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Heterogeneity of Rural Schools in the World
Effects of School Location on Academic Achievement Across 28 Countries

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Executive Summary

Rural schools have been consistently under examined compared with urban and suburban counterparts. This paper examines the effects of school location, specifically rural schools, on student academic achievement in 28 countries, using TIMSS 2011 data for fourth grade students. After controlling for student, family, teacher, and school characteristics, as well as country fixed effects, rural schools in 5 countries have shown significant and positive effects on student math achievement, and those in another 5 countries have shown significant and negative effects.

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I. Introduction

In the United States, 57 percent of all operating regular school districts are located in rural areas. In 2013, among approximately 100,000 public schools, about one third were located in rural areas educating 12 million students, or 24 percent of the total enrollment (Aud et al., 2013). However, research that specifically examines rural education is scant (Mulkey, 1993; Stern, 1994). Those working in the field consistently voice frustration with the body of existing data and literature (Sherwood, 2000). “Lack of adequate research and impact evaluations, together with definitional inconsistencies severely limit policymakers’ ability to know either the effect of federal, state, and local programs on rural schools or whether rural interests are being equitably addressed,” wrote Stern (1994, p. 31) in “The Condition of Education in Rural Schools”. And little has changed over the last two decades.

From global perspective, the situation of rural education is as urgent if not more than that in the U.S. According to United Nations Educational, Scientific and Cultural Organization (UNESCO), 60 percent of the population in developing countries still lives in rural areas, and 75

percent of the world's poor who earn less than \$1 a day live in the countryside.¹ Many countries report that low school attendance, early dropouts, adult illiteracy and gender inequality in education are disproportionately high in rural areas. Moreover, urban-rural disparities in educational investment and in teaching quality are widespread across countries.

In order to examine student achievement, policy impacts, as well as education systems across countries, the International Association for the Evaluation of Educational Achievement (IEA) was founded in 1958. The founders of IEA viewed the world as a natural educational laboratory where they aimed to identify factors that influence educational outcomes across the wide range of education systems across countries². Since the 1960s, IEA has conducted more than 30 research studies across dozens of countries and educational systems looking at students' mathematics and science, reading literacy, civic and citizenship education, early childhood education as well as computer and information literacy. These studies have also contributed to the development of data collection for international comparative assessments of educational achievement.

With the availability of large-scale international educational datasets, researchers began to evaluate student outcomes and policies and factors that affect student, teacher and school performance across countries. This paper looks the effects of school location on students' academic achievements across 28 countries. Specifically, what impacts do rural schools in different countries have on students' math test score performance?

¹ Director-General of UNESCO, Launching the FAO/UNESCO EFA flagship programme on Education for Rural People. http://portal.unesco.org/en/ev.php-URL_ID=5748&URL_DO=DO_TOPIC&URL_SECTION=201.html Accessed on March 22, 2016.

² Brief history of IEA: 55 years of educational research. http://www.iea.nl/brief_history.html Accessed on March 30, 2016.

The paper is organized as follows: Section II discusses previous research. Section III addresses data, conceptual framework, and methodology of the research. Section IV presents the empirical results. And finally, Section V includes the discussion and conclusion of the paper.

II. Literature Review

Since the 1960s, numerous researchers have studied the factors that influence students' academic achievement. Socioeconomic background has consistently been increasingly found to be one of the most important variables (Coleman, 1988; Brooks-Gunn & Duncan, 1997; McLoyd, 1998). In particular, parents' education has a persistent influence on predicting children's educational achievement since it tends to remain the same level over a child's lifetime, and it strongly predicts parents' income level (Hauser & Warren, 1997). Cross-country studies have found similar results. Woessmann (2004) examined 18 countries and concluded that family background, especially parents' education level, is consistently and strongly associated with student performance in all Western Europe countries and the U.S. More recently, researchers have also started looking at various home resources such as computers, books, and whether a child has his/her own room as indicators of family socioeconomic background (Coleman, 1988; Angrist & Lavy, 2002; Fuchs & Woessmann, 2004). However, the findings of those studies vary on a large scale. While Evans et al. (2014) found that number of books at home strongly enhances students' academic performance in a study of 42 countries; Fuchs and Woessmann (2004) examined 31 countries and found negative effects of home computers possibly because once controlling extensively for family background, the availability of computer at home seems to distract students from effective learning.

When it comes to school resources, Coleman et al. (1966) were the first to study the association between school inputs and student achievement. Ever since the Coleman report, there has been a wave of studies examining the effects of school resources on students' academic achievement (Konstantopoulos, 2005). Overall, the studies showed mixed results – some researchers have found little or no effects of school resources on student achievement (Hanushek, 1989), while others found significant effects of school resources on students' test scores (Greenwald, Hedges & Laine, 1996). International and cross-country studies show similarly inconclusive results. Heyneman and Loxley (1983) examined 28 countries in Africa, Asia, Latin America, and the Middle East and found that school resources explain a considerably higher proportion of variance of student achievement in poor countries, which suggests that school resources are more important in developing countries. However, Hanushek and Luque (2003) used data from the Third International Mathematics and Science Study (TIMSS) and found no evidence to support this view.

Other school characteristics can also have strong effects on student achievement. In the United States, it is common to use the percentage of students who are eligible for free lunch and percentage of minority students at school as socioeconomic indicators (Sirin, 2005). Generally, studies have found significantly negative effects of high percentage of both minority and low-income students at school on student achievement (Caldas & Bankston, 1997). Another factor that potentially affects student achievement is class size. Recently, extensive research has been done on the effects of class size on student achievement in the U.S., specifically using the Tennessee Student/Teacher Achievement Ratio experiment (“Project STAR”), which strongly supports the reduction of class size. However, due to several design problems, the effects of the class size can be biased (Hanushek, 1999; Hoxby, 2000). International evidence has shown that

smaller classes are beneficial in some countries, but not so much in others (Woessmann & West, 2006).

Since the mid-1980s, researchers have started to look at school location as a potential influence on student achievement. Plenty of studies have focused on student achievement differences between suburban and urban schools and have found that students in affluent suburban schools performed significantly and consistently better than those in “disadvantaged” urban schools (U.S. Department of Education, 2000). However, geographically isolated, rural schools remain under-examined relative to those of their suburban and urban counterparts (Cowen et al., 2012). In the review of education research from 1990-2000 by Sirin (2005), 26 studies out of 64 contained data on school location, and among those, only four looked at rural schools. Generally, the public believes that students from rural schools receive an education that is inferior to that of students from larger urban or suburban schools, but several studies in the U.S. have not found significant achievement differences (Young, 1998). Monk and Haller (1986) looked at New York State and found that students from smaller, often rural schools performed as well as students from larger schools. Ward and Murray (1985) looked at New Mexico schools and found students attending rural schools performed as well as those in urban schools.

Internationally, however, studies on urban-rural student achievement have shown mixed results. Young (1998) examined rural and urban schools in Western Australia and found that even after controlling for student background, grade and average socioeconomic status of students in the school, rural and remote students were still significantly disadvantaged in terms of their achievement. Williams (2005) analyzed 24 industrialized countries using 2000 PISA data and found that in 14 countries, rural students scored considerably lower in mathematics than those in urban and medium-sized schools. Zhang (2006) used data from 14 sub-Saharan school

systems between 2000 and 2002 and found that rural students underperformed their urban counterparts by large margins in most countries. Tayyaba (2012) looked at fourth-grade students across provinces in Pakistan and found that in some provinces, rural and urban students had comparable achievement levels, while in another province, rural students outperformed their urban counterparts.

III. Data and Methodology

This paper attempts to answer two questions: whether school locations have any effects on students' math performance across countries, and whether the effects, specifically of rural schools, vary by country.

Data

For this paper, I used the 2011 data from Trends in International Mathematics and Science Study (TIMSS), which is conducted by the International Association for the Evaluation of Educational Achievement (IEA). TIMSS measures trends in mathematics and science achievement at the fourth and eighth grades across countries. It is one of the largest international large-scale assessments that collect rich contextual information at different levels related to student science performance in both national and international contexts (Martin, Mullis, and Foy, 2008). The datasets contain student achievement data in math and science as well as student, teacher, school, and curricular background data.

In order to collect valid and reliable data and control for selection bias, TIMSS employs rigorous two-stage random sampling techniques so that achievement in the student population as a whole may be estimated accurately by assessing a sample of students from a sample of

schools.³ To meet the TIMSS standards for sampling precision, national student samples from each country must provide a standard error no greater than 0.035 standard deviation units for the country's mean achievement, which corresponds to a 95 percent confidence interval. For most countries, TIMSS samples 150 schools with 4,000 students for each target grade. In addition, TIMSS sets high standards for a national sample to be fully acceptable in order to minimize the potential bias for nonparticipation.⁴

In attempt to answer the research questions, I only used data from 28 countries out of the 63 represented in TIMSS 2011. I excluded 35 countries since some are benchmarking participants that are only represented by regional jurisdictions of countries (i.e., in addition to the U.S., several U.S. states also participated in TIMSS 2011), and others did not measure fourth grade students, the focus of my analysis. I used fourth grade students' math test scores as the measure of students' math performance.⁵ For school locations, TIMSS 2011 school questionnaire breaks them down into five categories: urban-densely populated, suburban-on fringe or outskirts of urban area, medium size city or large town, small town or village, and remote rural area.

The model in the paper includes over 105,000 student-level observations from 28 countries (See Table 1). Among all the countries, students from Hong Kong have the highest mean score of 611.92, followed by Singapore, Chinese Taipei, Northern Ireland, and Finland. On

³ Marc Joncas and Pierre Foy, Sample Design in TIMSS and PIRLS. *Methods and procedures in TIMSS and PIRLS 2011*. http://timss.bc.edu/methods/pdf/TP_Sampling_Design.pdf Accessed on March 31, 2016.

⁴ Minimum participation rates for randomly selected schools, classes, and students are set between 85 percent and 95 percent. And a minimum combined school, classroom, and student participation rate of 75 percent is required, based on originally sampled schools.

⁵ TIMSS 2011 uses a plausible values methodology to address the potential bias of cognitive skills testing. The plausible values approach uses all available achievement data, along with all background data, to estimate directly the characteristics of student populations and subpopulations, see more in TIMSS and PIRLS Achievement Scaling Methodology (Yamamoto and Kulick, 2000). TIMSS 2011 includes five plausible values for fourth grade math scores, and the estimations use the average of the five values as the dependent variable.

the other hand, students from Iran, Qatar, Saudi Arabia, Oman, and Morocco scored the lowest with Morocco at the bottom of the list with mean score of 355.90.

Table 1. Descriptive Statistics – Country/Math Score

Country/Math Score	Obs.	Mean	Std. Dev.	Min	Max
Hong Kong	3952	611.92	56.56	395.03	767.62
Singapore	7605	608.70	72.83	314.63	787.17
Chinese Taipei	6790	599.29	65.48	341.46	766.76
Northern Ireland	1140	588.51	73.29	303.77	787.79
Finland	3527	550.55	61.63	328.60	736.34
Russian Federation	3244	550.11	68.76	315.48	772.82
Lithuania	3526	546.28	67.58	321.11	739.25
Germany	2777	538.41	57.32	341.49	703.24
Portugal	2806	538.09	60.81	310.04	744.01
Australia	2038	536.52	76.76	248.53	737.13
Ireland	3174	534.47	70.91	291.70	757.54
Hungary	4490	531.29	78.91	238.94	742.84
Slovak Republic	5756	514.29	70.60	198.33	741.82
Italy	1966	513.83	66.17	272.21	702.25
Sweden	2423	509.00	61.14	314.72	697.81
Malta	3546	506.85	69.49	291.99	704.01
Norway	1874	502.64	62.05	296.45	684.72
Romania	2625	501.25	94.80	173.31	779.34
Spain	2594	494.67	63.06	245.45	676.96
Poland	3639	490.96	66.67	256.31	705.42
Azerbaijan	2629	469.24	89.93	214.86	780.28
Georgia	3466	462.45	77.32	187.85	730.49
United Arab Emirates	9839	448.76	90.29	179.46	779.54
Iran, Islamic Rep. of	3944	442.41	85.29	128.68	720.06
Qatar	2579	432.56	93.67	188.22	712.76
Saudi Arabia	4786	411.98	94.47	125.54	815.12
Oman	6097	389.23	96.14	121.80	717.12
Morocco	2516	355.90	90.69	130.34	659.92
Total	105348	505.96	102.28	121.80	815.12

Table 2 shows the descriptive statistics of school locations across the 28 countries in the model. Roughly 33 percent of students in the dataset are from urban schools, 17 percent come from suburban schools, 21 and 23 percent students are from schools in medium-size cities and small towns, respectively. And about 5 percent of students in the data come from rural schools.

Table 2. Descriptive Statistics - School Location

School Location	Percentage	Std. Err.	[95% Conf.	Interval]
Urban	0.334	0.001	0.332	0.337
Suburban	0.174	0.001	0.171	0.176
Medium-size city	0.217	0.001	0.215	0.220
Small town	0.228	0.001	0.226	0.231
Remote rural	0.047	0.001	0.045	0.048

Methodology

In order to estimate the effects of school location on students' educational achievement, I used the standard education production function model (Hanushek, 1979). The output of the function – student achievement – is measured by students' math test scores. The model measures the output as a function of student's individual background, family background, teacher characteristics and school characteristics. Conceptually, the model is:

$$A_i = f(I_i, F_i, T_i, S_i),$$

where A is the math test score for student i , I is student i 's individual characteristics, F is family background for student i , T is student i 's math teacher's characteristics, and S is the school characteristics for student i .

Furthermore, in order to minimize omitted variable bias, a student's individual background in the model includes math ability before elementary school. In the family background questionnaire filled out by students' parents, there are five variables that relate to students' math ability before entering elementary school: "count by himself/herself", "recognize different shapes", "recognize the written numbers from 1-10", "write the numbers from 1-10", "do simple addition", as well as "do simple subtraction". And since this paper aims to study multiple countries, it is essential to control for the "fixed effects" associated with each country.

Additionally, in order to capture the effects of school location, specifically rural schools, for each country, I created a new variable for the model to make rural schools interact with the country the student is from. Thus, the model used for estimations is:

$$A_i = \beta X_i + \alpha_i + \text{rural} * \alpha_i + \varepsilon_i,$$

where A_i is the math test score of student i , X_i is the matrix of characteristics of students, families, teachers and schools, α_i is the fixed effects of the country that student i comes from and that cannot be directly observed, $\text{rural} * \alpha_i$ is the interaction variable of rural schools with countries, and ε_i is the error term for student i .

In the model, variables that represent individual background are student's age, gender, and years of preschool completed, as well as math ability before elementary school. For family background, control variables are father's education level, mother's education level, frequency of speaking test language at home, whether the child has his/her own room at home, and whether there is an Internet connection at home. For teacher characteristics, I controlled for years of teaching experience, gender, age, education level, whether the teacher majored in math, how often the teacher assign math homework, and whether teacher is evaluated based on student achievement. Finally, for school characteristics, I controlled for class size, school size, math instructional hours per week, percentage of students who are economically disadvantaged, and the immediate area where the school is located. And both models controlled for country fixed effects.

IV. Empirical Results

Overall, rural schools, when compared with schools in urban, suburban, middle size cities and small towns, have shown significant effects in 10 countries (See Table 3). Among those,

rural schools in Azerbaijan, Germany, Ireland, Morocco, and Portugal have shown significantly positive effects after controlling for everything else; and rural schools in Chinese Taipei, Hungary, Iran, Romania, and Saudi Arabia have shown significant and negative effects. Specifically, after controlling for student background, family background, teacher characteristics and school characteristics, students from rural schools in Portugal are likely to score, on average, 71.9 points higher than those from schools at other locations, while in Hungary, rural school students tend to score 48.1 points lower than those from schools in other locations.

When looking at student background, several variables have shown significant effects. Both age and the length of preschool attended are, on average, positively and significantly related to higher math test scores across 28 countries. As for student's previous math ability measured by six variables, five of them appear to be positively and significantly related to student's math score performance at fourth grade – ability to count by oneself, recognize different shapes, recognize written numerals, simple addition and simple subtraction, and only one variable negatively affect student math score across countries – the ability to write numerals, yet the coefficients are relatively small.

When looking at family background, across all of the 28 countries, both father and mother's education have significant and positive effects on student's math score performance, and the coefficients increase gradually for both father and mother. In addition, higher frequency of the test language spoken at home is associated with higher math score. As for the two proxies of family income, Internet connection at home has positive and significant effects, while having his/her own room at home has slightly negative effects on student's math score across 28 countries.

Table 3. Effects of Rural Schools on Student Math Performance

rural#country	Coef.	Std. Err.	t	P> t
Azerbaijan	21.481	9.537	2.250	0.024
Australia	-7.897	17.666	-0.450	0.655
Chinese Taipei	-15.926	7.259	-2.190	0.028
Finland	5.363	7.014	0.760	0.445
Georgia	12.517	10.498	1.190	0.233
Germany	21.495	7.682	2.800	0.005
Hungary	-48.133	11.404	-4.220	0.000
Iran, Islamic Rep. of	-19.274	8.107	-2.380	0.017
Ireland	19.082	7.537	2.530	0.011
Italy	6.330	7.136	0.890	0.375
Lithuania	8.746	23.333	0.370	0.708
Malta	9.127	11.566	0.790	0.430
Morocco	51.763	11.949	4.330	0.000
Oman	-15.341	8.720	-1.760	0.079
Norway	6.198	7.229	0.860	0.391
Poland	-0.153	7.427	-0.020	0.984
Portugal	71.938	21.119	3.410	0.001
Qatar	-18.231	14.816	-1.230	0.219
Romania	-19.090	8.346	-2.290	0.022
Russian Federation	-7.447	7.172	-1.040	0.299
Saudi Arabia	-43.566	10.091	-4.320	0.000
Spain	25.939	19.881	1.300	0.192
Sweden	5.871	7.118	0.820	0.409
United Arab Emirates	-0.943	7.223	-0.130	0.896

Note: Hong Kong, Singapore, and Slovak Republic are not shown in the table because no schools in the dataset from those countries are located in rural areas. Northern Ireland is omitted since most schools in the dataset are located in rural areas.

For teacher characteristics, male teachers tend to be related with slightly lower math scores compared with female teachers. Across the board, teacher's higher education is associated with higher math scores. As for instructional environment, class size has significantly negative but small effects whereas the math instructional hours per week has significantly positive but small effects on student's math test score achievement.

For school characteristics, across the 28 countries, higher percentage of economically disadvantaged students of a school is negatively and significantly associated with student's math score performance. Total enrollment of students has positive but small effects, whereas school location has no significantly effect on student's math score (See Appendix for full table of estimation results).

Table 4. Countries' Fixed Effects on Student Math Performance

Country	Coef.	Std. Err.	t	P> t
Hong Kong SAR	131.081	2.264	57.890	0.000
Singapore	107.803	2.278	47.320	0.000
Northern Ireland	107.490	2.978	36.090	0.000
Chinese Taipei	96.522	2.209	43.690	0.000
Portugal	64.438	2.386	27.000	0.000
Hungary	53.935	2.252	23.950	0.000
Lithuania	52.343	2.191	23.890	0.000
Germany	51.888	2.275	22.810	0.000
Ireland	51.813	2.396	21.630	0.000
Russian Federation	47.162	2.368	19.920	0.000
Italy	45.294	2.753	16.450	0.000
Australia	45.099	2.578	17.490	0.000
Finland	42.478	2.363	17.980	0.000
Malta	39.119	2.401	16.290	0.000
Romania	28.707	2.578	11.130	0.000
Slovak Republic	27.120	2.280	11.900	0.000
Sweden	11.227	2.380	4.720	0.000
Poland	9.704	2.293	4.230	0.000
Spain	3.728	2.314	1.610	0.107
Iran, Islamic Rep. of	1.174	2.359	0.500	0.619
Norway	1.021	2.564	0.400	0.691
Georgia	-36.221	2.308	-15.690	0.000
United Arab Emirates	-48.106	2.168	-22.190	0.000
Saudi Arabia	-53.249	2.422	-21.990	0.000
Qatar	-65.316	2.565	-25.470	0.000
Oman	-65.917	2.344	-28.120	0.000
Morocco	-71.730	2.901	-24.730	0.000

Finally, the model controlled for each country's fixed effects⁶. The base comparison country is Azerbaijan and most of the countries in the dataset have significant effects on student's math test score performance (See Table 4). Countries with positive and significant effects are Australia, Chinese Taipei, Finland, Germany, Hong Kong, Hungary, Ireland, Italy, Lithuania, Malta, Poland, Portugal, Romania, Russia, Singapore, Slovak Republic, Sweden, and Northern Ireland. Countries with negative and significant effects are Georgia, Morocco, Oman, Qatar, Saudi Arabia, and United Arab Emirates.

V. Conclusion and Discussion

Overall, the estimations have shown that, on average, school locations do not have any significant effects across all 28 countries. However, when looking at each country by itself and comparing schools located in rural areas with schools that are located in urban, suburban, middle-size cities, and small towns, rural schools have shown significant effects in 10 countries. Among those, rural schools in Portugal have the most significantly positive effects on student math test score performance, and those in Hungary have the most significantly negative effects. There are potentially a few explanations for the results. One, there might exist some inconsistencies across countries during the data collecting process. Since TIMSS 2011 sampled students in different schools in each country, it is possible that the sample does not represent the population objectively or accurately across all countries. Even when the number of students and schools are chosen based on local population ratio; it is possible that the quality of students might not be representative of the whole population. Moreover, since students from rural schools

⁶ When running the model without controlling for country and country-related variables, the R^2 dropped from 0.55 to roughly 0.35, which shows that country fixed effects count for about 20 percent of the variation in the data.

only count for about 5 percent of all students in the dataset, some can argue that the sample size is relatively small to be representative of the overall trend.

Another potential explanation for the results comes from the variation of school systems and socioeconomic characteristics across countries. It is plausible that families from different countries choose to live in rural areas for different reasons, and the difference in motivation might lead to unobservable factors that affect student's math test score performance. In this case, the variation in math scores might not be explained by school location, but instead, family characteristics. In addition, differences in school systems across countries might have different effects on rural schools, such as resources, student composition, and teacher preferences.

Moreover, despite the variations in characteristics of individual countries, there might exist some underlying relationships among countries that have shown positive effects (Azerbaijan, Germany, Ireland, Morocco, and Portugal) and countries that have shown negative effects (Chinese Taipei, Hungary, Iran, Romania, and Saudi Arabia). It is possible that the correlations observed in this study reflect more than the effects of school locations; rather, it is likely that other factors are driving the effects on student achievement. Future research can look into different school systems and cultures across countries, as well as economic or social trends among groups of countries, which is likely to present a clearer picture of why rural schools have positive effects on student achievement in some countries while have negative impacts in some other countries.

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Appendix:

Full Table of Estimation Results

Math Score	Coef.	Std. Err.	P> t
Student Background			
Age	3.543	0.516	0.000
Gender (Female)			
Male	0.438	0.429	0.307
Preschool			
3 years or more	10.563	2.116	0.000
Less than 3 years but more than 1 year	7.529	2.116	0.000
1 year or less	6.757	2.204	0.002
Did not attend	5.364	2.220	0.016
<i>Previous Math Ability</i>			
Count by oneself (Up to 100 or higher)			
Up to 20	-14.507	0.522	0.000
Up to 10	-22.543	0.827	0.000
Not at all	-17.709	2.806	0.000
Recognize different shape (More than 4 shape)			
3-4 shapes	-7.020	0.501	0.000
1-2 shapes	-16.857	0.878	0.000
None	-13.074	2.020	0.000
Recognize written numeral (All 10 numbers)			
5-9 numbers	-10.003	1.015	0.000
1-4 numbers	-11.991	1.269	0.000
None	-4.158	2.141	0.052
Write numerals 1-10 (All 10 numbers)			
5-9 numbers	3.244	0.883	0.000
1-4 numbers	5.174	0.997	0.000
None	8.859	1.395	0.000
Simple addition (Yes)			
No	-6.092	0.829	0.000
Simple subtraction (Yes)			
No	-5.317	0.717	0.000
Family Background			
Father's Education (No school)			
Primary or lower secondary	7.383	2.272	0.001
Lower secondary	13.014	2.247	0.000

Math Score	Coef.	Std. Err.	P> t
Upper secondary	22.201	2.248	0.000
Post-secondary non tertiary	28.105	2.329	0.000
Associate/Occupational	32.171	2.364	0.000
Bachelor's degree	42.653	2.308	0.000
Beyond	49.375	2.358	0.000
Not applicable	14.955	3.171	0.000
Mother's Education (No school)			
Primary or lower secondary	-4.804	1.860	0.010
Lower secondary	2.981	1.824	0.102
Upper secondary	14.348	1.823	0.000
Post-secondary non tertiary	20.772	1.928	0.000
Associate/Occupational	25.568	1.969	0.000
Bachelor's degree	33.226	1.905	0.000
Beyond	42.726	2.007	0.000
Not applicable	3.377	3.273	0.302
Test Language Spoken at Home (Always or almost always)			
Sometimes	-2.148	0.553	0.000
Never	-14.470	1.120	0.000
Own Room at Home (Yes)			
No	4.294	0.472	0.000
Internet Connection at Home (Yes)			
No	-18.207	0.662	0.000
Teacher Characteristics			
Teacher gender (Female)			
Male	-5.097	0.610	0.000
Teacher age	-0.182	0.377	0.629
Years Teaching	0.066	0.040	0.099
Teacher education (Not completed)			
Lower secondary	15.423	4.735	0.001
Upper secondary	15.966	4.842	0.001
Associate/Occupational	19.398	4.781	0.000
Bachelor's degree	22.018	4.705	0.000
Master's degree	23.113	4.754	0.000
Math Major (Yes)			
No	-0.021	0.568	0.971
Math homework assigned			
No math homework assignment	-2.076	2.736	0.448
Less than once a week	-16.026	2.109	0.000
1 or 2 times a week	-0.761	1.077	0.480
3 or 4 times a week	-3.384	0.968	0.000
Every day	-0.636	0.966	0.510

Math Score	Coef.	Std. Err.	P> t
Evaluate-Student achievement (Yes)			
No	0.858	0.665	0.197
Number of students in class	-0.305	0.044	0.000
Math instructional hours/week	1.239	0.178	0.000
School Characteristics			
Total enrollment of students	0.005	0.000	0.000
Economic Disadvantaged Student% (0-10%)			
11 to 25%	-5.867	0.531	0.000
26 to 50%	-13.408	0.665	0.000
More than 50%	-19.192	0.778	0.000
School Location (Urban)			
Suburban	-0.201	0.694	0.773
Medium-size city	-0.081	0.645	0.900
Small town	0.175	0.685	0.798
Remote rural	-0.005	6.302	0.999
rural#idcntry			
Azerbaijan	21.481	9.537	0.024
Australia	-7.897	17.666	0.655
Chinese Taipei	-15.926	7.259	0.028
Finland	5.363	7.014	0.445
Georgia	12.517	10.498	0.233
Germany	21.495	7.682	0.005
Hungary	-48.133	11.404	0.000
Iran, Islamic Rep. of	-19.274	8.107	0.017
Ireland	19.082	7.537	0.011
Italy	6.330	7.136	0.375
Lithuania	8.746	23.333	0.708
Malta	9.127	11.566	0.430
Morocco	51.763	11.949	0.000
Oman	-15.341	8.720	0.079
Norway	6.198	7.229	0.391
Poland	-0.153	7.427	0.984
Portugal	71.938	21.119	0.001
Qatar	-18.231	14.816	0.219
Romania	-19.090	8.346	0.022
Russian Federation	-7.447	7.172	0.299
Saudi Arabia	-43.566	10.091	0.000
Spain	25.939	19.881	0.192
Sweden	5.871	7.118	0.409
United Arab Emirates	-0.943	7.223	0.896

Math Score	Coef.	Std. Err.	P> t
Country			
Australia	45.099	2.578	0.000
Chinese Taipei	96.522	2.209	0.000
Finland	42.478	2.363	0.000
Georgia	-36.221	2.308	0.000
Germany	51.888	2.275	0.000
Hong Kong SAR	131.081	2.264	0.000
Hungary	53.935	2.252	0.000
Iran, Islamic Rep. of	1.174	2.359	0.619
Ireland	51.813	2.396	0.000
Italy	45.294	2.753	0.000
Lithuania	52.343	2.191	0.000
Malta	39.119	2.401	0.000
Morocco	-71.730	2.901	0.000
Oman	-65.917	2.344	0.000
Norway	1.021	2.564	0.691
Poland	9.704	2.293	0.000
Portugal	64.438	2.386	0.000
Qatar	-65.316	2.565	0.000
Romania	28.707	2.578	0.000
Russian Federation	47.162	2.368	0.000
Saudi Arabia	-53.249	2.422	0.000
Singapore	107.803	2.278	0.000
Slovak Republic	27.120	2.280	0.000
Spain	3.728	2.314	0.107
Sweden	11.227	2.380	0.000
United Arab Emirates	-48.106	2.168	0.000
Northern Ireland	107.490	2.978	0.000
Cons	401.866	8.201	0.000

Note: There are 105,348 observations in the model, where the R^2 is 0.5456.