School and teacher characteristics vs. student progress

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- The decision to invest in education is taken jointly by the family and the student, who compare the benefits and costs of such investment
- Educational externalities
- Education is one of the main services provided by governments
- School assessment has been an instrument of a guarantee of productivity and efficiency of the education systems, and used to improve the quality of education

- School performance can be evaluated by its value-added
- Using data at the student level, for the period 2010–2012, we analyse possible factors that influence students' achievement gains on Portuguese and Mathematics national exams
- One concludes that achievement gains, both in Portuguese and in Mathematics, are mainly determined by student's characteristics
- While peers' characteristics seem not to influence students' performance, class size does play a role

Research question:

What are the factors that determine students' performance?

Internacional

- In the economics of education literature, one of the most common conceptual frameworks employed takes the form of a production function, also referred to as "input–output" analysis:
  - The output corresponds to the results achieved by the students at the end of a cycle of studies
  - Education outcomes: test scores, in particular, the maths, reading and science scores, students' success rates, attendance rates, repetition rates and dropout rates
  - 3 groups of inputs: student, family e school characteristics
- Parametric estimators: OLS, multilevel, fixed-effects
- Non-parametric: DEA

Internacional

Leading results in the literature:

- Lee e Barro (2001) – family background and socio–economic factors are the most important determinants of student performance as compared to school resources
- Hanushek et al. (2003) and Kirjavainen (2012) – the higher the prior achievement scores, the higher the final achievement scores
- Hanushek (1986) and Lee e Barro (2001) – growing up in a low–income family has a negative impact on educational outcomes

Internacional

- Hanushek (1986), Lee and Barro (2001), Woessman (2003) and Kirjavainen (2012) – parents' education level influences positively student's performance
- Hanushek (1997), Krueger (2003) and Lee and Barro (2001) – the results suggest only weak relationships between school expenditures and student performance, once one controls for family characteristics
- Lee e Barro (2001) and Akerhielm (1995), for example - smaller classes have a positive effect on student achievement

Internacional

- Empirical evidence on peer effects is rather mixed
- However, the average peer group achievement (Hanushek, 2003), the average education of mothers of other students in the same class (McEwan, 2003), and a high proportion of girls, (Kirjavainen2012, have a highly significant effect on student performance
- Brunello and Rocco (2013) – the higher the share of immigrant pupils in schools, the lower the performance of native students, especially those with a disadvantaged parental background

Portugal

- Carneiro (2008) –
  - The observable factor that contributes the most to the inequality in student performance is the family background
  - The school resources have a limited role on student results
- Pereira (2010) –
  - Male students perform better in mathematics and female students have better reading performance;
  - Socio–economic background has a strong effect on test scores
  - Parents' education (secondary and university education) has a positive impact on student achievement;

Portugal

- Ferrão (2012): the relationship between prior achievement and student performance is stronger than the relationship between socio–economic status and student performance
- Oliveira and Santos (2005): school environment characteristics (e.g., unemployment rate, access to health care services, adult education and living infrastructures) are determinants of school efficiency
- Several authors, e.g., Oliveira and Santos (2005), Pereira e Reis (2012) and Portela et al. argue that coastline schools have better performance when compared too the inland ones

Education production function

$$\log A_{ijk} = \lambda \log {A_i}^9 + \beta X_{ijk} + \delta C_{jk} + \theta S_k + \epsilon_{ijk} \quad (1)$$

A_{ijk}: student's achievement in Portuguese or Mathematics, measured by the 12^{th} grade national exam score, for student i in class j in school k;
A_i^9 : student's achievement in the 9^{th} grade exam in the same subject;
X_{ijk} : observable student and family characteristics;
C_{jk}: measurable class j, in school k, characteristics;
S_k: measurable school characteristics;
ϵ_{ijk}: error term

Estimation methods

- OLS
- Fixed – effects (school level)
- A multilevel model with 3 levels – student, class and school
- Non–parametric approach: Data Envelopment Analysis (DEA)

The dataset was built from two distinct databases managed by the Portuguese Ministry of Education:

- ***MISI (Sistema de Informação do Ministério da Educação)***: it is a very detailed administrative database that contains information on pre–school education, as well as basic and secondary education, in public schools, overseen by the Ministry of Education. It contains information at student–level, such as gender, nationality, academic outcome, grade, social support eligibility, type of student, type of education, residence, availability of computer and internet at home, kinship of legal–guardians, legal–guardians'/parents' employment situation and legal–guardians'/parents' education, class and school. Information at school–level includes location, school resources

- ***JNE (Statistics published by Júri Nacional de Exames – Direção Geral de Educação)*** : information on scores in national exams on all disciplines of basic and secondary education subjected to examination.

- Time interval: 2010 – 2012

- Estimations are performed, separately, for national exams on Mathematics and Portuguese
- About 36,000 students performed the exam of Mathematics type A and/or Portuguese at upper secondary education ("12º ano")
- Only internal students and students who enrolled in the national exam but who attended the discipline throughout the school year are included

- $\approx$ 25% – benefits from social support
- $\approx$ 26% – without internet at home
- $\approx$ 71% – the mother is the legal–guardian
- $\approx$ 53% – with parents/legal–guardians with at least the high school diploma
- 351 public schools (Portugal mainland)
- 4,817 teachers in Mathematics and Portuguese
  - $\approx$ 35% of teachers work outside their county
  - $\approx$ 92% have an undergraduate degree
  - $\approx$ 75% are women

Table 1: Descriptive statistics on students

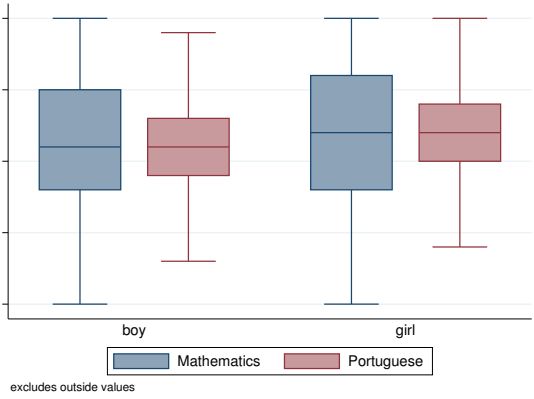
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
	2010		2011		2012	
Mathematics	125.34	46.164	108.33	47.256	106.833	44.743
Portuguese	116.95	29.499	105.93	31.347	112.418	30.261
Maths 9^{th}	95.00	43.401	124.28	47.051	133.712	38.589
Portuguese 9^{th}	138.37	24.046	138.60	25.401	129.029	26.927
Female	0.596		0.588		0.579	
Age	18.11	0.401	18.280	0.551	18.27	0.528
Portuguese student	0.991		0.995		0.995	
Internet	0.587		0.806		0.832	
Beneficiary s.s.	0.267		0.249		0.221	
Parent/legal–guardian						
Father	0.219		0.203		0.195	
Mother	0.712		0.700		0.709	
Own	0.045		0.076		0.073	
Other	0.025		0.021		0.023	
Parent/legal–guardian education						
Tertiary	0.249		0.227		0.241	
Secondary	0.221		0.237		0.244	
3^{rd} cycle	0.209		0.239		0.235	
2^{nd} cycle	0.174		0.165		0.157	
1^{st} cycle or less	0.147		0.133		0.122	
Parent/guardian employment status						
Worker for others	0.640		0.636		0.633	
Self-employed	0.114		0.101		0.104	
Unemployed	0.049		0.053		0.061	
Student	0.048		0.079		0.075	
Domestic/retired	0.140		0.125		0.119	
Other	0.009		0.006		0.008	

Source: Computations of the author based on *MISI* and *JNE Statistics*, 2010–2012.
Note: The number of observations in all variables, except Mathematics and Portuguese variables, is 12,782, 9,984 and 13,131 in 2010, 2011 and 2012, respectively. The corresponding values for Mathematics variable are 7,800, 6,109 and 8,454, and for Portuguese variable are 12,773, 9,550 and 12,583, respectively.

Table 2: Descriptive statistics on classes and schools

Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
	2010		2011		2012	
Class level variables						
Class size	23.80	4.961	25.11	5.194	25.57	5.453
% economically disadvantaged	24.46	17.31	23.96	16.74	21.67	15.45
% of girls	57.05	17.91	56.55	17.55	55.98	17.74
% of immigrants	3.608	5.876	3.667	5.666	3.335	5.166
% more educated parent/guardian	83.06	14.88	82.94	14.50	82.49	14.25
School level variables						
School size	969.7	315.9	1,056	325.3	1,030	342.0
% economically disadvantaged	31.87	14.67	29.67	14.24	28.90	14.03
% of girls	51.51	3.755	50.59	3.878	50.05	3.655
% of immigrants	4.496	4.844	4.890	5.413	4.590	4.941
% more educated parent/guardian	86.40	9.389	86.53	9.869	86.37	9.460
Expenditure–student ratio	567.1	229.1	518.1	204.5	477.6	165.2

Source: Computations of the author based on *MISI* and *JNE Statistics*, 2010–2012.
Note: The number of classes observed is 1,817, 1,928 and 2,115 in 2010, 2011 and 2012, respectively; the number of schools is 284, 283 and 322 in 2010, 2011 and 2012, respectively.



Source: Created by the author based on *MISI* and *JNE Statistics*, 2010–2012

Figure 1: Mean national exams scores by discipline and by gender

Table 3: Multilevel model results (Year of examination: 2012)

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Dependent variable: Log of Mathematics scores				Dependent variable: Log of Portuguese scores			
Fixed–effects Parameters								
Log Maths 9^{th}		1.0110***	1.0000***	1.0006***				
		(0.0246)	(0.0246)	(0.0246)				
Log Portuguese 9^{th}						0.5869***	0.5873***	0.5874***
						(0.0098)	(0.0099)	(0.0099)
Female		0.0742***	0.0773***	0.0785***		0.0488***	0.0484***	0.0483***
		(0.0106)	(0.0106)	(0.0106)		(0.0043)	(0.0044)	(0.0044)
Age		-0.1037***	-0.1039***	-0.1026***		-0.1025***	-0.1018***	-0.1019***
		(0.0128)	(0.0128)	(0.0128)		(0.0045)	(0.0045)	(0.0045)
Beneficiary S.S.		-0.0571***	-0.0533***	-0.0534***		-0.0062	-0.0080	-0.0080
		(0.0142)	(0.0144)	(0.0144)		(0.0054)	(0.0055)	(0.0055)
Internet		0.0217	0.0166	0.0190		-0.0009	-0.0003	-0.0004
		(0.0158)	(0.0158)	(0.0158)		(0.0063)	(0.0063)	(0.0064)
Portuguese student		-0.0120	-0.0161	-0.0152		-0.0418	-0.0482	-0.0483
		(0.0726)	(0.0727)	(0.0726)		(0.0283)	(0.0284)	(0.0284)
Class size			0.0281**	0.0303**			0.0123***	0.0122***
			(0.0106)	(0.0106)			(0.0034)	(0.0034)
Class size sq			-0.0006**	-0.0006**			-0.0002***	-0.0002***
			(0.0002)	(0.0002)			(0.0001)	(0.0001)
% of economically disadvantaged (class)			-0.0004	-0.0007			0.0003	0.0003
			(0.0006)	(0.0006)			(0.0002)	(0.0002)
% of female (class)			-0.0009	-0.0008			-0.0015*	-0.0015*
			(0.0017)	(0.0017)			(0.0006)	(0.0006)
% more educated parents/guardians (class)			-0.0029***	-0.0040***			0.0004	0.0004
			(0.0006)	(0.0007)			(0.0002)	(0.0003)
% more educated parents/guardians (school)				0.0031**				-0.0002
				(0.0011)				(0.0005)

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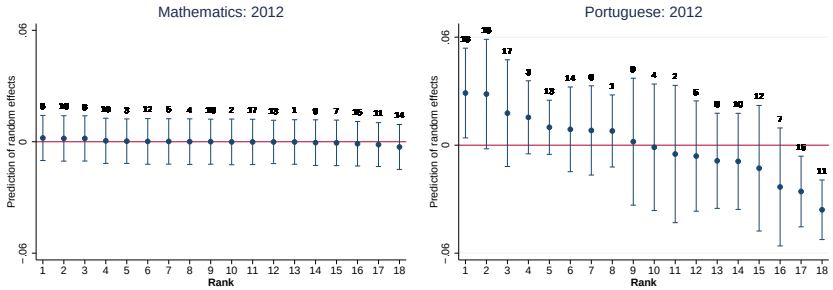
Table 5.4.3 – continued from previous page

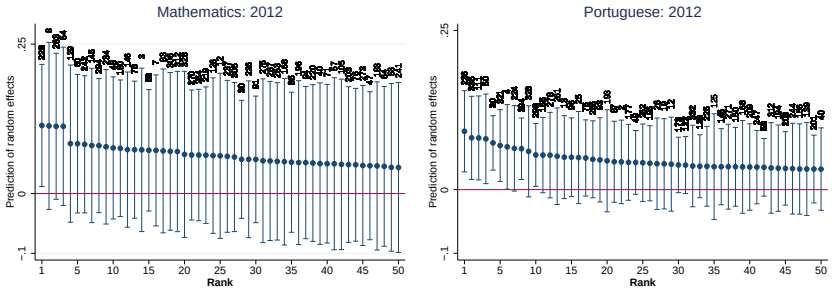
Random–effects Parameters								
Level–three variance:								
σ^2_{v0} Intercept variance	0.0130***	0.0067***	0.0075***	0.0073***	0.0036***	0.0021***	0.0020***	0.0020***
	(0.0028)	(0.0017)	(0.0018)	(0.0017)	(0.0006)	(0.0004)	(0.0003)	(0.0003)
Level–two variance:								
σ^2_{u0} Intercept variance	0.0361***	0.0174***	0.0148***	0.0147***	0.0079***	0.0034***	0.0033***	0.0033***
	(0.0040)	(0.0025)	(0.0023)	(0.0023)	(0.0007)	(0.0004)	(0.0004)	(0.0004)
Level–one variance:								
σ^2_e Residual variance	0.2714***	0.2101***	0.2101***	0.2101***	0.0727***	0.0506***	0.0507***	0.0507***
	(0.0046)	(0.0035)	(0.0035)	(0.0035)	(0.0010)	(0.0007)	(0.0007)	(0.0007)
Deviance	13877.12	11463.36	11414.94	11406.04	3910.46	-935.15	-959.05	-959.18
Observations	8454	8454	8454	8454	12583	12583	12583	12583
LR test (χ^2)	430.80	217.47	196.72	192.84	598.56	384.73	351.22	349.85
Prob > chi2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Source: Computations of the author based on *MISI* and *JNE Statistics*, 2010–2012.
Note: Standard errors in parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. All regressions include a set of dummies for the parents'/legal–guardians' education, except in the null model.



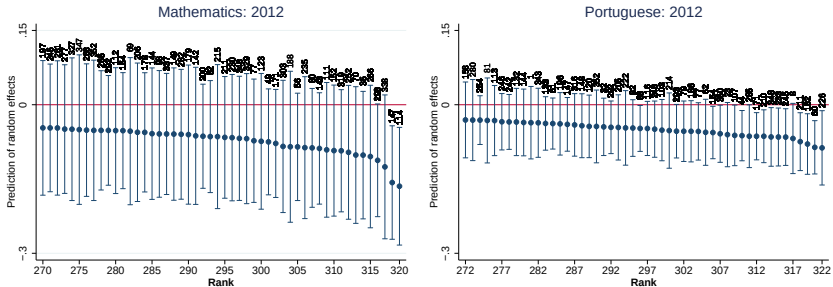
Source: Created by the author based on *MISI* and *JNE Statistics*, 2010–2012.
Note: Each number represents a district: 1 – Aveiro; 2 – Beja; 3 – Braga; 4 – Bragança; 5 – Castelo Branco; 6 – Coimbra; 7 – Évora; 8 – Faro; 9 – Guarda; 10 – Leiria; 11 – Lisboa; 12 – Portalegre; 13 – Porto; 14 – Santarém; 15 – Setúbal; 16 – Viana do Castelo; 17 – Vila Real; 18 – Viseu.

Figure 2: District effects and approximate 95% confidence intervals versus ranking of districts in Mathematics and Portuguese achievement gains (district identifiers are shown on the top of the error bar)



Source: Created by the author based on *MISI* and *JNE Statistics*, 2010–2012

Figure 3: School effects and approximate 95% confidence intervals versus ranking of 50 best schools in Mathematics and Portuguese achievement gains (school identifiers are shown on the top of the error bar)



Source: Created by the author based on *MISI* and *JNE Statistics*, 2010–2012.

Figure 4: School effects and approximate 95% confidence intervals versus ranking of 50 worst schools in Mathematics and Portuguese achievement gains (school identifiers are shown on the top of the error bar)

- Student prior achievement is the strongest predictor of current performance in both subjects, Mathematics and Portuguese (the effect is stronger for Math)
- Female students perform better than males students in both fields; results for 2012 show that on average girls perform better than boys in about 8% for Mathematics and 5% for Portuguese
- Age has a negative and significant influence on student achievement gains, which probably reflects a grade repetition effect
- Low income students perform worse than the higher income ones, mainly in Mathematics (-5% in 2012)

- Student background characteristics, in particular, the parent/guardian education has an important, positive influence on student achievement gains
- School resources, measured by the teaching expenditure–student ratio, have no effect on student achievement gains
- At the school level, the class size gets the highest weight in students' performance, mainly in Mathematics: by adding 5 students to a class of size 20 increases student's performance by about 1,7%; an increase of 10% reduces the effect to 0,3% (estimates for 2012))
- In most cases the school–effect is null

How do teacher characteristics impact on student's performance?

Production function

$$\log A_{ijt} = \lambda \log {A_i}^9 + \beta X_{it} + \delta T_{jt} + \gamma_t + \varepsilon_{ijt} \quad (2)$$

A_{ijt}: is the student outcome in the 12^{th} grade national exams Portuguese or Mathematics A, measured by the national exam score;
${A_i}^9$: score of the i^{th} student in the national exam of 9^{th} grade;
X_{it} : vector of student and family background characteristics;
T_{jt}: measurable teacher characteristics and includes the class size;
γ_t: time fixed-effects;
ε_{ijt}: error term.

Estimation methods

- Ordinary Least Squares (OLS);
- Fixed-effects (FE)

$$\log A_{ijt} = \lambda \log A_i{}^9 + \beta X_{it} + \delta T_{jt} + \tau_j + \varepsilon_{ijt} \tag{3}$$

where τ_j is a teacher fixed–effect.

- A matched student–teacher dataset including the national test scores of students in Mathematics and Portuguese, student background information, and teacher information;
- Information at the student–level: gender, date of birth, nationality, academic outcomes, year of schooling, social support eligibility, residence, availability of computer and internet at home, parents' employment situation and parents' education, class and school, among others;
- Information at the teacher–level: gender, date of birth, education, teaching experience, disciplinary group, salary, county and district of residence, among others;
- Period: 2010 – 2012;

The sample contains:

- 21,549 student observations:
  - attended the scientific–humanistic courses of secondary education;
  - performed the 12^{th} grade national exams of Mathematics and Portuguese;
  - aged between 17 and 20 years (91% of students are 18 years old);
  - 23% of the students benefit from social support;
  - 73% of the students have internet access at home.
- 4,817 unique teachers:
  - working in 446 Portuguese public secondary schools;
  - about 35.1% are working outside their county of residence;
  - 91.8% of the teachers have a *bacharelato* or bachelor degree as the highest level of education;
  - 75% are female;
  - 50% of the teachers have at least 25 years of experience;

Table 4: OLS estimates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		All students			**Mathematics**			**Portuguese**	
Log of 9^{th} exam scores	0.7110***	0.7101***	0.7101***	0.9534***	0.9503***	0.9505***	0.6972***	0.6959***	0.6959***
	(0.0129)	(0.0129)	(0.0129)	(0.0242)	(0.0241)	(0.0241)	(0.0133)	(0.0133)	(0.0133)
Female student	0.0598***	0.0597***	0.0598***	0.0594***	0.0589***	0.0589***	0.0602***	0.0604***	0.0604***
	(0.0050)	(0.0050)	(0.0050)	(0.0103)	(0.0103)	(0.0103)	(0.0044)	(0.0044)	(0.0044)
Age	-0.1211***	-0.1210***	-0.1210***	-0.1865***	-0.1845***	-0.1841***	-0.0974***	-0.0968***	-0.0968***
	(0.0077)	(0.0077)	(0.0077)	(0.0234)	(0.0232)	(0.0232)	(0.0066)	(0.0066)	(0.0066)
Beneficiary S.S.	-0.0494***	-0.0489***	-0.0488***	-0.0853***	-0.0842***	-0.0844***	-0.0301***	-0.0295***	-0.0296***
	(0.0062)	(0.0062)	(0.0062)	(0.0141)	(0.0141)	(0.0141)	(0.0053)	(0.0053)	(0.0053)
Internet	0.0196***	0.0195***	0.0196***	0.0175	0.0177	0.0179	0.0157***	0.0157***	0.0157***
	(0.0057)	(0.0057)	(0.0057)	(0.0126)	(0.0126)	(0.0126)	(0.0049)	(0.0049)	(0.0049)

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Female teacher	0.0219***	0.0219***	0.0222***	0.0288**	0.0278**	0.0281**	0.0120**	0.0120**	0.0120**
	(0.0060)	(0.0060)	(0.0060)	(0.0117)	(0.0117)	(0.0117)	(0.0053)	(0.0053)	(0.0053)
Advanced degree	0.0157*	0.0161*	0.0165*	-0.0082	-0.0089	-0.0080	0.0254***	0.0253***	0.0252***
	(0.0089)	(0.0089)	(0.0089)	(0.0198)	(0.0198)	(0.0197)	(0.0071)	(0.0071)	(0.0071)
Experience	0.0013***	0.0013***	-0.0010	0.0012	0.0012	-0.0061	0.0007**	0.0007**	0.0011
	(0.0004)	(0.0004)	(0.0022)	(0.0008)	(0.0008)	(0.0046)	(0.0003)	(0.0003)	(0.0018)
Experience sq			0.0000			0.0002			-0.0000
			(0.0000)			(0.0001)			(0.0000)
Commuting	-0.0081	-0.0078	-0.0081	-0.0162	-0.0152	-0.0163	-0.0084*	-0.0080*	-0.0079*
	(0.0053)	(0.0053)	(0.0053)	(0.0114)	(0.0113)	(0.0114)	(0.0046)	(0.0046)	(0.0046)
Class size		0.0156***	0.0156***		0.0355***	0.0356***		0.0064**	0.0065**
		(0.0035)	(0.0035)		(0.0087)	(0.0087)		(0.0028)	(0.0028)
Class size sq		-0.0003***	-0.0003***		-0.0007***	-0.0007***		-0.0001**	-0.0001**
		(0.0001)	(0.0001)		(0.0002)	(0.0002)		(0.0001)	(0.0001)
Observations	21,549	21,549	21,549	8,100	8,100	8,100	13,449	13,449	13,449
R-squared	0.251	0.252	0.252	0.298	0.300	0.300	0.329	0.329	0.329
RMSE	0.245	0.245	0.245	0.245	0.245	0.245	0.245	0.245	0.245

Source: Computations of the author based on *MISI* and *JNE Statistics*, 2010–2012.

Note: Robust standard errors in parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. The dependent variable is log 12^{th} grade national exam score. All regressions include a set of dummies to control for district/region and year.

Table 5: FE estimates

	(1)	(2)	(3)	(4)	(5)	(6)
	All students		**Mathematics**		**Portuguese**	
Log of 9^{th} exam scores	0.7067***	0.7066***	0.8347***	0.8341***	0.6466***	0.6463***
	(0.0149)	(0.0148)	(0.0297)	(0.0296)	(0.0151)	(0.0151)
Female student	0.0544***	0.0544***	0.0661***	0.0661***	0.0607***	0.0607***
	(0.0055)	(0.0055)	(0.0126)	(0.0126)	(0.0054)	(0.0054)
Age	-0.1112***	-0.1105***	-0.1983***	-0.1963***	-0.0932***	-0.0925***
	(0.0087)	(0.0088)	(0.0289)	(0.0289)	(0.0078)	(0.0078)
Beneficiary S.S.	-0.0443***	-0.0442***	-0.0706***	-0.0714***	-0.0327***	-0.0325***
	(0.0072)	(0.0072)	(0.0188)	(0.0187)	(0.0064)	(0.0064)
Internet	0.0141*	0.0142*	0.0017	0.0024	0.0226***	0.0225***
	(0.0080)	(0.0080)	(0.0191)	(0.0190)	(0.0073)	(0.0073)

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Advanced degree	-0.0223	-0.0218	-0.0957	-0.0913	0.0505	0.0501
	(0.0507)	(0.0505)	(0.1136)	(0.1107)	(0.0411)	(0.0411)
Experience	0.0565***	0.0567***	0.2238***	0.2195***	0.0076	0.0084
	(0.0211)	(0.0209)	(0.0492)	(0.0486)	(0.0179)	(0.0179)
Experience sq	-0.0018***	-0.0018***	-0.0065***	-0.0063***	-0.0003	-0.0003
	(0.0004)	(0.0004)	(0.0010)	(0.0010)	(0.0004)	(0.0004)
Commuting	-0.0216**	-0.0215**	-0.0136	-0.0136	-0.0214**	-0.0212**
	(0.0100)	(0.0100)	(0.0255)	(0.0254)	(0.0090)	(0.0090)
Class size		0.0142**		0.0315*		0.0103**
		(0.0060)		(0.0169)		(0.0051)
Class size sq		-0.0003**		-0.0007**		-0.0002*
		(0.0001)		(0.0003)		(0.0001)
Observations	21,549	21,549	8,100	8,100	13,449	13,449
No. of teachers	4,817	4,817	2,868	2,868	3,828	3,828

Source: Computations of the author based on *MISI* and *JNE Statistics*.

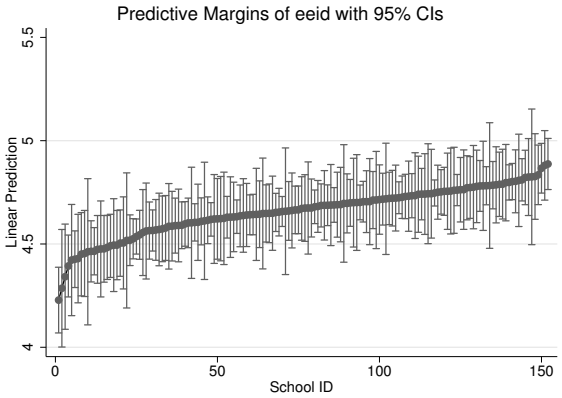
Note: Robust standard errors in parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. The dependent variable is log 12^{th} grade national exam score. All regressions include a set of dummies to control for district/region.

- Results show that female teachers have a positive effect on students' achievement gains
- Teachers working away from home have negative and significant effects on student results
- Teachers with more qualifications (postgraduate, masters or PhDs) do not show better performance than those with a *bacharelato* or licentiate diploma
- Teachers with more experience are more effective in increasing students' performance than those with less experience

Table 6: Teacher & School fixed-effects: mathematics

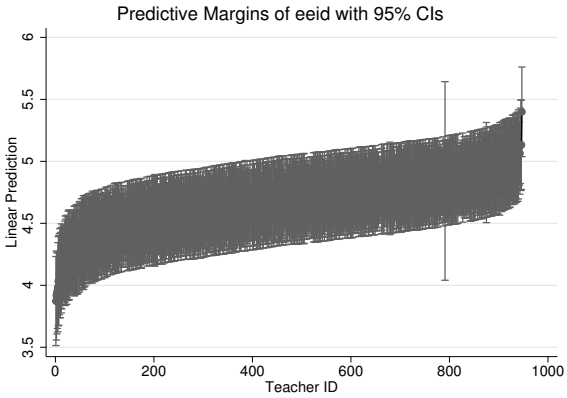
	No FE	Teacher FE	School FE	T. and S. FE
$Math9$	0.6551***	0.6279***	0.6324***	0.6284***
	(0.0129)	(0.0142)	(0.0131)	(0.0143)
Female	0.0868***	0.0845***	0.0853***	0.0847***
	(0.0086)	(0.0092)	(0.0086)	(0.0092)
R2-adjusted	0.30	0.33	0.32	0.33
RMSE	0.42	0.41	0.42	0.41

Source: Computations of the author based on *MISI* and *JNE Statistics*, 2010–2012.
Note: The number of observations 11,407. 2018 teachers & 286 schools. 52% girls. $Math^9$: mean = 135, median = 140, 10^{th} percentile = 74, sd = 40.



Source: Created by the author based on *MISI* and *JNE Statistics*, 2010–2012

Figure 5: Marginal effects by School



Source: Created by the author based on *MISI* and *JNE Statistics*, 2010–2012

Figure 6: Marginal effects by Teacher