Gender and Students' Achievements: Evidence from PISA 2015

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Abstract

This study's objective is to examine school performance gaps according to gender on a global scale. After exploiting the data of the Program for International Student Assessment (PISA) of 2015, we can see inequalities of students' achievements between countries and within every country, by mobilizing a multilevel modelling. Resorting to this type of modelling has allowed more robustness, as opposed to the OLS estimator, which doesn't take data hierarchy into consideration. Our results generally reveal that gender has a significant impact on school performance. Thus, girls perform a lot better than boys when it comes to reading, while boys perform better than girls in mathematics and science. Our thinking and analysis are made in the context of the verification of hypotheses on a global scale, in order to draw innovative and coherent conclusions. This contribution can also be a line of research to verify other hypotheses that are linked to the deciding factors of inequalities of students' achievements.

Keywords: gender, student's achievements, PISA

1. Introduction

In a global context based on knowledge economy, the question of valorisation of human capital has become indispensable in development schemes, for both industrialized countries and so-called transition countries. The question of training and human capital accumulation automatically appeals to the concept of performance of educational systems.

In fact, in every single country, the national education sector takes on a particular importance. It first allows to contain the phenomenon of illiteracy, but it also and foremost allows education and training for future generations, as well as their preparation for the working world challenges. The success of any educational system is measured by the level of its performance, which can be apprehended through measuring students' achievements.

Public policies regarding national education and educational reforms can be very diverse and depend on the suffering afflicted on the sector, on the available budgetary resources, but also on the objectives set by public authorities. Should the condition of existing schools be improved, or should there be new units built, in order to increase access to education on a national scale? Should the management of schools be centralized, or, on the contrary, should local school principals have more autonomy? The answer to these questions and to similar ones would allow to assess public policies to adopts, with the ultimate objective of improving students' achievements and hence the performance of the education system. But, beyond the national framework, and taking into consideration the great similarity of issues at a regional scale, and sometimes at a global scale, the study of international experience can end up being very interesting.

The international comparison in terms of educational systems performances is indeed very uplifting, particularly in the presence of results of international surveys in this field, such as PISA, PIRLS, TIMSS surveys, and many more.

The results of these surveys can be useful in several areas. First of all, they allow to compare the performance levels of students on an international scale. They also allow decision-makers to set improvement goals, such as reaching other countries' average scores or reaching a higher degree of fairness in terms of perspective et educational results. Finally, these results enable the understanding of strengths and weaknesses of different educational systems throughout the group of the studied country. This way, they constitute an endless source of information for researchers who are interested in the study and the comparison of school performances and educational systems performances on an international scale.

The theme that we propose to study in doing so concerns the comparative study of school performance inequalities on 15-year-old students according to gender, while showing estimation biases created by classic estimators, such as the OLS estimator. Also, our study's objective is to verify the following hypotheses:

- Estimating within-country inequalities from the within-class coefficient ρ;
- Do girls always perform better than boys in reading, regardless of the educational system they are a part of?
- Do boys always perform better than girls in mathematics and science, regardless of the educational system they are a part of?

In the first section, we discuss theoretical and empirical literature on the posed issues. Then, we present the methodological framework that has been adopted for the implementation of our work. Finally, we address the modelling of school performance inequalities according to gender, in the countries participating to PISA 2015, in order to demonstrate that gender has an impact on students' achievements, regardless of the adopted educational system. To this end, we begin by presenting the description of the students' scores on a global scale. The results of the multi-level estimation are then presented and commented, concerning both empty models for the calculation of the inequality coefficient (rho within-class coefficient) and models that are proposed with the help of the gender variable for the verification of hypotheses of this empirical research.

2. Theoretical and Empirical Literature Review

Many contributions suggest that school results differ between girls and boys and that, in other words, gender differences also influence students' academic results between levels and within classes.

In that sense, many works have demonstrated that girls perform better than boys in reading and worse than them in quantitative subjects (mathematics and science). These subjects are considered to be male performance subjects.

Indeed, Rasmusson (2016) has examined the impact of gender difference on students' performance variabilities, and has noticed that boys perform better than girls in mathematics and science.

This observation has also been recently borne out by Contini, Di Tommaso and Mendolia (2017) who have demonstrated that, for most of the OECD countries, girls perform less in mathematics than boys.

Carneiro, Cruz-Aguayo and Schady (2017) have shown the important gap between boys' and girls' academic results in mathematics, and have specified that this gap progressively decreases with the improvement of the parents' level of education.

This result has also been demonstrated by Liouaeddine, Bijou and Naji (2017) who, after using the TIMSS and PIRLS databases (2013) and adopting a multilevel modelling, have shown that girls outperform boys in reading. However, this observation is reversed concerning scientific subjects, in which boys achieve better performances than girls. This performance gap is less pronounced if the parents' education level is higher.

Based on a meta-analysis covering 100 studies, Lamon, Fennema and Hyde (1990) came to the conclusion that the extent of the difference of students' achievements between genders has decreased over the years, and that gender differences in mathematics results are minimal. Furthermore, examination by age indicates that girls show a slight superiority in calculus in primary school, while boys do in middle school and high school.

Also, Fuchs and Wößmann (2004) found out that boys perform better in mathematics and in science, while the contrary is true for girls concerning reading. This observation is also confirmed through the meta-analysis conducted by Else-Quest, Hyde and Linn (2010) regarding 69 countries. The results show that boys register more positive attitudes towards mathematics than girls. In addition to that, Chiu and McBride-Chang (2006) have demonstrated that girls' performances in reading exceed boys' in 43 analysed countries.

From another angle, the results of Nosek and al. (2009), across approximately 70% of more than half a million tests completed by the citizens of 34 countries, suggest that girls perform less than boys in science.

Murphy (2000) specifies that girls and boys develop different learning strategies, and argues that boys surpass girls in mathematics and science, while the contrary is true for reading. This result has been confirmed by Hanchane, Benbiga and Idir (2012).

These observations have been shaded by Halpern and al. (2007) who suggest that if girls have a tendency to excel in verbal capacities and in writing and boys in quantitative areas, the latter requires the ability to communicate effectively and to understand abstract ideas, in order for the girl's advantage in writing to be useful in every single academic area.

The authors conclude that: first experiences, biological factors, educational policies and cultural context have an impact on the number of girls and boys who undertake university studies in science and mathematics, and these impacts add up and interact in a complex manner.

Also, Ian, Armstrong and Rounds (2009) show, through a meta-analysis, that men prefer to work with things, and lean towards certain areas, such as science, mathematics and engineering, while women prefer to work with people, and thus develop interests related to artistic and social activities.

Existing research studies show inequalities between countries as well as in within every country. In fact, many factors explain the differences in academic performance between students of such an educational system. More precisely, this study attempts to focus only on academic performance inequalities regarding gender, based on scores registered by 15-year-old students for the entirety of the educational systems participating in the PISA survey of 2015. This study had the specific goal of answering the following research questions:

1. Estimating within-country inequalities from the within-class coefficient ρ;

2. Do girls always perform better than boys in reading, regardless of the educational system they are a part of?

3. Do boys always perform better than girls in mathematics and science, regardless of the educational system they are a part of?

3. Method

Modelling environmental impacts on individuals amounts to processing data on two different levels. Some are about the environment and are, therefore, global or aggregated characteristics, while others are individual data and are at a lower level than the environment's, since the latter encompasses several individuals.

In this notion, we are dealing with a hierarchical structure composed of different levels, with units of lower levels being grouped in units of higher levels.

As for the environment, it can be characterized by two types of variables: global variables and aggregated variables.

Aggregated variables define the group in which the individuals are inserted. It is about aggregating the individual characteristics of the members of the group. Aggregated variables then indicate composition effects, also called contextual effects or peer effects. They reflect the impact of group composition on individuals' behaviours, beyond their own individual characteristics.

As for global variables, they don't come from the aggregation of individual data. They are strictly about the higher level – environment – and they don't identify the group as such, but they identify the treatment to which it is subjected.

It appears that the fact of treating environmental impacts on individuals leads to an inevitable linking of variables of different levels, which don't characterize the same statistical units: some variables are about individuals, while others are about the environment in which they are inserted.

Furthermore, data treatment which is situated at different levels of the hierarchy poses certain analysis issues in case of a use of the regression method by Ordinary Least Squares (OLS).

The statistical modelling of environmental impacts on individuals has, for a long time, consisted in using regression analysis by Ordinary Least Square (OLS). In the latter, the error term (ε) should follow the normal law of mean-zero with constant variance (i.e.: hypothesis of homoscedasticity). In addition, errors are meant to be independent of one another.

The two hypotheses mentioned above are far from being verified in the case of linear modelling with a hierarchical structure.

On one side, a sort of non-independency is established between individuals as a result of the common environmental impact, which is contradictory with the independence hypothesis for errors concerning OLS. However, violating this hypothesis of the OLS model leads to underestimating standard coefficient errors, thus increasing the risk of considering, wrongly, certain relationships as being significant.

On the other hand, it is often difficult to assert whether the homoscedasticity hypothesis is verified or not. It is even very rare in the case of hierarchical structures. Even then, the violation of this hypothesis leads to underestimating standard errors of regression coefficients in the case of the use of the OLS model. Moreover, when it comes up, it may be required to have appropriate models that are able to model it, due to its interest and to the information surplus it procures.

The limitations mentioned above regarding the OLS model will give multilevel models a great importance in order to study environmental impacts on individuals, especially in the field of education research.

3.1 Presentation of the Multilevel Model

Issues raised by the OLS analysis, highlighted for a long time, have only been aware of satisfying solutions during the 80's, with the implementation of models described as "multilevel" or "hierarchical", or even "random coefficient model". The pioneer authors of these models are principally AitKin and Longford (1986), Goldstein (1986), Mason, Wong and Entwisle (1983), and finally, Raudenbush and Bryk (1986).

The multilevel model is a very adaptable model that presents numerous advantages regarding OLS models. It will allow to abandon or to amend some of the very restrictive hypotheses of the OLS models. It will then authorize a non-independency of errors within every macro unit, and will allow a homoscedasticity hypothesis through a weaker one whereby error variance can vary according to a linear or a non-linear function of explanatory variables.

The multilevel model can be formalized by first distinguishing, to simplify the presentation, the writings in function of the different levels involved in the analysis.

At level 1.

$$\mathbf{Y_{ij} = \beta_{0j} + \beta_{1j}X_{ij} + e_{ij}} \quad (1)$$

For which the indices "i" and "j" refer to individuals "i" (micro-units) and to environments "j" (macro-units).
Regression coefficients β_{0j} and β_{1j} that can vary from one environment "j" to another.
At level 2, we show that coefficients β_{0j} and β_{1j} are random by introducing random error terms u_{0j} and u_{1j}.

$$\beta_{0j} = \gamma_{00} + u_{0j}$$

$$\beta_{1j} = \gamma_{10} + u_{1j} \quad (2)$$

By replacing the coefficient values β_{0j} and β_{1j} in the equation above (1), we obtain the following equation:

$$Y_{ij} = \gamma_{00} + \gamma_{10}X_{ij} + u_{0j} + u_{1J}X_{ij} + e_{ij} \quad (4)$$

For which:

γ_{00} represents the overall average of Y.

γ_{10} is the average regression slope for all the groups.

u_{0j} represents a random error associated to every group "j" assumed to be normally distributed, of zero-mean and variance ${\sigma_{u0}}^2$.

u_{0j} represents the gap of every group compared to the average relationship. It is a random variable of zero-mean and variance ${\sigma_{u1}}^2$.

From the fact that there are now two error terms at level 2, we can predict an additional parameter: the covariance between constants and slopes, noted σ_{u01}.

The following writing shows, in a condensed way, the structure's conception of the random parameters to predict at level 2:

$$\begin{bmatrix} \boldsymbol{u_{0j}} \\ \boldsymbol{u_{1j}} \end{bmatrix} \sim \boldsymbol{N}\left[\begin{pmatrix} \mathbf{0} \\ \mathbf{0} \end{pmatrix}, \begin{pmatrix} \boldsymbol{\sigma_{u0}}^2 & \boldsymbol{\sigma_{u01}} \\ \boldsymbol{\sigma_{u10}} & \boldsymbol{\sigma_{u1}}^2 \end{pmatrix}\right]$$

At level 1, $e_{ij} \sim N(0, \sigma_e{}^2)$.

3.2 Presentation of PISA Database of 2015

The sampling methodology of the PISA study is based on the method of stratified sampling in two steps in every country (OECD, 2015). In the first step, schools are systematically sampled with proportional probabilities to the size of the school (number of enrolled 15-year-old students). School sampling is then followed by the sampling of students who are eligible for PISA (15 years-old) in every school. PISA only focuses on 15-year-old teenagers in order to be able to make international comparisons, since these students approach the end of compulsory education in most countries (OECD, 2013, 2014, 2015).

The data of PISA 2015 are grouped under a hierarchical structure of two levels. The first level clusters students, while the second level reflects the school context. This data structure requires a multilevel modelling, since classic OLS estimators don't allow to estimate a variance-covariance matrix without bias, and, thereafter, biases in term of significance of the model's parameters (Champ, 2013).

In this study, we have focused the entirety of the empirical work on estimating an empty model to calculate school performance gaps in scientific subjects (within-class coefficient), and then, on estimating a model that contains a "gender" explanatory variable, in order to demonstrate gender inequalities in regards to school performances of students in all the educational systems. This study has used the final weighting of students in order to control the fact that some sampling units can be proportionally bigger than others, which can lead to biased results (Kim, Anderson, Keller, 2014). This has also allowed us to estimate bias values between the OLS estimator and the multilevel model.

Table 1. Countries Participating in PISA 2015

CNT	Number of students	Num. of schools	CNT	Number of students	Num. of schools	CNT	Num. of students	Num. of schools
ALB "Albania"	5215	230		5809	160	**POL "Poland"**	4478	169
ARE "United Arab Emirates"	14167	473	**HUN "Hungary"**	5658	245	**PRT "Portugal"**	7325	246
AUS "Australia"	14530	758	**IDN "Indonesia"**	6513	236	**QAR "Argentina (Ciudad Autónoma de Buenos)"**	1657	58
AUT "Austria"	7007	269	**IRL "Ireland"**	5741	167	**QAT "Qatar"**	12083	167
BEL "Belgium"	9651	288	**ISL "Iceland"**	3371	124	**QCH "B-S-J-G (China)"**	9841	268
BGR "Bulgaria"	5928	180	**ISR "Israel"**	6598	173	**QES "Spain (Regions)"**	32330	976
BRA "Brazil"	23141	841	**ITA "Italy"**	11583	474	**ROU "Romania"**	4876	182
CAN "Canada"	20058	759	**JOR "Jordan"**	7267	250	**RUS "Russian Federation"**	6036	210
CHE "Switzerland"	5860	227	**JPN "Japan"**	6647	198	**SGP "Singapore"**	6115	177
CHL "Chile"	7053	227	**KOR "Korea"**	5581	168	**SVK "Slovak Republic"**	6350	290
COL "Colombia"	11795	372	**KSV "Kosovo"**	4826	224	**SVN "Slovenia"**	6406	333
CRI "Costa Rica"	6866	205	**LBN "Lebanon"**	4546	270	**SWE "Sweden"**	5458	202
CZE "Czech Republic"	6894	344	**LTU "Lithuania"**	6525	311	**TAP "Chinese Taipei"**	7708	214
DEU "Germany"	6504	256	**LUX "Luxembourg**	5299	44	**THA "Thailand"**	8249	273
DNK "Denmark"	7161	333	**LVA "Latvia"**	4869	250	**TTO "Trinidad and Tobago**	4692	149
DOM "Dominican Republic"	4740	194	**MAC "Macao"**	4476	45	**TUN "Tunisia"**	5375	165
DZA "Algeria"	5519	161	**MDA "Moldova"**	5325	229	**TUR "Turkey"**	5895	187
ESP "Spain"	6736	201	**MEX "Mexico"**	7568	275	**URY "Uruguay"**	6062	220
EST "Estonia"	5587	206	**MKD "Macedonia'**	5324	106	**USA "United States"**	5712	177
FIN "Finland"	5882	168	**MLT "Malta"**	3634	59	**VNM "Vietnam"**	5826	188
FRA "France"	6108	252	**MNE "Montenegro**	5665	64	-	-	-
GBR "United Kingdom'	14157	550	**NLD "Netherlands'**	5385	187	-	-	-
GEO "Georgia"	5316	262	**NOR "Norway"**	5456	229	-	-	-
GRC "Greece"	5532	211	**NZL "New Zealand**	4520	183	-	-	-
HKG "Hong Kong"	5359	138	**PER "Peru"**	6971	281	-	-	-

4. Results

The results of our models fall within the framework of multilevel models, with the purpose of revealing the bias gaps triggered by the non-awareness of the hierarchical modelling. First starting with performances in mathematics, only 14% of all the countries participating to PISA 2015 show that girls perform better than boys. This result has been revealed in ALB, FIN, GEO, ISL, JOR, KOR, MDA, NOR, QUD, TTO, while the hypothesis has been verified for 85% of the cases. Concerning performances in scientific subjects, our results show that the percentage is rather high compared to performances in mathematics. The latter is of 27%, which means that in 27% of the countries participating to this international survey, girls succeed better than boys, while the hypothesis has been verified for 72% of the cases. ALB, ARE, DZA, FIN, GBR, GEO, ISL, JOR, KOR, LBN, LVA, MDA, MKD, MLT, QTA, QUD, SWE, THA, TTO are all the countries in which girls perform better than boys in scientific subjects.

Concerning reading, the obtained results surely verify the hypothesis that says that girls always perform better than boys, and that is for every country participating to the survey of PISA 2015.

Obviously, all the estimated parameters that measure gender inequality differ from one country to the next, and are all significant at a degree of 5%. These results are presented in Table N°2 in the annex.

Concerning the values of estimated biases between the OLS model and the multilevel model, results clearly show that the awareness of hierarchical data has allowed to correctly estimate, without bias, the coefficients of our model. Thus, the values of the estimated biases are all different from 0, which could mean that hierarchical modelling allows to completely reverse the expected signs of our model, and can also, in some cases, skew the results and, therefore, validate wrong hypotheses. Also, we were able to demonstrate that the awareness of data hierarchy in models can certainly lead to relevant public policies, either in relation to the study of the existing relationship between genders and school performance, or in relation to other issues that are more complex to treat, such as class size or social diversity. Table N°4, in the annex, illustrates all the parameters of both models, as well as the biases' values between them.

As a consequence, reflecting upon issues linked to school performances necessarily requires instruments such as PISA, and a hierarchical structure that can provide robust and consistent results. Our results can take the shape of an explanatory analysis field, in order for us to further examine the inequality issue, by studying determining factors that explain the difference in scores in accordance to students' gender. It can also allow us to help future works of other researchers who are interested in the issue of school achievement assessments at an international scale.

Table 2. The Percentage of Countries According to the Degree of Gender Inequality in Mathematics

β mathematics	Frequency	Percentage	Cumulative percentage
β (0;10)	25	36.76	36.76
β (11;20)	26	38.24	75.00
β (21;30)	7	10.29	85.29
β (0;-10)	9	13.24	98.53
β (-11;-20)	1	1.47	100.00
β (-21;-30)	-	-	-
Total	68	100.00	

Concerning countries that record positive gender impacts on educational achievements in mathematics, 36.76% of the countries show a positive impact ranging from 0 to 10 points. In other words, in these countries, boys perform better than girls, registering coefficients between 0 and 10. However, 38.24% of countries show impact varying between 11 and 20 points. Moreover, 10% of the countries record impacts varying between 21 and 30 points.

Concerning the 10 countries that record negative gender impacts on educational achievements in mathematics, only 13% of the countries show a negative effect varying between 0 and -10 points, and only 1.47% of the countries have a varying parameter between -11 and -20 points. However, there are no countries in which the impact varies between -21 and -30 points (Table N°5).

Table 3. The Percentage of Countries According to the Degree of Gender Inequality in Science

β science	Frequency	Percentage	Cumulative percentage
β (0;10)	28	40.00	40.00
β (11;20)	20	28.57	68.57
β (21;30)	3	4.29	72.86
β (0;-10)	15	21.43	94.29
β (-11;-20)	3	4.29	98.57
β (-21;-33)	1	1.43	100.00
Total	70	100.00	

Concerning countries that record positive gender impacts on educational achievements in science, 40% of the countries show a positive impact varying between 0 and 10 points. In other words, in these countries, boys perform better than girls, registering coefficients between 0 and 10. However, 28.57% of the countries record impacts varying between 11 and 20 points. Moreover, only 4.29% of the countries record impacts varying between 21 and 30 points.

Concerning the 19 countries recording negative gender impacts on educational achievements in mathematics, 21.43% of the countries show a negative impact varying between 0 and -10 points, and only 4.29% of the countries have a varying parameter between -11 and -20 points. However, 1.43% of the countries have an impact varying between -21 and -33 points (Table N°6).

Table 4. The Percentage of Countries According to the Degree of Gender Inequality in Reading

β Reading	Frequency	Percentage	Cumulative percentage
β (0;20)	-	-	-
β (21;40)	-	-	-
β (41;60)	-	-	-
β (0;-20)	37	52.86	52.86
β (-21;-40)	27	38.57	91.43
β (-41;-60)	6	8.57	100.00
Total	70	100.00	

Concerning reading, our results show that there are no countries in which boys perform better than girls. However, we have demonstrated that 52.86% of the countries recording coefficients between 0 and -20 points, 38% of the countries have impacts between -21 and -40 points, and only 8.57% of the countries record high impacts, varying between -41 and -60 points (Table N°7).

Table 5. The Ranking of the Countries by the Degree of Gender Inequality in Mathematics Achievement

β mathematics	Countries																									
β (0;10)	AUS	DNK	DOM	DZA	EST	GBR	IDN	LTU	LVA	MAC	MEX	MKD	MLT	MNE	NLD	NZL	QAT	QUC	QUE	RUS	SGP	SWE	TAP	THA	USA	-
β (11;20)	BGR	BRA	CHE	COL	CRI	CZE	ESP	FRA	GRC	HKG	IRL	ITA	JPN	LBN	LUX	PER	POL	PRT	QCH	QES	SVK	SVN	TUN	TUR	URY	VNM
β (21;30)	AUT	BEL	DEU	HRV	HUN	KSV	QAR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
β (0;-10)	ALB	FIN	GEO	ISL	KOR	MDA	NOR	QUD	TTO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
β (-11;-20)	JOR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
β (-21;-30)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 6. The Ranking of the Countries by the Degree of Gender Inequality in Science Achievement

β science	Countries																											
β (0;10)	AUS	BGR	BRA	CAN	DNK	DOM	ESP	EST	GRC	IDN	ISR	KSV	LTU	MAC	MEX	MNE	NOR	NZL	POL	QES	QUC	QUE	ROU	RUS	SGP	TAP	TUR	USA
β (11;20)	CHE	CHL	COL	CRI	CZE	FRA	HKG	HUN	IRL	ITA	JPN	NLD	PER	PRT	QAR	QCH	SVK	SVN	URY	VNM	-	-	-	-	-	-	-	-
β (21;30)	AUT	BEL	HRV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
β (0;-10)	ARE	DZA	GBR	ISL	KOR	LBN	LVA	MDA	MKD	MLT	QAT	QUD	SWE	THA	TTO	-	-	-	-	-	-	-	-	-	-	-	-	-
β (-11;-20)	ALB	FIN	GEO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
β (-21;-33)	JOR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 7. The Ranking of the Countries by the Degree of Gender Inequality in Reading Achievement

β Reading	Countries																		
β (0;20)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
β (21;40)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
β (41;60)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	AUT	BEL	BRA	CHE	CHL	COL	CRI	CZE	DEU	ESP	FRA	GRC	HKG	HRV	HUN	IDN	IRL	ITA	JPN
β (0;-20)	LUX	MAC	MEX	NLD	PER	PRT	QAR	QCH	QES	QUC	ROU	SGP	SVK	TUN	TUR	URY	USA	VNM	
	ARE	AUS	BGR	CAN	DNK	EST	GBR	ISR	KOR	KSV	LBN	LTU	LVA	MKD	MLT	MNE	NOR	NZL	POL
β (-21;-40)	QAT	QUD	QUE	RUS	SWE	TAP	THA	TTO											
β (-41;-60)	ALB	FIN	GEO	ISL	JOR	MDA	-	-	-	-	-	-	-	-	-	-	-	-	-

5. Discussion

This chapter attempts to study the issue of educational achievements inequalities according to gender. By exploiting the data of PISA 2015, we have estimated a multilevel model, in order to show all the performance gaps between girls and boys, for every subject, namely reading, science and mathematics. The aim of this exercise is to verify the two following hypotheses:

If there are educational achievements inequalities between countries, does it also exist between schools of a same educational system?

Do girls always perform better than boys in reading, regardless of the tested educational system?

Do boys always perform better than girls in mathematics and science subjects, regardless of the tested educational system?

The results of our estimations, through a hierarchical model, show that in only 14% of the countries participating to the PISA 2015 girls perform better than boys. This result has been revealed in ALB, FIN, GEO, ISL, JOR, KOR, MDA, NOR, QUD, TTO, while the opposite hypothesis has been verified in 85% of the cases.

Concerning performances in scientific subjects, our results show that the percentage is rather high, compared to the performances in mathematics. Our results reveal that in 27% of the countries participating to the PISA 2015, girls perform better than boys. However, the reverse hypothesis has been verified in 72% of the cases. ALB, ARE, DZA, FIN, GBR, GEO, ISL, JOR, KOR, LBN, LVA, MDA, MKD, MLT, QTA, QUD, SWE, THA, TTO are all the countries in which girls perform better than boys in scientific subjects.

Concerning reading, the results verify the hypothesis that girls always perform better than boys, and that is the case for all the countries participating to the PISA 2015 survey.

Of course, all the estimated parameters that measure gender inequalities differ from one country to the next, and are also always significant at a degree of 5%.

Concerning the values of estimated biases between the OLS model and the multilevel model, the show clearly show that the awareness of hierarchical data has allowed to correctly estimate, without bias, the coefficients of our model. Thus, the values of estimated biases are all different from 0, which means that hierarchical modelling allow to completely reverse the expected signs of our model, and can, in some cases, skew the results, and therefore, validate wrong hypotheses. Also, we were able to demonstrate that the awareness of data hierarchy in the models would give relevant public policies, either in relation to the study of the relationship between gender and school performance, or in relation to any other issues that can be harder to treat, such as class size or social diversity.

As a consequence, reflecting upon issues linked to school performances necessarily requires instruments such as PISA, and a hierarchical structure that can provide robust and consistent results. Our results can take the shape of an explanatory analysis field, in order for us to further examine the inequality issue, by studying determining factors that explain the difference in scores in accordance to students' gender. It can also allow us to help future works of other researchers who are interested in the issue of school achievement assessments at an international scale.

Therefore, this study can be qualified as an exploratory analysis for researchers who are interested in the issue of educational quality, and can also be qualified as a reference for a fair assessment of public policies in general, and of educational policies in particular.

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