** (2,350)
6000	9.853*** (3.058)	−3.606 (6,636)
7000	10.9845***	10,772*** (3,767)
8000	9.848*** (2.277)	2,720 (5,960)
9000	5.053*** (1.299)	12,644*** (2,871)
9702	7.947 (7.085)	63,959*** (22,254)
9703	−6.218*** (1.673)	−0.324 (5,070)

Source: Own elaboration.

The table reveals several interesting features. In the case of mathematics, every coefficient is significant expect for the 9702 (student). All of these coefficients except for the 9703 (social beneficiary) are positive, which implies an improvement in maths test scores of students whose mother is not a housewife with respect to the students whose mother is a housewife. These improvements range from 5 to 40 points. In the case of reading, not every coefficient is significant. However, if we focus on those which are, a similar pattern is displayed. All the significant coefficients are positive, which implies an improvement in students reading test scores if the mother is not a housewife with respect to the mother being a housewife.

If these results are analysed altogether, it draws the attention the following facts. The mother's occupations which suppose a higher improvement in the students' test scores are managers (1000), professionals (2000), technicians (3000) and clerical support workers

(4000), with improvements ranging from 30 to 50 points. On the other hand, those occupations that imply a smallest improvement in scores are skilled agricultural, forestry and fishery workers (6000), craft and related trade workers (7000), plant and machine operators, and assemblers (8000) and elementary occupations, except for housewife, student and social beneficiary (9000), with improvements varying from 1 to 13 points. Furthermore, in the case of mathematics, the effect of having a mother who is a social beneficiary supposes a decrease in student's test scores of 6.218 points in comparison with having a housewife mother.

To assess whether this impact on students' test scores of mother's occupation is different from boys and girls, we focus on the results of the interaction between the dichotomous variable "Female" and the dummies for the mother's occupation. A positive and significant coefficient will imply that having a mother with that specific occupation improves the test scores of daughters relatively more than it improves the scores of sons, pointing to intergenerational transmission of gender roles from mothers to daughters.

Yet, these coefficients turned out not to be significantly different from zero is most of the interactions and, for those for which they were significant, their signs were in some cases positive and in other cases negative. This implies that the mother's has an impact on the students' test scores but it seems to be independent of the gender of the student, that is, it seems that the mother's occupation does not improve the results of daughters more than it does the results of sons. This finding points to a lack of transmission of gender roles attitudes from mothers to daughters in the European Union countries.

Although Sara de la Rica and González (2012) did find a transmission of gender roles from mothers to daughters, this was mainly for cases in which (1) the participation of the mother in the labour market was low, which entail that a working mother will actually break the role of women imposed by society, and (2) the performance of the student is low. Considering that the members of the EU are among the countries which have a higher participation of women in the labour market and, as shown below, their results are above the OECD average, it seems consistent with Sara de la Rica and González (2012) to not have found a significant transmission of gender role attitudes from mothers to daughters.

Furthermore, we have repeated the same analysis but for the father's occupation instead of the mother's. The following table represents the impact that the father's occupation has on the student's test scores, for mathematics and reading separately, with respect to the father being a housewife.

Table 9. Impact of father's occupation in students tests scores.

FATHER'S OCCUPATION	MATHEMATICS	READING
0000	27.268*** (6.029)	28.630** (4.003)
1000	39.323*** (5.256)	41.994 (121.532)
2000	52.500*** (5.235)	59.512*** (10.377)
3000	38.003*** (5.255)	40.671 (45.052)
4000	33.095*** (5.378)	36.675 (24.504)
5000	21.035*** (5.259)	23.467 (45.505)
6000	10.742** (5.408)	2.139 (156.871)
7000	13.867*** (5.217	11.722 (32.279)
8000	10.824** (5.261)	8.404* (4.989)
9000	11.257** (5.367)	9.195 (9.256)
9702	27.361** (12.904)	27.319* (14.793)
9703	13.590** (5.588)	12.278* (7.158)

Source: Own elaboration

The table above reveals several facts. On the one hand, the impact of father's occupation in the student's performance in mathematics is very similar to the impact of the mother's occupation. For both cases, occupations with the highest impact on maths test scores are managers (1000), professionals, (2000) and technicians and associate professionals (3000), whereas the occupations with the smallest impact are skilled agricultural, forestry and fishery workers (6000), craft and related trade workers (7000), plant and machine operators, and assemblers (8000) and elementary occupations, except for housewife, student and social beneficiary (9000). On the other hand, the impact of father's occupation on reading test scores is not significant in most of the cases, although for those cases which is significant the impact is positive. Besides, the occupation with the highest impact is, as in the case of mathematics, professionals (2000), with an improvement of 59 points in reading test scores.

Moreover, to assess whether there is any difference in the impact of father's occupation between boys and girls, we have taken a look to the coefficients of the interaction between the dichotomous variable "Female" and the dummies for father's occupation. In the case of mathematics, these coefficients are negative and significant in every case except for skilled agricultural, forestry and fishery workers (6000) and armed forces (0000), varying from -4 to -48 points. A negative and significant coefficient means that the father's occupation improves the maths test scores of boys more than it does the scores of girls. In the case of reading, these coefficients are not significant in any case except for student (9702), which implies that the father's occupation has not a different impact on reading test scores between boys and girls.

To sum up, it has been observed that the parents' occupation have an impact on the student's performance. In general, it has been found that students test scores are higher in mathematics if parents are not a housewife (9701) with respect to if they are. In the case of reading, not all the parent's occupations have a significant improvement is test scores. Yet, for those which are significant, the impact is always positive. As mentioned above, the parent's occupations with a highest improvement in students' performance are managers (1000), professionals (2000) and technicians and associate professionals (3000). Regarding the difference in the impact between boys and girls, it seems that the mother's occupation does no impact differently boys and girls. However, in the case of the father's occupation, it clearly impacts negatively on girls in the case of mathematics, as the improvement in test scores is almost in every case lower for girls than for boys, whereas in the case of reading it does not seem to have a different impact.

6.2 The impact of parents' level of education.

Now that the effect of parent's occupation in students' test scores have been analysed, it has been consider of interest to show the impact that the parent's education has in the students test scores. To do so, we run the same model as the one presented above except for the variables of occupation and the interaction between these variables and the variable of "Female". Instead, we have introduced to the model a dummy indicating whether the mother has university studies or not and another one for the father[2]. Furthermore, these two variables have been interacted with the variable "Female".

Table 10 shows the impact of parents' education, both mother's and father's, have on the test scores of their children. The table displays the coefficients of parents' education to assess the impact their education has on students. Additionally, it also presents the interactions of these variables with the dichotomous variable female, to determine whether this impact is different from girls and boys.

[2] Parents have university studies if their ISCED is 5 or 6, whereas they do not have them if their ISCED is 4 or lower. Therefore, we have created a dichotomous variable being 1 if the mother or father ISCED is 5 or 6 and 0 otherwise.

Table 10. Impact of parents' education on students' tests scores.

	MATHEMATICS	READING
Mother's education	1,902*** (0.674)	0,8576 (0.838)
Female * Mother's education	4,161*** (0.918)	6,094*** (1.138)
Father's education	2,115*** (0.648)	1,217 (0.806)
Female * Father's education	1,084 (0.854)	0,3818 (1.061)

Source: Own elaboration.

Several conclusions can be drawn from this table. First, parents having university studies seem to improve the maths results of students but not those of reading. Specifically, if the mother has university studies, the student score is improved by 1.9016 points, whereas the student score is improved by 2.1148 points if is the father who has the university studies. Moreover, the impact of parents' university studies is different whether it is the mother or the father who has the university studies is. If the mother has university studies, the improvement in test scores, both for mathematics and reading, is higher for girls than for boys. However, the impact of having a father with university studies is not different between girls and boys.

7. CONCLUSIONS

This final section aims to sum up all the conclusions that have been extracted throughout the analysis. To recall, the objective of the present paper was to examine the gender gap in the 2018 PISA test scores between girls and boys in the European Union. This gender gap in test scores exists in countries all over the world and consists on a pattern by which girls underperform boys in mathematics and outperform them in reading. Besides, the study aimed to analyse the impact that a more gender-equal society will have in closing such gender gap. Moreover, another purpose of the paper was to analyse the existence of intergenerational transmission of gender role attitudes from parents to children.

The first part of the study focused on examining the gender gap in the EU and assessing how a more gender-equal society will impact this gender gap. It was found that, in average, girls scored 6.401 points lower than boys in mathematics but scored 30.553 points higher than them in reading. With respect to the impact that a more gender-equal society will have, the results were different from mathematics and reading. In the case of the former, it was proved that a more gender-equal society, measured by any of the three gender-equality measures (GGI, PEI, and FLFP+15), improved the performance of girls in mathematics, being this effect larger for the top-performer students. In the case of reading, it was shown that an improvement in the GGI involves an increase in girls' test scores. However, this increase was lower than the one observed in mathematics and the effect was larger for the low-performer students.

These results provide further evidence supporting the gender social stratification hypothesis. As a reminder, this hypothesis states that the gender differences between males and females are not the consequence of a biological difference rather than a consequence of gender roles imposed by society. Therefore, the fact that a more gender-equal society helps to close the gap between girls and boys in mathematics implies that girls are not biologically worse than boys in mathematics. Girls and boys have the same skills in this science. Nevertheless, the society established that mathematics is a male science, harming the non-cognitive skills of females and making them actually worse at it.

The second part of the study focused on assessing whether there is any transmission of gender role attitudes from parents to children in the European Union. To do so, we have explored the impact of two variables on the students' test scores, which are the parents' occupation and education.

With regards to the parents' occupation, several conclusions were extracted. We analysed the impact that the mother's and father's occupation had on the students' test scores separately. We found that, in both cases, the impact of parent's occupation followed the same pattern, that is, independent of whether it is the mother or the father, the parents' occupation of those students with better test results coincide. This parent's occupations, classified according to the ISCO-08, were managers (1000), professionals (2000) and technicians and associate professionals (3000). To assess whether there is any transmission of gender role attitudes from parents to students, we analysed if the impact of mother's and father's occupation was different depending on whether the student was male or female. We found that in the case of the mother's occupation, there seemed to be a lack of transmission of gender role attitudes from mothers to daughter, as the mother's occupation did not impact differently whether the student was a girl or a boy. On the contrary, the study showed that an improvement in mathematics test scores due to the father's occupation was almost in every case lower for girls than for boys, pointing out to a transmission of gender role attitudes from fathers to sons. In the case of reading, the impact was not different between girls and boy.

Afterwards, we analysed the impact of parents' education on students' test scores and the results were quite different. In the first place, it was found that parents having university studies had a positive impact on the students' performance in mathematics, whereas it did not have an effect on reading. With respect to the differences in the impact according to gender, it was shown that the impact on test scores of having a mother with university studies was higher for girls than for boys, which implies a transmission of gender role attitudes from mothers to daughter. However, the impact of having a father with university studies was similar for girls and boys.

To sum up, the study has provided further evidence supporting the social gender stratification strategy, as it was proven that a more gender-equal society improves the mathematics test score of girls, therefore closing the existing gender gap. Furthermore, it also has provided interesting results regarding the intergenerational transmission of gender role attitudes from parents to children. On the one hand, it has been proven that the father's occupation impacts more on boys than on girls, improving more the test scores of the former. On the other hand, in the case of education, it was shown that the impact of having a mother with university studies was higher for girls than for boys, improving more the test scores of the former.

REFERENCES

- Bowles , S., Edwards , R., & Rooselvelt , F. (2005). *Understanding capitalism: Competition, command, and change* . New York : Oxford University Press.

- Baker, D. P., & Jones, D. P. (1993). Creating gender equality: Cross-national gender stratification and mathematical performance. *Sociology of Education*, *66*(2), 91–103. https://doi.org/10.2307/2112795
- Daniels, R. (1959). International Standard Classification of Occupations. *Journal of Occupational and Environmental Medicine*, *1*(11), 615.
- De Beauvoir, S. (1949). The Childhood. In *The second sex: Vol. II*. http://uberty.org/wp-content/uploads/2015/09/1949_simone-de-beauvoir-the-second-sex.pdf

- European Insitute for Gender Equality . (2016). *Gender Statistics Database* . Retrieved from On average, how many hours per week are you involved in cooking and/or housework outside of paid work? (mean hours, 18+ population): https://eige.europa.eu/gender-statistics/dgs/indicator/ta_timeuse_hswk__eqls_famcarehours__cookm/bar/year:2016/geo:EU28,BE,BG,CZ,DK,DE,EE,IE,EL,ES,FR,IT,LV,LT,LU,HU,NL,AT,PL,PT,SI,FI,SE,UK/ANSWER:MEAN_HRS/CATEGORY:HOUSEWORK/sex:M,W

- European Institute of Gender Equality . (2019). *Gender Equality Index* . Retrieved from https://eige.europa.eu/gender-equality-index/2019

- González de San Román, A., & De la Rica Goiricelaya, S. (2016). Gender Gaps in PISA Test Scores: The Impact of Social Norms and the Mother’s Transmission of Role Attitudes. *Estudios de Economía Aplicada*, *34*(1), 79–108.
- Klassen, S. (2002). “Low Schooling for Girls, Slower Growth for All? Cross Country Evidence on the Effect of Gender Inequality in Education on Economic Development”. World Bank Economic Review, 16, 345-373

- NCES . (2019). *Program for International Student Assessment (PISA)*. Retrieved from Overview : https://nces.ed.gov/surveys/pisa/

- OECD . (2020). *PISA- FAQ*. Retrieved from https://www.oecd.org/pisa/pisafaq/

- OECD. (2016, October 27). *Youtube*. Retrieved from How does PISA work?: https://www.youtube.com/watch?v=i4RGqzaNEtg
- OECD. (n.d.). *PISA*. Retrieved from About : https://www.oecd.org/pisa/aboutpisa/
- World Economic Forum. (2019). 2018 The Global Gender Gap Report. In *World Economic Forum*. https://doi.org/10.1177/0192513X04267098.
- World Bank. (n.d.). *The World Bank: Database*. Retrieved from Labor force participation rate, female (% of female population ages 15+) (national estimate): https://data.worldbank.org/indicator/SL.TLF.CACT.FE.NE.ZS?end=2019&name_desc=false&start=1966