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**Access to computer and academic  
achievement. Where is it best: at home or at  
school?**

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# Access to computer and academic achievement. Where is it best: at home or at school?.

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## Abstract

*The aim of this document is to test whether there is any difference in the effect of having access to a computer at home or at school. In contrast to previous literature, we study the access and quality of computer uses in different percentiles of the score's distribution by means of Quantile regression. Our findings indicate that having computer at home improves the scores more than having computer at school, and the access to computer at school has a higher effect on the performance in sciences. Additionally, it seems to be a digital divide in education, because students from Non-OECD and from public schools tend to be overrepresented in the lower percentiles of the score's distribution, but at the same time, those who are in the lower quartiles tends to have a worse use of computers.*

**JEL codes:** C21, H75, I21, I28.

**Keywords:** Internet, academic achievement, quantile regression.

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## 1. Introduction

One of the most challenging goals in modern economies is the appropriate use of information and communication technologies (ICT). That is, how to use ICTs for improving economic development and reducing poverty levels and inequalities. However, the speed of diffusion of ICT varies according to the level of development in each country. Most of the diffusion of these technologies depends on the young people due to they are more prone to technological changes. Then, it is important to assess their actual level of use as a way of predicting future adoptions and use levels. This is also a situation of growing importance because of the amount of time that teens spent on the computer in home as well as in the school, which could compete for time or it can be a complement of homework and it may have an impact on academic performance.

Actual levels of access and use of computers by students in the school could have a positive effect of future productivity levels. Most of the literature of economics of education has been interested in the role of some specific inputs into the educational outcomes. In particular, the access of computer has received attention during the last decade and the evidence is not conclusive (see Spiezia, 2011; Judge, 2005, Fuchs and Woessman, 2005; Angrist and Levy, 2002, among others). Following Fuchs and Woessman (2005), the invention and use of computers generated dramatic transformations in modern life in multiple aspects such as entertainment, education, work, and trade (E-commerce). In consequence, many governments and non-government organization have designed programs and policies aimed to increase the access in the most vulnerable people.

Having access to computers could generate multiple economic effects: higher productivity, a source of income and learning. However, not all the uses of a computer carry out positive effects. Some authors state that excessive use of computers could have a negative effect on aspects such as creativity or the ability of work-in-group. These inconclusive findings motivate us to continue analyzing over those improvements in academic outcomes coming from the use of computers since two perspectives: quantity (do you have computer?) and quality (what do you know to do?).

The purpose of this paper is to analyze the differential importance of computers use at home or school on education achievements. In particular, this paper provides new evidence of the effect of modern technologies on the academic performance in sciences and mathematics in the Programme for International Students Assessment 2009 (PISA 2009). Our focus in Sciences and Mathematics come from two facts. On one hand, the capabilities developed by students in these subjects are related to the use of modern technologies such as computers, Internet, academic software. On the other hand, the information included in the questionnaires designed for students and school principals allows us to get an idea of the physical available capital in ICTs.

In contrast to previous literature, we provide at least two new outcomes. First, we use some variables of quality and quantity of use of computers as inputs in an educational production function. This strategy allows us to go beyond other studies of ICTs diffusion and their determinants. Second, differences into the effects of computer on the pupils are carried out by using a Quantile Regression model, which provide estimations according to the relative position of each student in the distribution of scores. That is, we analyze whether the relation between the access and use of computers has the same effect on each quantile of the score's distribution. Quantile Regression is useful in this case as a consequence of the distinct conditions faced by students from OECD and Non-OECD countries.

The structure of the document is as follows. Section 2 briefly summarizes some of the main recent findings in this field. Section 3 present the data and methodology used in the paper. Section 4 concludes.

## **2. Related Literature**

Modern technologies have changed dramatically relations around the world (labor, academic and government). In particular, the increasing use of computers have developed other areas and giving place to things such as Internet. However, not all the consequences have been positive. The evidence about the role of computer in student achievement is inconclusive. Some findings as Angrist and Levy (2002), Cuban (1993), Oppenheimer (1997), Kirkpatrick and Cuban (1998) and Wenglinsky (1998) are in the line of a negative effect of computers on the student performance. The hypothesis behind these works is that the extended use of computers can disrupt students, reduce effort levels, computer-based instruction could restrict the creativity of children. It is also stated that access of internet by using computers at the school could offer distractions to students.

On the other hand, there is a widely recognized literature that assumes that modern technologies could foster economic development, increase the capabilities in the people and reduce transaction cost. This approach seeks to increase the use of computers and internet everywhere. But it also generates some drawbacks such as digital divide that it is necessary to reduce at minimum levels. The term 'digital divide' is associated to the consequences from limited or null access to information and communication technologies in some spheres of the population. In countries such as USA, some previous research efforts have indicated that technology access, and their use in schools, is polarized: pupils from black, Hispanic, and low socio-economic status (SES) tend to have the lowest access to new technology (Becker, 2000, 2001; Wenglinsky, 1998). Also, there is a significant gap in home-computer ownership and Internet access between African American and white households (DeBell and Chapman, 2003; Fairlie, 2002). Then, access and use of computers could reduce the opportunities for those who do not have access to it. This implies that the people could face different transaction cost when access to technology is not equally distributed.

The existing research on how academic achievement is affected by computers in the classroom offers diverse conclusions. Some research indicates that computers may aid in achievement. It is possible to think almost in two channels to explain why ICTs could affect positively student performance: ICTs are complementary inputs into educational outcome, and ICTs could help to learn faster (by increasing specific abilities and capturing their interest). Others researchers conclude that computers have questionable effectiveness, particularly, when results among specific areas (math, science and reading) are compared. This debate is growing around the world because many public initiatives have been focused in providing ICT access to the population but the ability of adoption has been very different between countries and within countries.

Furthermore, the question about the self-reported level of use among those who have access to computers or internet at home implies to recognize the existence of different motivations around ICTs. Tomte and Hatlevik (2011) study the existence of gender-differences in self-efficacy in computer use in Finland and Norway using PISA 2006. Self-efficacy is related to the self- evaluation of the abilities for doing some specific tasks. Probably, self-efficacy could be associated to the level of access and their frequency. Then, people who owns a computer at home is more skilled than those who only have access in public places such as cybercafés, library, schools etc.

Spiezia (2011), assess whether the use of ICT has an effect on academic performance using PISA 2006 and he finds a positive effect of the frequency of computer use on the final scores in science. But what is most interesting is that the size of the effect depends on the place

where the teenager has access (home or school), being higher the marginal effect of having computer at home. Wenglinsky (1997) points out that student who used computers predominantly for drill and practice, as opposed to using them in ways that develop higher-order thinking skills, tended to do worse on the NAEP math test.

Thus, evidence of ICT's effect on different knowledge areas is mixed. A comparative study of the effect of ICT's use on math and language is developed by Carrillo *et al.* (2010), who evaluating a public program of computer-aid instruction, obtain that this program had a positive effect on math test scores but it did not affect language test scores. Other studies, in contrast, have found that ICT use contributes to higher science scores, but with negative effect on math (Antonijevic, 2007).

In the same way, comparing math and language scores, Gil-Flores (2009), analyze the differential effect of computer use at home and at school and finds a positive effect of ICT use on academic achievement for both cases. Using data of a specific test from students in Andalucia (Spain), this study points out that computer use at home has a positive effect on academic result, while computer use at school seems do not influence this outcome.

Other studies suggest that students who use computers in the classroom show at least a modest level of achievement gain over students who do not use computers. As it can be expected, the use of computer could depend on the extent of teachers' computer level of preparation in elementary schools. Recently, it has been emerging studies about the positive externalities coming from computers. Some critics consider computers in the classroom a mere fad, while others assert that because computers are growing in their importance to every aspect of society, it is better to expose children early to this evolving technology.

These facts tell us that not only is necessary to provide equal levels of access to technology but the ways to use it in students at the schools and homes are critical. Digital equity for children includes access to computer resources that are used in developmentally appropriate ways with teachers who have the knowledge and skills to integrate technology into meaningful activities of interest and relevance to children. Equitable use means that computers are fully integrated into a developmentally appropriate curriculum and include opportunities for interaction by virtue of placement and proximity, with relatively low computer-pupil ratios, and updated equipment with telecommunications access.

Studies conducted on the effectiveness of technology in the classroom often have mixed results, making it difficult to generalize about technology's overall effect on improving learning (Schacter, 1999; Sivin-Kachala and Bialo, 1999). More recent reports on the use of computers for instruction are beginning to show evidence of relationships between computer use and academic achievement (Wenglinsky, 1998). Other researchers are finding positive relationships between using computers and improved performances by young children (Clements and Natasi, 1993). Laffey *et al.* (2003) showed that at-risk African American children who were exposed to interactive computer technology gained mathematics knowledge significantly greater than the comparison group. In terms of reading and writing competences, it also exist some divergences.

On one hand, Pinkard (2001) shows gains in vocabulary in low-SES African American children who received computer instruction. But, some recent findings present that using chats and SMS could have a negative effect on writing because of the use of abbreviations and slang. Most of the communications done by young's are based in short messages that let them to minimize their spending. (For details about strategies of minimization, see Gamboa, 2009) Hoffman *et al.* (1996) found that people from 16 to 24 years old use intensively Internet in the United States. In fact, they found that women were more likely to use the Internet for e-mail, while men were more likely to download software and make purchases. This result could explain that males are more skilled than females surfing the web. Hoffman *et al.*(1999) summarize the literature on computer and Internet usage patterns over time and suggest that

gender digital divide is decreasing but it is not the case of the digital divide for race. The use of internet in adolescents is intensive in tasks such as downloading files, writing emails, using chat rooms and sharing newsgroups or social networks. These uses do not differ between countries around the world but in some cultures they are more time intensive.

From the previous literature emerge various facts. First, it is important to assess whether computer is a positive or negative externality on the academic performance. Second, which can be the best uses of a computer by the students?. Last by no least, it is necessary to establish whether the general or focused policies in ICTs are better for quality of education in developed and less developed countries.

### **3. Data, empirical strategy and Results**

#### *Data*

PISA was created by the OECD as an international initiative for assessing the competencies in mentioned areas and the test seeks to assess not merely whether students can reproduce what they have learned, but also to examine how well they can extrapolate it in understanding novel settings. PISA is carried out every three years since 2000. Each cycle of PISA has been conducted to specific cognitive areas. (Reading in 2000, Mathematics in 2003, Science in 2006 and Reading in 2009). Actually, it also includes non-OECD countries that allow the comparison between developed and less developed countries. The sample of students in PISA 2009 comes from a two-step random selection process. In the first stage, it was chosen a sample of schools in each country. Some countries who are more interested in this assessment carry out extended samples at regional or city level of significance. In the second stage, a sample of 15-years old students was extracted in each school.

As a result of this process, students were randomly selected representing 65 countries (including all 33 OECD countries). In contrast with other academic standardized test, PISA includes some questions in which students are required to construct their own answers as well as multiple-choice questions. The final database also includes information about family background, learning habits and school characteristics. Most of the results from previous versions of the test have been detailed analyzed in detail in OECD 2001a, 2001b, 2002a, 2002b). The size of the sample is about 277,267 students after controlling for missing values and reporting problems.

In order to assess the relation between the availability and the use of computer and academic achievement in the cases of math and science, we control by four groups of variables. The first group is linked with socioeconomic characteristics, including gender (dummy variable boys =1), and mother's educational level which is measured through a dummy variable that is active if mother's educational level is more than secondary. This second variable allows us to control familiar environment and household economic background.

The second group contains specific input-school such as the nature of the school (public/private), the teacher-student ratio and school size (logarithm of total students). The third set of control variables is related to social environment instrumented with relative mother's educational level and city size. The former, computed as the ratio of mother's educational level and its mean by country, gives information on the presence of peer effect and relative economic position while the last could give information on economic develop of residence city.

Finally, the focus is on the fourth group of variable, where it includes the availability and use of computers. In order to provide evidence on the relation between academic achievement and different dimensions of the ICTs, specifically computers, we take into account two different proxies. The first of these variables represents the availability of computers separating the effect if the computer is available at home or at school; and the second of the

variables is linked with the computer use but focused in the quality of the use instead intensity (time) in the use. Regarding these variable, we could contrast whether the availability at home has the same effect on pupil's scores than the availability at school, as well as if advanced management of the computer tools improve the academic achievement.

While computer availability is instrumented through a dummy variable that takes the value of 1 if the student has and uses the computer at home (or at school), quality in computer use is an index which is computed by aggregating the student abilities in the management of advanced computational tools such as edition of photos, working with data sets, plotting in spreadsheet, creating slides and creating multimedia presentations. As each component is classified from 1 to 4, we built the index using principal component analysis.

In this manner, we make inference on the relation between computers and pupil's scores analyzing the position of distribution scores for different value of our control variables. The analysis shows similar results for math and science indicating that: *i*) the computer availability at home has a positive effect on student's scores; while *ii*) the computer availability at school seems do not produce differences on academic achievement; and finally, *iii*) the quality in computer use produces important effect on pupil's performance, but this effect is reduced for high level of management of advanced computational tools. (see, Fig. 1)

From these outcomes, we can argue that it is necessary to separate the computer availability at home and at school and to consider conditional effect in the quality of computer use such that the improving in the management of computer use could has positive and significant effect on scores in math and science, but for students with high abilities, the effect could be minor. Thus, one might ask if included variables have the same marginal effect over scores distribution. For this, Tables 1a and 1b show the means and standard deviations of all control variables, including computer availability and quality in its use, by each quartile of the scores distribution for math and science, respectively. Here, additional variable of availability which is compute as the sum of availability at home and at school is included as robustness analysis; however, it is important to remember that the effect of the availability at home and at school on student's performance are different.

There is a set of common findings for sciences and mathematics. There is a high incidence of OECD students and private school' students in the top-quartiles. It also seems to have a positive relationship between the size of the city and the performance, which is normally attributed to availability of physical and human capital. Big cities are also characterized for having better networks and infrastructure. Other emerging fact, which is common in the literature, is the overrepresentation of boys in the top quartiles of the distribution in sciences and mathematics, but in the case of science the share of boys do not have a lineal trend over distribution. On the other hand, since ratio teacher-students seems reduce over scores distribution, schools size increase with the quartiles. In almost all of the cases the standard deviations are lower in the top of the score distributions

In the specific case of our main variables (availability and use of computers), it is noted that the percentage of students with that have and use a computer is higher in the top of scores distribution, but the change in this percentage is 4 to 1 when the availability at home is compared with the availability at school; and, the same relation is obtained when the index associated with the quality of management of the computers is analyzed.

In order to give more details of this relationship, we have estimated the mean of math and science scores for different dimension of availability and use of the computers (see Table 2). Considering specific tasks like doing homework or chatting online is found that the use of computer has a positive effect on academic achievement in math and science, and this effect is slightly higher for the case of doing homework indicating that it is possible that specific use

could improve the student performance<sup>1</sup>. In contrast to this result, the intensity (time in lessons of math and science) in computer use seems do not increase the academic results. Finally, analyzing specific abilities in computer it is found mixed evidence since that the ability in spreadsheet improve pupil's performance, but the capacity of creating dataset show a contrary conclusion.

### *Empirical strategy*

In order to estimate the effect of computer availability and its use on math and science scores, it is justifiable the separation between having computer at home and having computer at school, as well as the use of Quantile Regression. Even though the framework of this paper is closed to Fuchs and Woessman (2005), we think our approach is different. Our variables allow us to measure the effect of the quality in computer use instead intensity (number of time per week) in computer use. This point is important given that a variable that only measures the intensity in computer use, it does not permit to differentiate if the computer is used in entertainment or if computer is used to encourage specific abilities. Furthermore, the estimation through Quantile Regression allows us to identify the magnitude of marginal effects over score distribution, which could have special interest for policy makers from point of view of possible public policies.

Academic achievement in students can be described by an educational production function, where the outcome is a function of a specific set of inputs such as physical capital at the school, availability of resources in the school as well as in household. One important input in this case is the information and communication technologies, which in our case is represented by computers. In fact, modern technologies such as computers can be understood as inputs because of its role in the classroom as a learning tool or at home as means of information for doing homework. Thus, an alternative educational production function could be represented as follows:

$$E(Y_{i,j}|X) = F(X, Z) \quad (1)$$

Where  $Y_{i,j}$  is the outcome of the student  $i$  in the country  $j$ .  $X$  is a vector of computer-related variables. In particular, we focus in the access and the quality in computer use.  $Z$  is a vector of other control variables. Given that our main interest is to assess whether exist differential levels of impact of computers on the entire outcome distributions (math and sciences), the procedure followed in this document includes Quantile Regression Analysis (see for a brief discussion, Koenker and Hallock, 2001). This methodology allows us to have an estimation of the coefficients for each computer-related variable and other controls for selected quartiles. Additionally, Quantile Regression is interesting due to it allows us to understand different results of public policy scenarios.

Furthermore, the analysis is done by splitting the sample in some quartiles according to their performance in each subject (math or sciences). As it can be seen in the descriptive statistics, each quartile exhibit different characteristics in the incidence of people according to their gender, their country characteristics and the size of the city in which they live.

Then, since there are some unobserved specific institutional aspects and educational systems in each country than could provide biased findings, we also include country fixed effects in the regression. As Koenker (2004) states, this strategy can inflate the variability of estimates; so it is mandatory to introduce a penalty term on the likelihood function included. Assuming that each individual  $i$  in the country  $j$  has  $m_j$  observations, the minimization problem of Quantile Regression with fixed effect is as follows:

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<sup>1</sup> This hypothesis was statistical significant at 5%



$$\underset{(\alpha, \beta)}{\text{Min}} \sum_{k=1}^q \sum_{j=1}^{m_i} \sum_{i=1}^n \omega_k \rho_{\tau_k} (Y_{ij} - \alpha_j - X_{ij}^T \beta(\tau_k) - Z_{ij}^T \gamma(\tau_k)) + \lambda \sum_{i=1}^n |\alpha_i| \quad (2)$$

The first part denotes the classical problem of Quantile Regression as Koenker and Bassett (1978) proposed; and the last part is the penalty factor. In fact,  $\rho_{\tau_k}$  is the linear quantile loss function, and  $\omega_k$  controls the relative influence of the  $k^{\text{th}}$  quantile on fixed effect parameters. So, if  $\lambda \rightarrow 0$  the fixed effects can be estimated; but, when  $\lambda \rightarrow \infty$  it must be that  $\hat{\alpha}_i \rightarrow 0$ .

### **Results**

First of all, we estimate OLS model, as benchmark, in order to verify whether the effect of having computer at home or the effect of having computer at school are different, and to contrast the relative importance of computer access and quality in its use. We perform estimations using as dependent variables the scores of math and science in logarithms, including the access of computer discriminating between having computer at home and at school, and in a second specification the availability of computers is instrumented through the sum of these two variables (see Table 3). As result of these estimation, one might to highlight that all control variables are statistical significant individual and jointly.

In Model 1 is found that access and quality in use have a positive effect on student performance, and the marginal effect of access of computer at home is higher and statistically different than the marginal effect of access of computer at school. On the other hand, Model 3, as robustness check, instruments the computer access as the sum of availability at home and at school, and a positive coefficient is obtained.

Models 5 and 7, which are similar to Models 1 and 3, use the logarithm of Science scores as dependent variable and it shows the same qualitative findings and similar magnitudes in coefficients respect Models 1 and 3. It is interesting to note that the main difference in the estimated coefficients is related to the sign of gender. This means that the historical superiority of boys in sciences is finishing. Meanwhile, boys outperform the academic achievement in Math, this pattern is not present in science. However it is important to note that the size of this coefficient is very small.

Model 2 (in math) and Model 6 (in science) are estimated controlling by country fixed effects. The results are very similar, with the exception of city size, teacher-student ratio and school nature, but our variables of interest are robust of these specifications. It seems that it can be a ‘crowding out effect’ between computers and teacher-student ratio where it can be substitutes. In fact, in education exist a particular effect of class-size on educational outcomes. On one side, bigger classes reduce the interactions between teacher and students, but on the other side, smaller classes reduce the peer effect that comes from the interaction with other’s beliefs and answers.

Following the results of Models 2 and 6 and in order to identify potential differences in the marginal effect of our control variables over score distributions, we estimated these specifications using Quantile Regression controlling by idiosyncratic country effects (Table 4). In both cases, math and sciences, the marginal effect of computer access at home decreases over scores distribution and this effect is in all cases higher than marginal effect of computer access at school; likewise, the effect of quality in computer use is positive but decreases with the scores quantiles. The intuition behind the existence of decreasing coefficients as the quartile increase is that pupils with low scores, which in general belong to low socioeconomic households, could face higher gains in academic scores than pupils from wealthy households because the computer

is probably the most reliable source of information. In the case of rich households, the pupils commonly have access to other sources of information such as their parents (with higher schooling levels in most cases). Similar behavior in marginal effects on math scores and science scores are observed.

Other interesting differences between determinants of math scores and science scores are found. In the case of gender, the marginal effect increases over scores distribution, but in the case of science girls have better perform on the bottom score distribution, but in the top of the distribution boys outperform. Even though the findings for math and science are similar, it is not clear what effect is higher. In order to contrast this idea, we estimated an additional model in which we take the ratio math to science as dependent variable including the same control variables described above. As result (see Appendix), all control variables, except school nature and dummy for small city, increase the relative performance math to science for students with high relative performance in science; while that for students with better relative results in math, the variables associated to mother's educational level, school size and dummy for intermediate cities reduce the ratio math to science. Additionally, on the top of the ratio math to science distribution, public school has a positive effect.

Respect to our interest variables, it is obtained that students with relative good scores in math (science) could improve their performance in science (math) if they have and use computer at home; while, computer availability at school, almost ever, encourages better results in science respect math. Finally, quality in computer use exhibit similar results than computer access at home, but this effect in only positive on the math to science ratio in the extremely cases in which a student has good result in science comparing with math.

#### **4. Concluding remarks**

Modern economies seek to increase the access and use of computers in all the spheres of the population in order to cause specific positive externalities into the population. At the same time, increases in the percentage of the people with a computer at home can be used as a way to reduce the possible existence of 'digital divide' in most of the less developed countries. Although, it is common in many OECD countries to have access to this ICT, in other countries it is not the rule. The evidence presented here suggests that it is important to increase the initiatives oriented to increase the use of computer in young people in order to generate a positive externality on their academic achievements, but it is important to try to focus these kinds of initiatives in pupils with low socioeconomic background. It also should be jointly implemented with training programs in the use of some potentialities of computers that go beyond the use of them for chat, social networks or downloading music. It does not imply that these tasks are not important, but it is better to provide basic skills that let the students to use more intensively the ICTs.

In particular, the access and use of computer is a basic necessity in actual educational systems that have to be fostered in vulnerable populations in order to reduce 'digital divide' in academic performance in areas such as mathematics and sciences where it appears new ways of learning daily. Access at home and at school plays specific roles on student training, and the quality in use, rather than intensity in use, affect positively the student performance.

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**Table 1a. Summary Descriptive by quartile in Math**

<b>Variables</b>	<b>Total</b>	<b>Quartile 1</b>	<b>Quartile 2</b>	<b>Quartile 3</b>	<b>Quartile 4</b>
<b>Gender</b>	0.493 (0.00094)	0.461 (0.00189)	0.468 (0.00189)	0.487 (0.00190)	0.554 (0.00188)
<b>Mother's educational level</b>	0.369 (0.00091)	0.266 (0.00167)	0.329 (0.00178)	0.394 (0.00185)	0.486 (0.00189)
<b>Public school</b>	0.806 (0.00075)	0.864 (0.00130)	0.824 (0.00144)	0.792 (0.00154)	0.744 (0.00165)
<b>Teacher - student ratio</b>	0.103 (0.00015)	0.106 (0.00033)	0.105 (0.00032)	0.103 (0.00030)	0.098 (0.00025)
<b>School size</b>	6.386 (0.00153)	6.286 (0.00317)	6.340 (0.00307)	6.397 (0.00301)	6.519 (0.00288)
<b>OECD</b>	0.743 (0.00083)	0.601 (0.00185)	0.746 (0.00164)	0.800 (0.00152)	0.824 (0.00144)
<b>Town</b>	0.298 (0.00086)	0.342 (0.00180)	0.309 (0.00175)	0.293 (0.00173)	0.250 (0.00164)
<b>Small city</b>	0.317 (0.00088)	0.336 (0.00179)	0.327 (0.00177)	0.315 (0.00176)	0.291 (0.00172)
<b>Relative mother's educational level</b>	1.015 (0.00117)	0.785 (0.00184)	0.947 (0.00206)	1.076 (0.00234)	1.253 (0.00269)
<b>Computer availability at home</b>	0.917 (0.00052)	0.813 (0.00147)	0.919 (0.00103)	0.959 (0.00075)	0.978 (0.00055)
<b>Computer availability at school</b>	0.713 (0.00085)	0.693 (0.00175)	0.710 (0.00172)	0.719 (0.00171)	0.731 (0.00168)
<b>Computer availability</b>	1.630 (0.00106)	1.507 (0.00252)	1.629 (0.00210)	1.677 (0.00192)	1.708 (0.00181)
<b>Quality in computer use</b>	0.019 (0.00306)	-0.336 (0.00718)	0.019 (0.00614)	0.153 (0.00562)	0.242 (0.00513)

**Table 1b. Summary Descriptive by quartile in Science**

<b>Variables</b>	<b>Total</b>	<b>Quartile 1</b>	<b>Quartile 2</b>	<b>Quartile 3</b>	<b>Quartile 4</b>
<b>Gender</b>	0.493 (0.00094)	0.505 (0.00189)	0.472 (0.00189)	0.474 (0.00189)	0.518 (0.00189)
<b>Mother's educational level</b>	0.369 (0.00091)	0.268 (0.00168)	0.326 (0.00177)	0.389 (0.00185)	0.493 (0.00189)
<b>Public school</b>	0.806 (0.00075)	0.868 (0.00128)	0.818 (0.00146)	0.786 (0.00155)	0.754 (0.00163)
<b>Teacher - student ratio</b>	0.103 (0.00015)	0.107 (0.00035)	0.105 (0.00032)	0.102 (0.00029)	0.097 (0.00024)
<b>School size</b>	6.386 (0.00153)	6.284 (0.00317)	6.345 (0.00311)	6.406 (0.00301)	6.508 (0.00285)
<b>OECD</b>	0.743 (0.00083)	0.616 (0.00184)	0.741 (0.00166)	0.787 (0.00155)	0.827 (0.00143)
<b>Small city</b>	0.298 (0.00086)	0.343 (0.00180)	0.312 (0.00175)	0.289 (0.00172)	0.249 (0.00164)
<b>City</b>	0.317 (0.00088)	0.335 (0.00179)	0.323 (0.00177)	0.315 (0.00176)	0.296 (0.00173)
<b>Relative mother's educational level</b>	1.015 (0.00117)	0.790 (0.00184)	0.947 (0.00214)	1.075 (0.00238)	1.247 (0.00260)
<b>Computer availability at home</b>	0.917 (0.00052)	0.820 (0.00145)	0.917 (0.00104)	0.954 (0.00079)	0.977 (0.00056)
<b>Computer availability at school</b>	0.713 (0.00085)	0.696 (0.00174)	0.712 (0.00172)	0.714 (0.00171)	0.730 (0.00168)
<b>Computer availability</b>	1.630 (0.00106)	1.516 (0.00251)	1.629 (0.00210)	1.668 (0.00195)	1.707 (0.00181)
<b>Quality in computer use</b>	0.019 (0.00306)	-0.357 (0.00726)	0.023 (0.00614)	0.164 (0.00555)	0.248 (0.00507)

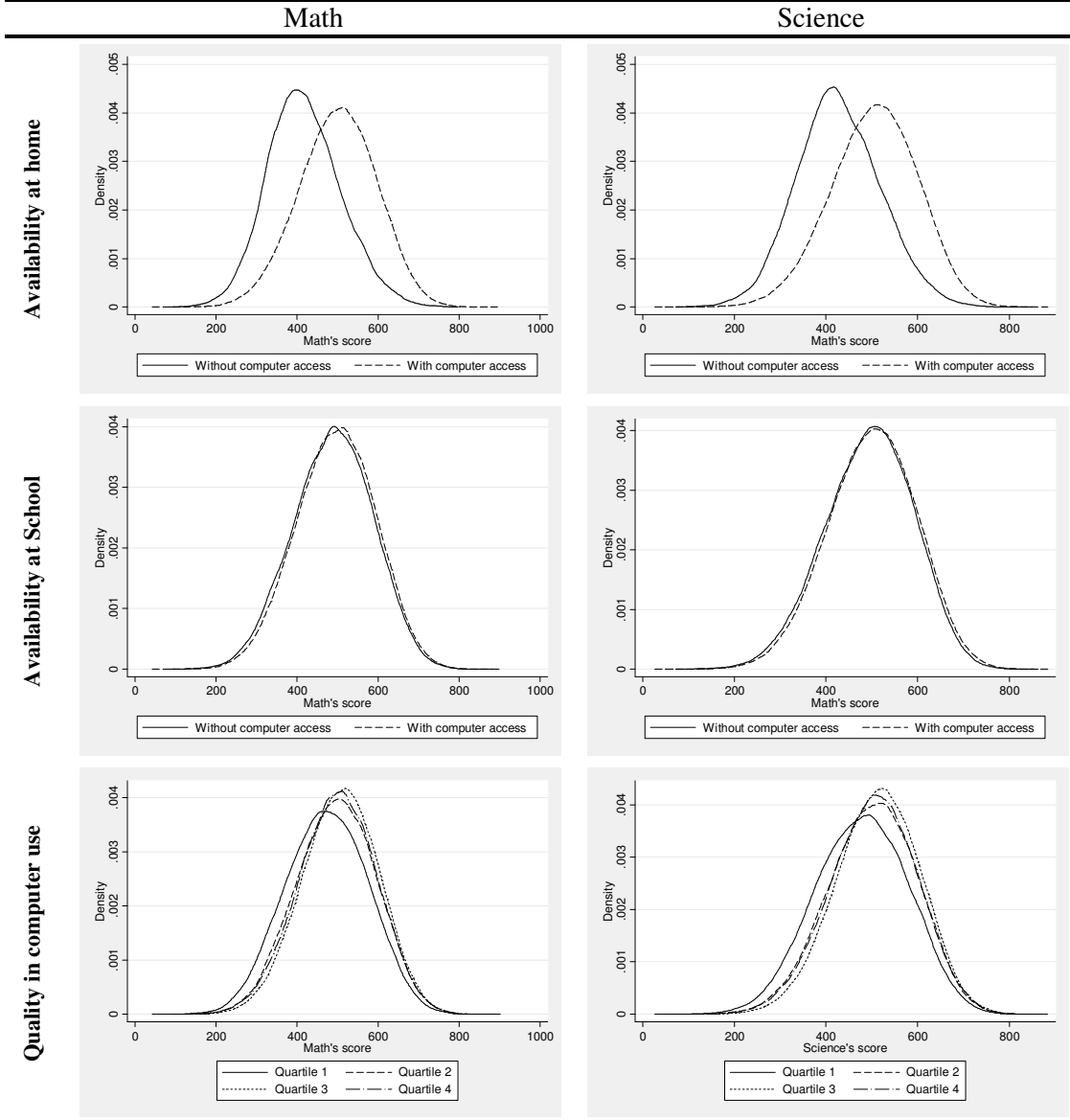
Source: PISA- 2009

**Table 2. Means of math and science scores by selected groups**

		<b>Math</b>	<b>Science</b>
Have computer at home		504.17	508.45
Do not have computer at home		423.94	433.12
Have computer at school		493.03	497.88
Do not have computer at school		499.62	504.23
Quality in compute use	Bottom 25%	475.49	479.28
	Top 25%	502.41	506.56
Use computer doing homework	Never or hardly ever	469.41	475.13
	Every day or almost every day	499.00	504.09
Use compute chat online	Never or hardly ever	476.95	486.26
	Every day or almost every day	502.30	505.86
Time using computer during math lessons	No time	501.23	506.27
	More than 60 min a week	474.84	475.41
Time using computer during science lessons	No time	498.74	503.77
	More than 60 min a week	495.24	495.78
Ability to create dataset	Without ability	512.02	517.09
	High ability	486.69	491.07
Ability to use a spreadsheet to plot	Without ability	469.29	470.30
	High ability	507.83	513.23



**Figure 1. Score Densities by subject**



**Table 3. OLS Models for Math and Science Scores Determinants.**

Variables	Math				Science			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<b>Gender</b>	0.0217*** (0.000)	0.0204*** (0.000)	0.0223*** (0.000)	0.0208*** (0.000)	-0.0079*** (0.000)	-0.0090*** (0.000)	-0.0073*** (0.000)	-0.0086*** (0.000)
<b>Mother's educational level</b>	0.0630*** (0.000)	0.0355*** (0.000)	0.0666*** (0.000)	0.0369*** (0.000)	0.0624*** (0.000)	0.0352*** (0.000)	0.0658*** (0.000)	0.0365*** (0.000)
<b>Public school</b>	-0.0065*** (0.000)	0.0086*** (0.000)	-0.0050*** (0.000)	0.0090*** (0.000)	-0.0045*** (0.000)	0.0093*** (0.000)	-0.0030*** (0.000)	0.0097*** (0.000)
<b>Teacher - student ratio</b>	0.0190*** (0.001)	-0.0288*** (0.001)	0.0255*** (0.001)	-0.0274*** (0.001)	-0.0083*** (0.001)	-0.0426*** (0.001)	-0.0023** (0.001)	-0.0413*** (0.001)
<b>School size</b>	0.0140*** (0.000)	0.0209*** (0.000)	0.0151*** (0.000)	0.0232*** (0.000)	0.0112*** (0.000)	0.0224*** (0.000)	0.0122*** (0.000)	0.0244*** (0.000)
<b>OECD</b>	0.0992*** (0.000)		0.1086*** (0.000)		0.0975*** (0.000)		0.1062*** (0.000)	
<b>Small city</b>	-0.0226*** (0.000)	0.0002 (0.000)	-0.0260*** (0.000)	-0.0022*** (0.000)	-0.0215*** (0.000)	0.0038*** (0.000)	-0.0247*** (0.000)	0.0016*** (0.000)
<b>City</b>	-0.0217*** (0.000)	-0.0004** (0.000)	-0.0228*** (0.000)	-0.0014*** (0.000)	-0.0197*** (0.000)	0.0005*** (0.000)	-0.0207*** (0.000)	-0.0004** (0.000)
<b>Relative mother's educational level</b>	0.0575*** (0.000)	0.0656*** (0.000)	0.0610*** (0.000)	0.0679*** (0.000)	0.0490*** (0.000)	0.0563*** (0.000)	0.0523*** (0.000)	0.0585*** (0.000)
<b>Computer availability at home</b>	0.0809*** (0.000)	0.0548*** (0.000)			0.0760*** (0.000)	0.0522*** (0.000)		
<b>Computer availability at school</b>	0.0034*** (0.000)	0.0011*** (0.000)			0.0036*** (0.000)	0.0030*** (0.000)		
<b>Computer availability</b>			0.0322*** (0.000)	0.0205*** (0.000)			0.0305*** (0.000)	0.0207*** (0.000)
<b>Quality in computer use</b>	0.0087*** (0.000)	0.0125*** (0.000)	0.0105*** (0.000)	0.0134*** (0.000)	0.0102*** (0.000)	0.0137*** (0.000)	0.0120*** (0.000)	0.0146*** (0.000)
<b>Constant</b>	5.8752*** (0.001)	-0.0016*** (0.000)	5.8770*** (0.001)	-0.0017*** (0.000)	5.9376*** (0.001)	-0.0012*** (0.000)	5.9393*** (0.001)	-0.0013*** (0.000)
<b>Observations</b>	242,637	242,637	242,637	242,637	242,637	242,637	242,637	242,637
<b>R-squared</b>	0.217	0.161	0.208	0.156	0.193	0.137	0.185	0.133

Standard errors in parentheses  
 \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

**Table 4. Quantile Regression Models for Math and Science Scores Determinants.**

Variables	Math					Science				
	Q(0.05)	Q(0.25)	Q(0.50)	Q(0.75)	Q(0.95)	Q(0.05)	Q(0.25)	Q(0.50)	Q(0.75)	Q(0.95)
<b>Gender</b>	0.0100*** (0.000)	0.0162*** (0.000)	0.0224*** (0.000)	0.0265*** (0.000)	0.0280*** (0.000)	-0.0415*** (0.000)	-0.0174*** (0.000)	-0.0055*** (0.000)	0.0034*** (0.000)	0.0086*** (0.000)
<b>Mother's educational level</b>	0.0423*** (0.000)	0.0391*** (0.000)	0.0337*** (0.000)	0.0331*** (0.000)	0.0280*** (0.000)	0.0420*** (0.000)	0.0403*** (0.000)	0.0325*** (0.000)	0.0298*** (0.000)	0.0283*** (0.000)
<b>Public school</b>	0.0214*** (0.000)	0.0064*** (0.000)	0.0052*** (0.000)	0.0073*** (0.000)	0.0057*** (0.000)	0.0232*** (0.000)	0.0041*** (0.000)	0.0084*** (0.000)	0.0116*** (0.000)	0.0061*** (0.000)
<b>Teacher - student ratio</b>	-0.0270*** (0.002)	-0.0438*** (0.001)	-0.0315*** (0.001)	-0.0320*** (0.001)	-0.0296*** (0.001)	-0.0724*** (0.002)	-0.0638*** (0.001)	-0.0507*** (0.001)	-0.0368*** (0.001)	0.0010 (0.001)
<b>School size</b>	0.0461*** (0.000)	0.0285*** (0.000)	0.0226*** (0.000)	0.0110*** (0.000)	0.0010*** (0.000)	0.0467*** (0.000)	0.0289*** (0.000)	0.0212*** (0.000)	0.0137*** (0.000)	0.0049*** (0.000)
<b>Small city</b>	-0.0059*** (0.000)	0.0021*** (0.000)	0.0053*** (0.000)	0.0009*** (0.000)	-0.0071*** (0.000)	0.0070*** (0.000)	0.0100*** (0.000)	0.0042*** (0.000)	0.0008*** (0.000)	-0.0107*** (0.000)
<b>City</b>	-0.0124*** (0.000)	-0.0013*** (0.000)	0.0029*** (0.000)	0.0030*** (0.000)	0.0017*** (0.000)	-0.0148*** (0.000)	0.0017*** (0.000)	0.0045*** (0.000)	0.0017*** (0.000)	-0.0005*** (0.000)
<b>Relative mother's educational level</b>	0.0564*** (0.000)	0.0703*** (0.000)	0.0715*** (0.000)	0.0678*** (0.000)	0.0563*** (0.000)	0.0504*** (0.000)	0.0604*** (0.000)	0.0588*** (0.000)	0.0560*** (0.000)	0.0469*** (0.000)
<b>Computer availability at home</b>	0.0769*** (0.000)	0.0590*** (0.000)	0.0507*** (0.000)	0.0461*** (0.000)	0.0444*** (0.000)	0.0930*** (0.000)	0.0575*** (0.000)	0.0500*** (0.000)	0.0407*** (0.000)	0.0381*** (0.000)
<b>Computer availability at school</b>	0.0013*** (0.000)	-0.0025*** (0.000)	0.0007*** (0.000)	0.0034*** (0.000)	0.0050*** (0.000)	0.0029*** (0.000)	0.0004*** (0.000)	0.0009*** (0.000)	0.0037*** (0.000)	0.0050*** (0.000)
<b>Quality in computer use</b>	0.0153*** (0.000)	0.0141*** (0.000)	0.0126*** (0.000)	0.0110*** (0.000)	0.0086*** (0.000)	0.0168*** (0.000)	0.0155*** (0.000)	0.0140*** (0.000)	0.0121*** (0.000)	0.0095*** (0.000)
<b>Constant</b>	-0.3076*** (0.000)	-0.1027*** (0.000)	0.0151*** (0.000)	0.1181*** (0.000)	0.2465*** (0.000)	-0.3107*** (0.000)	-0.1010*** (0.000)	0.0169*** (0.000)	0.1206*** (0.000)	0.2441*** (0.000)
<b>Observations</b>	242,637	242,637	242,637	242,637	242,637	242,637	242,637	242,637	242,637	242,637
<b>P-seudo R-squared</b>	0.0696	0.0868	0.092	0.0954	0.0968	0.0713	0.0788	0.0789	0.0751	0.0716

Standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

**Appendix: Quantile Regression Models for Ratio Math to Science Scores Determinants.**

<b>Variables</b>	<b>Q(0.05)</b>	<b>Q(0.25)</b>	<b>Q(0.50)</b>	<b>Q(0.75)</b>	<b>Q(0.95)</b>
<b>Gender</b>	0.0281*** (0.000)	0.0267*** (0.000)	0.0270*** (0.000)	0.0300*** (0.000)	0.0344*** (0.000)
<b>Mother's educational level</b>	0.0046*** (0.000)	0.0036*** (0.000)	0.0014*** (0.000)	-0.0018*** (0.000)	-0.0094*** (0.000)
<b>Public school</b>	-0.0013*** (0.000)	-0.0010*** (0.000)	-0.0031*** (0.000)	-0.0028*** (0.000)	0.0053*** (0.000)
<b>Teacher - student ratio</b>	0.0079*** (0.001)	0.0297*** (0.001)	0.0122*** (0.000)	0.0180*** (0.001)	0.0005 (0.001)
<b>School size</b>	0.0108*** (0.000)	0.0032*** (0.000)	-0.0021*** (0.000)	-0.0052*** (0.000)	-0.0106*** (0.000)
<b>Small city</b>	-0.0013*** (0.000)	-0.0012*** (0.000)	-0.0047*** (0.000)	-0.0022*** (0.000)	-0.0062*** (0.000)
<b>City</b>	0.0023*** (0.000)	0.0011*** (0.000)	-0.0008*** (0.000)	0.0004*** (0.000)	-0.0048*** (0.000)
<b>Relative mother's educational level</b>	0.0174*** (0.000)	0.0127*** (0.000)	0.0091*** (0.000)	0.0067*** (0.000)	0.0006*** (0.000)
<b>Computer availability at home</b>	0.0140*** (0.000)	0.0079*** (0.000)	0.0035*** (0.000)	-0.0010*** (0.000)	-0.0120*** (0.000)
<b>Computer availability at school</b>	-0.0012*** (0.000)	0.0007*** (0.000)	-0.0012*** (0.000)	-0.0028*** (0.000)	-0.0016*** (0.000)
<b>Quality in computer use</b>	0.0014*** (0.000)	-0.0001*** (0.000)	-0.0013*** (0.000)	-0.0022*** (0.000)	-0.0044*** (0.000)
<b>Constant</b>	-0.1565*** (0.000)	-0.0619*** (0.000)	-0.0020*** (0.000)	0.0593*** (0.000)	0.1587*** (0.000)
<b>Observations</b>	242,637	242,637	242,637	242,637	242,637
<b>P-pseudo R-squared</b>	0.0279	0.0182	0.0148	0.0148	0.0195

Standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1