THE EFFECT OF SCHOOL SPENDING ON THE QUALITY OF SECONDARY EDUCATION IN UKRAINE

by

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Abstract

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This study examines the effect of school spending on the results of External testing of graduates from Ukrainian schools, using the school-level data in 2016 and 2017. The effect of spending per pupil is highly significant in urban areas and has a hump shape form. However, in rural areas it is insignificant in 2016 and is significant only in some specifications in 2017. We also find that specialized schools such as gymnasium or lyceum in urban area are the best performing schools in Ukraine, while schools in rural areas having a low number of students and low average class size show the worst performance. In the process of reforming the secondary education, policymakers should take the priority attention to the school network. Small schools with a very small class size are not competitive and students from that schools show bad results of external testing, even in urban areas. That is why the optimization of the school network and creation of base schools are necessary steps to improve the quality of secondary education in Ukraine.

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GLOSSARY

TIMSS. Trends in International Mathematics and Science Study

GDP. Gross domestic product

OECD. The Organisation for Economic Co-operation and Development

PISA. Program for International Student Assessment

EIT. External independent testing

OLS. Ordinary least squares

IV. Instrumented variables

MoES. Ministry of Education and Science

Chapter 1

INTRODUCTION

The government of Ukraine spent 222 billions of UAH for education in 2018, which comprises 6.7% of GDP. This percentage is one of the highest if compared to OECD countries, at the same time Ukraine has below average level of education performance according to international estimation Trends in International Mathematics and Science Study (TIMSS).

Ukraine is in its active process of reforming the post-soviet system of education, including secondary education that plays a key role in developing of skills (Jayaram et. al(2013). There is a new law "On Education" that creates new opportunities to drive changes. There is also a draft law "On Secondary Education" that will bring new conceptual rules for education of students in schools. It gives an opportunity to increase the efficiency of secondary education.

However, there are the policy issues that should be addressed to make reforms successful. Ukraine has 16,180 schools, a large part of which are small rural schools. Financing per pupil in these schools is several times higher than in urban areas, but according to the research of Sondergaard et al. (2018) graduates of small schools in Ukraine have the worst test scores.

The new law "On Education" obligates to raise teachers salaries to 4 times the minimum wage by 2023, which could be very challenging for the financial stability in Ukraine. The number of students per teacher in Ukraine is 8.9, while in OECD countries the average is 13.1. According to Sondergaard et al. (2018)

implementing a new law increases spending for education from 7% of GDP to 8.8%.

Policy optimization of schools network and teacher's staff should be implemented for the successful educational reform. The critical variable here for policymakers is financing per pupil. There is no evidence what should be the optimal level of finance that would maximize the educational performance of schoolchildren, but this knowledge could have a significant impact for the process of optimization.

Several methods can be used to evaluate learning outcomes of children at school. There are such international tests as the Program for International Student Assessment (PISA) and Trends in International Mathematics and Science Study (TIMSS). Ukraine takes part in PISA in 2018, but the results will be available only in 2019. TIMSS was conducted in Ukraine in 2011 and showed the below average country level performance.

This study aims at estimating the effect of school spending on performance of schools. That is why, the best statistic to be used as a proxy for educational performance of schoolchildren is a test unified for everyone, adapted for Ukraine. The data are available by school level and with a high level of pupils' participation. The one possible option for Ukraine is External independent testing (EIT) on Ukrainian language, Mathematics, History of Ukraine.

Considering the described policy issues and available data, our research question is whether high spending per pupil is related to higher EIT results. Increasing teachers' salaries will significantly increase spending per pupil because labor cost is around 75% of school's expenditures. According to the contemporary research that we explore in the next Chapter, there is an positive effect for results of students of increasing the teachers' salaries, but it depends on the capacity of schools.

Consequently, we try to estimate the effect of increased spending for different types of schools and the optimal amount that will maximize the performance for both rural and urban areas, but more importantly for rural areas.

My thesis consists of the following blocks. Chapter 1 explains the issues of reforming secondary education and how the results of our paper can assist in the process. Chapter 2 describes the evidence about factors of school outcome such as competition, quantitative characteristics of school and spending. The methodology of the thesis is in Chapter 3 and Chapter 4 outlines the data of our research. The results of the paper are distinguished in Chapter 5. Chapter 6 has the policy recommendation and overall conclusions.

Chapter 2

LITERATURE REVIEW

The factors, affecting the quality of education, are always relevant issues for policymakers and researchers. And the most popular factors for investigation are competition, the quantitative characteristics of schools (number of students, teachers, etc.) and school spending.

According to the papers, there is no considering point about the effect of competition among schools. On the one hand, there is some empirical evidence that competition increases productivity, particularly in the paper of Hoxby (2003) the author says that if all the schools in the US had a traditional form choice, it would increase productivity by 28 percent. MacLeod et al. (2015) partially agreed with this, but on condition of restricting selection.

Clark (2009) found that schools in Great Britain that became autonomous had improvements in a score of students. The magnitude of that effect is 0.25 from standard deviation.

But in the case of competition the autonomy of schools is necessary but not enough. There also should be the choice for parents and children. And one way of implementing that policy is a voucher system. McMillan (2003) claims that the establishment of uniform voucher reduced the quality of public schools because the rational behavior of schools was lowering the cost. That is why, the efficient way of using vouchers is to make them non-uniform, using information about personal and community endowment. Particularly, a coupon for households in the lower percentile of income has the most effect. Therefore, introducing a policy of self-selection creates incentives for people to move from public to

private schools if they seek less intensive study. It can increase the results of public schools because weak pupils leave (Hsieh et al., 2006).

On the other hand, competition could hurt school performance. Using an example of education reform in Poland, we can see that introducing autonomy for schools has a significant adverse effect. However, according to the paper Bukowski and Kobus (2018), this effect is not far-reaching in magnitude.

After all, MacLeod et al. (2012) conclude that competition has a mixed effect in case of productivity and it depends on individuals' outcome at the school level.

The second common factor in the papers – quantitative characteristics of schools. This includes class size, school size, number of teachers and other similar components. The results of paper based on the developed countries data are opposed to the transition countries results in general. For instance, California spent more than billion dollars to reduce class size. Jepsen and Rivkin (2009) used a comparing analysis to see the direct effects of the program. A class with fewer students shows better performance in reading and math. Furthermore, there is an unequal distribute effect across grades. The class size reduction increased the performance for early grades the most.

Fredriksson et al. (2011) get similar results for Sweden. Small Swedish classes are better for developing cognitive skills and even non-cognitive. They also find that the class size has a rate of return on future wage of around 20%, which is the most influential factor in the long term.

However, the paper of Eide et al. (1997) claims that it is not right to use estimation approaches based on OLS and IV, we need to see the effect on different quantiles. The data for the US show that a student-to-teacher ratio has a sizeable adverse impact on the score in 0.05 quantile, and very small for the 0.95

quantiles. So, by increasing the number of teachers at school, we will help the pupils with the worst results, but not improve the outcomes of the best students. A recent paper of Leithwood and Jantzi (2009) about schools in the US and Canada determine that smaller schools have a positive impact on young students and also students from the less attractive demographic group.

Nonetheless, as can be seen in developed countries, it is mainly negative relations between the class size and school size. The paper of Coupe et al. (2011) has interesting and not trivial results for Ukraine. Schools with more students have better performance in External testing of Ukrainian language, mathematics, and history. Notwithstanding, the size of this effect is not large, especially for rural areas, where self-selection bias is absent. Results of the paper suggest that school size should have a small positive effect and that the class size has no significant impact on school performance. A finding broadly in line with what was found for other developing countries. Coupe et al. (2011) also use the quantile model for estimating the effects. The difference between 25th percentile and the 75th percentile of school size is 4 points of External testing on average.

And the most recent study on Ukraine of Sondergaard et al. (2018) suggests that there should be a substantial impact of school size and teacher-to-classroom ratio for school performance. In particular, this effect is large in magnitude for a lower percentile of performance. Adding by 0.42 teacher (1 st. dev.) to each classroom will increase students' performance for schools in 8th percentile by 2.5 points of EIT on average.

Similar results have been found in other studies on transition countries. For example, Kallai and Maniu (2004) found a small positive effect of school size in Romania, but the impact of class size was also insignificant. However, Herczynski and Herbst (2005) show that the class size has a positive effect for results in

Poland. There is the same sign in the context of class size in papers of MacDonald et al. (2009) about Serbia and Asadullah (2005) about Bangladesh.

The third and the most common factor in the papers is school spending. Most of the works use the US data spending, due to the availability of the data and the possibility of implementing the results. Furthermore, we could see some similar patterns in all papers about resource spending.

Diane et al. (2003) explore in details the school spending in 4 US states: Arkansas, Texas, New Mexico, and Louisiana. They compared low- and high-income districts in these states and found that higher spending on core expenditures and instructions increase the productivity of schools in low-income communities by a high magnitude.

Chaudhary (2007) get similar results, using the data from the finance reform in Michigan schools, where the main component was to increase teachers' salaries. Analyzing test scores in mathematics in the 4th and 7th grade, she found that increased spending by 60% drove the performance by one standard deviation.

From the other side, Verhoeven et al. (2007) reveal that high wages for teachers correlate with lower efficiency in G7 countries. Uniform increasing the number of teachers will not undoubtedly support the rise of performance results. The authors conclude that policymakers should consider the capacity (class size, number of students in schools, etc.) for maximizing the efficiency of such a policy.

The recent paper of Kirabo et al. (2015) analyzed the reform of education in all states of the US of 70-s and 80-s and 2000-s. They found that an increase in per-student spending by 10% had a significant positive effect on completed years of education, future wages, and health factor. As in previous studies, the effect is

more substantial for children from low-income families. The results also showed that such school inputs as a student-to-teacher ratio and teacher's wages were associated with increasing per-pupil spending. In the context of an efficient way of spending, they found that a 25% increase in per-student spending would narrow the gap between pupils from low- and high-income families.

One of the fundamental papers in the case of a contribution of spending to schools is the paper of Hanushek (1997). He made a meta-analysis of 400 studies of students achievements in the US and found that they were controversial. For example, there are three times more papers suggesting that expenditures per pupil had rather positive effect than negative. Simultaneously spending per pupil in the US raised by 70% for 20 years (from 1970 to 1990), but there was no significant increase in student performance. He also makes a conceptual remark that the effect of spending on performance has no sense without analyzing the goals of student results and how the goals are achieved. That is why, it is hard to compute the optimal resource allocation in education spending.

As result, we use as base papers for our thesis – the study of Coupe et al. (2011), where we get the basic model approach, Sondergaard et al. (2018), where it is the improvement of the basic model of Coupe et al. (2011) and also quantile model. Kirabo et al. (2015) propose the model for estimation the effect of spending-per-pupil, that we also use in our thesis.

Chapter 3

DATA DESCRIPTION

In this research we use the school-level data of quantitative characteristics of school as the total number of children, classes, teachers, rooms, type of schools, location of school, number of teachers across different ages, different qualification; performance of schools – average results of External testing in school in a particular year in Ukrainian language, Mathematics, Ukrainian history; proxy for school spending per pupil.

We have 9044 observations for quantitative characteristics. 4572 schools in 2016 year and 4472 schools in 2017 year. There are data from all schools in 12 Ukrainian regions, that report the data to MoES and have examinees in 2016, 2017 and 2018 years. There is representative sample to all country according to geographical context. There are western regions (Ivano-Frankivska, Volynska, Zakarpatska), eastern regions (Donetska, Sumska, Dnipropetrovska), central regions (Kyivska, Zhytomyrska, Vinnytska), south regions (Odeska, Kirovogradska, Zaporizhska).

We use quantitative characteristics of school and proxy for school spending per pupil in 2016/2017 and 2017/2018 educational year and performance of schools in 2017 and 2018 year respectively.

There are the following quantitative characteristics of schools: number of teachers, number of classes, number of pupils, percent of teachers-pensioners, percent of teachers before 30-year-old, a type of schools, the location of school, average class size and teacher-to-classroom ratio. More details about mentioned above variable are located in Table 1.

Table 1.Descriptive statistics of quantitative characteristics of school for 2016 2017 years.

Stat/ Variable	Total teachers	Total students	Total classes	Percent of teachers 60plus	Percent of teachers 30bef	Class size	Ratio teacher-to-class
mean	28.65	356.85	12.96	0.12	0.15	18.02	1.69
median	22	240	11	0.10	0.14	18.36	1.63
st. dev.	17.69	315.95	9.53	0.09	0.10	7.18	0.52
min	2	15	1	0	0	4.63	0.43
max	167	2186	121	0.68	1	35.97	12

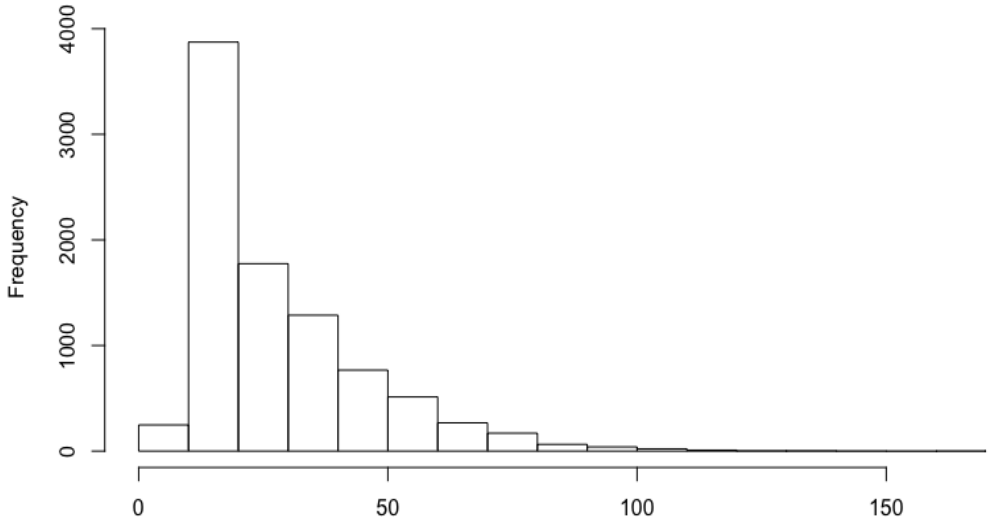

Figure 1.Distribution of total number of teachers in school.

Distribution of the total number of teachers looks very thought-provoking. We can see that the most frequent number of teachers in school are from 10 to 20. There is around half of schools with that range of teachers. The source of the quantitative data is the Ministry of Education and Science (MoES).

The key factor of estimation in our models is financing per pupil. We have relatively large sample of schools for our analysis, and there is no available aggregate info about financial spending per school. There is information about spending in paper form in each municipality authority, however, there is no aggregate info in MoES. That is why, we chose the way of estimation the financing per pupil in schools.

According to Sondergaard et al. (2018), around 74% of spending on secondary education is payroll spending. We estimate the teacher salary spending per pupil by the next algorithm. Teacher's salary depends on the rank and Uniform Tariff Grid. There are 4 groups of teachers who have different income (a teacher without rank, a teacher with 2 ranks, a teacher with 1 rank, a teacher with high-rank).

For estimating the salary for 1 period we divide that for 2 subperiods (from 1 July to 31 December and from 1 January to 31 May). So, the teacher salary spending per pupil (SPP) in period 2016/2017 academic year will look.

$$SPP_{t/t+1} = \frac{\Sigma\left(\left(N_{t,r} \times W_{t,r}\right) \times 0.5 + \left(N_{t+1,r} \times W_{t+1,r}\right) \times 0.5\right)}{NS_t} \quad (1)$$

Where, t – 2016 year; r – rank of teacher; N – number of teachers; W – average income of teacher; NS – number of students.

The same algorithm for estimating the teacher salary spending per pupil in period 2017/2018.

There is different information for the average teacher salary across different categories. That is why we decided to calculate the average teacher salary, knowing the components of a teacher salary. So, according to the law "On Education", "On Budget of Ukraine", Tariff grid we have next formula of teacher salary:

$$Salary = BS(according\ to\ category) + BS \times SWP + BS \times SCW + BS \times SYS + BS \times FPW \quad (2)$$

Where, BS – base salary; SWP - Supplement for the work prestige of work; SCW - Supplement for checking written work; SYS - Supplement for years of service; FPW - Fee for hours of pedagogical workload

Base salary and Supplement for the year of service are different across the category. However, Supplement for the prestige of work and Supplement for checking written works does not depend on the category.

According to the law, supplement for the prestige of work has ranged from 5 to 30 percent. There is a special group that should have a minimum of 20% according to the law. So, we decided to make the one number for all categories – 25%. On the one hand, we assume a normal distribution of supplement for the

prestige of work across teachers, and as support of our decision I made some personal interviews with 5 teachers in different schools (both from rural and urban areas), and the average was around 25%.

Supplement for checking written works is fixed and it is 20%, so we take it by default.

Fee for hours of pedagogical workload are given for teachers, who work more than 18 hours. There are teachers who work 18 hours, but also teachers who work much more than 18 hours. So, consider the answer of interviewing teachers we assume 23 hours working in average.

The formula for calculating fee for hours of pedagogical workload:

$$Fee\ for\ hours\ of\ pedagogical\ workload\ =\ BS \times 23/18 \qquad (3)$$

Where, *BS* – base salary

As is known, supplement for years of service depends on the year of service. The range supplement for years of service has ranged from 0 to 20, however, we have 4 types of the category. The staff without a category has little experience, so our assumption of 0% supplement for years of service is fair.

According to Resolution №78 of the Cabinet of Ministers, we set supplement for years of service for a teacher with 2 categories - 10%, for 1 category – 20%, for high category - 30%.

In the case of base salary, there are exact values according to the Tariff grid. Base salaries are varying across the category and years, so we need representation in table form.

Table 2. Teachers' base salary by rank (UAH), 2016-2018

	2016	2017	2018
Without category	2334	3152	3471
2 category	2512	3392	3735
1 category	2690	3632	4000
High category	2868	3872	4264

Source: Ministry of Finance

Based on Table 2 and assumptions we calculate the Average income of teacher by rank (see Table 3).

Table 3. Average income of teacher by rank (UAH), 2016-2018

	2016	2017	2018
Without category	4032.63	5445.96	5997.12
2 category	4591.38	6199.82	6826.75
1 category	5185.72	7001.69	7711.11
High category	5815.67	7851.56	8646.44

Source: Author's calculation

Now we can calculate spending of teacher salary per pupil (SPP) for each school (Figure 2).

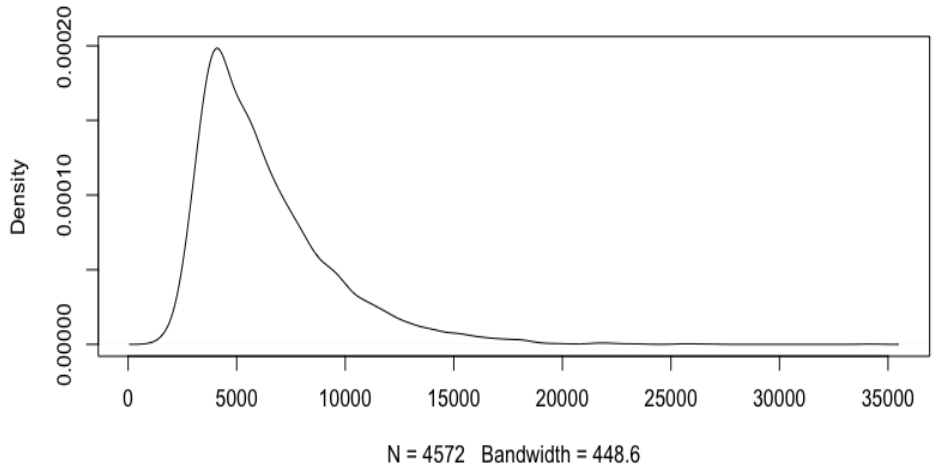

Figure 2. Distribution of spending of teacher salary per pupil (UAH), 2016

The Figure 2 shows some concentration of SPP that can be a reason for heterogeneity, so a logarithm form of SPP will be used, the resulting distribution is presented on the graph. (Figure 3)

The data of the school's performance are based on the open data source of Ukrainian Center for Education Quality Assessment about External testing. We have average results of External testing by school level. There is a widespread opinion that results of External testing are from 100 to 200, but it's not actually true. The range of EIT results is from 0 to 200. A student gets 0 if he/she doesn't pass the minimum score.

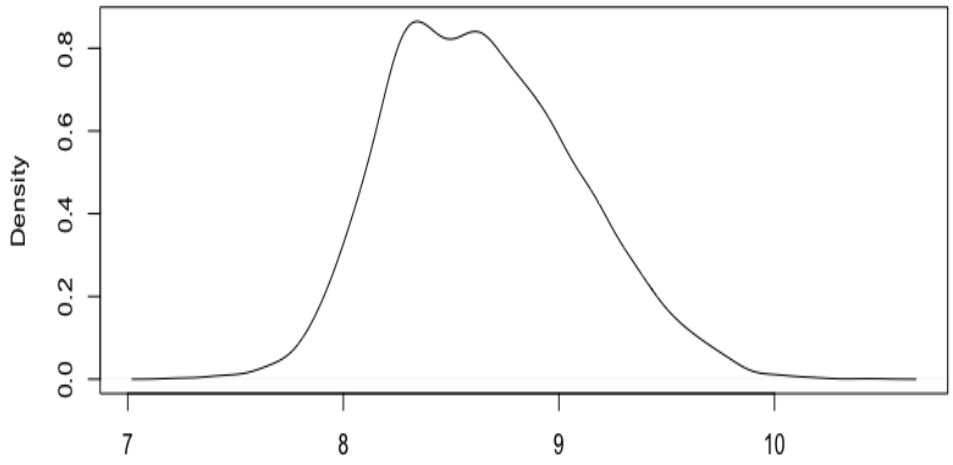

Figure 3. Distribution of logarithm of spending of teacher salary per pupil, 2016

The method of calculating the average score of External testing per school is simple:

$$UkrAvg = SRS/NS \quad (4)$$

Where, *SRS* – Sum of results of each student writing EIT this subject; *NS* – Number of students writing EIT of this subject

So, important here to note, that UkrAvg could be less than 100, because there are students who did not pass the exam, but they are taken into account. For example, there are 3 students in a particular rural school who write External testing in Ukrainian language. Student №1 takes 130 score, Student №2 takes 120 score, Student №3 takes 0 score. So, in this case UkrAvg = 250/3 = 83.3 score.

We assume that there is a normal distribution of failures of students, so we don't make any correction in computation according to that fact.

Table 4 shows the mean, median, standard deviation, minimum and maximum values of the school-average results of External testing across 3 subjects. We can also see the difference between urban schools and rural schools. The results are visible lower for the rural area schools. This table shows us that separate estimation for all population, urban and rural areas is crucial for making the correct conclusion.

Table 4. Descriptive statistics of average results of External testing, 2016

Stat/Variable	Ukrainian language (urban area)	Ukrainian language (rural area)	Math (urban area)	Math (rural area)	Ukrainian history (urban area)	Ukrainian history (rural area)
mean	144.53	123.05	133.03	112.84	132.99	118.15
median	146.09	124.00	134.25	113.00	133.11	118
st. deviation	17.29	20.60	20.56	25.68	15.00	16.21
Min	60.00	20.00	52.88	20.00	66.66	40.00
max	189.85	189	192.00	193.00	183.59	184.00

Chapter 4

METHODOLOGY

Similar to the paper of Coupe et al. (2011) and Sondergaard et al. (2018) I make use of the two models for estimation. The first one is the basic model of OLS with dependent variables such as average EIT results of Mathematics, Ukrainian language and History of Ukraine and explanatory variables such as characteristic of school (type of the school, spending per pupil, number of students, average class size, share of teacher pensioners, share of young teachers, teacher-to-classroom ratio, urban-rural dummy).

The second model is quantile regression. We have the same dependent variables and explanatory variables as in the basic model. However, the effect of each factor on different quantiles of EIT will be observed.

4.1 Basic model

Our main variable of interest is spending per pupil. However, we also estimate the effect of school size, class size, ratio of young teachers and ratio of teacher pensioners, teacher to classroom ratio. They are important from the side of policy implication. Moreover, these factors are also related to spending per pupil. If policy maker decreases average class size it increases the spending per pupil.

We also control for the location (urban dummy) and the type of school. There are factors which policy makers could not influence, but according to Coupe et al. (2011) and Sondergaard et al. (2018) they have a significant impact on External tests results.

External testing (EIT) takes place every year in June, however, the quantitative characteristics of schools are based on information by the start of the academic year (1 September). That is why, in OLS we use all explanatory variables for 2016 and 2017 years and dependent variables for 2017 and 2018 respectively.

Dependent variable – average EIT of Math/Ukrainian language/Ukrainian history:

$$\begin{aligned} EIT_{kt} = F(&\beta_0 + \beta_1 type_{t-1} + \beta_2\, log(spending\ per\ pupil)_{t-1} \\ &+ \beta_3 \log(spending\ per\ pupil)^2_{t-1} \\ &+ \beta_4 schools\ size_{t-1} + \beta_5 class\ size_{t-1} \\ &+ \beta_6 ratio\ of\ young\ teachers_{t-1} \\ &+ \beta_7 ratio\ of\ teacher\ pensioners_{t-1} \\ &+ \beta_8 urban_{t-1} + \beta_9 teacher - to \\ &- classroom\ ratio_{t-1}) \end{aligned} \quad (5)$$

Where, *β0* – intercept; *type* – 1 if specialized school/gymnasium/lyceum, 0 – otherwise; *spending per pupil* – spending per pupil for teachers' salary in school for 1 year in UAH; *school size* – number of students in school; *class size*– average number of pupils in class; *share of young teachers* – share of teachers under 30 years in the total number teachers in school; *share of teacher pensioners* – share of teachers after 60 years in the total number teachers in school; *urban* – 1 if urban area, 0 – otherwise; *k* – Math/Ukrainian language/Ukrainian history; *teacher-to-classroom ratio* – number of teachers per one class in school.

We estimate the model separate for the rural area sample, urban area sample and for all schools and also estimate the model just for 1 year (separate for 2016 and 2017).

I expect the positive sign (Table 5) for type dummy variable, because gymnasium, lyceum and specialized school in general prepare more advanced pupils. I also expect positive sign for school size and class size, because it a source of competition inside of schools. Urban dummy will have positive sign, because we already saw the average results of EIT in urban and rural areas. However, the most interesting results I expect from spending per pupil. There is intuitive expectation, that's more money associated with better results, but it could be non-intuitive findings.

Table 5. Expected sings for explanatory variables.

Variable	Expected sign
type	+ (for type=1)
Log(spending per pupil)	+ (for all sample, for urban area)
	- (for rural area)
school size	+
class size	+
ratio of young teachers	+
ratio of teacher pensioners	-
urban	+
teacher-to-classroom ratio	-

4.2 Quantile model

The basic model shows us a partial effect of each factor variation for an average school. However, we are more interested to see the effect for a different school (good/bad performed). In the paper of Eide et al. (1997) the authors discussed the effect of increasing the number of teachers for different size of schools. So, the quantile method is also appropriate for our research question.

Model of quantile regression:

$$Min \sum_{n:Yn \geq Xn\beta} \theta[Y_n - X_n\beta] + \sum_{n:Yn < Xn\beta} (1-\theta)[Y_n - X_n\beta] \qquad (5)$$

Where, *Yn* – dependent variable (*EIT ukr, EIT math, EIT hist); Xn* – vector of explanatory variables (*type, spending per pupil, school size, class size, number of teachers, number of teacher pensioners, urban);* β – coefficient vector; θ – quantile to be estimated

In our model the step of 0.1 percentile is used. The question arises, what exactly quantile regression shows us. For example, we can see how increasing the number of teachers by 1 unit in school of 0.1 percentile of UkrAvg distribution could increase the results of UkrAvg particularly for this school. These results are more useful for policymakers in particular.

Chapter 5

RESULTS

5.1 Basic model

Our estimation procedure consists of several steps. At first, we run the basic model with all exoplanetary variables in model separate for Ukrainian language.

(1) model is for all samples (urban and rural) for 2016 year; (2) model for all samples (urban and rural) for 2017 year; (3) model for urban area for 2016 year; (4) model for urban area for 2017 year; (5) model for rural area for 2016 year; (6) model for rural area for 2017 year;

After running the models, we can see the first non-intuitive results. At first, we see that spending per pupil are significant in 5 from 6 models. WE have "+" sign in simple form and "-" sign in quadratic form.

An interesting case, that log(SPP) for the rural area, is an insignificant in 2016. This could mean, that increasing of spending is less important for the rural area. However, it's much more important school size, class size and teacher-to-classroom ratio for rural area. It could be explained by the fact that in urban areas there is a competition between better qualified teachers, so school hunts for the most qualified and experienced teachers. So, the spending factor play more important role. From the side of rural area, there is no competition between teachers, but there are a lot of small schools, and that means no competition between students and less knowledge flow between them (MacLeod et al. (2012)). That is why, increasing of school size and class size could have a significant role in the case of improving performance.

Table 6. Results of 6 models for EIT on Ukrainian language as a dependent variable, 2016-2017

	All samples, 2016	All samples, 2017	Urban, 2016	Urban, 2017	Rural, 2016	Rural, 2017
log(SPP)	45.34*	81.21***	126.4*	161.4**	38.02	92.08**
	(2.44)	(3.32)	(2.05)	(2.66)	(1.30)	(2.94)
$\log(SPP)^2$	-1.969	-3.723**	-6.611	-8.171*	-1.742	-4.585**
	(-1.81)	(-2.70)	(-1.71)	(-2.20)	(-1.04)	(-2.61)
class size	1.263***	1.549***	0.957***	1.189***	0.838***	0.861***
	(10.75)	(11.81)	(4.13)	(5.10)	(4.17)	(3.76)
teacher-to-classroom	-3.832***	-5.662***	-2.760	-5.389	-3.001*	-3.664*
	(-4.40)	(-5.60)	(-1.02)	(-1.83)	(-2.38)	(-2.54)
school size	0.0154***	0.0150***	0.0160***	0.0147***	0.00546	0.00872*
	(11.36)	(11.04)	(10.83)	(10.52)	(1.36)	(2.15)
ratio young teachers	-6.577*	-11.31**	-2.994	-7.924	-8.028*	-12.66**
	(-2.18)	(-3.16)	(-0.53)	(-1.16)	(-2.19)	(-3.01)
ratio pensioners	-5.796	-10.07**	-15.36***	-16.81***	-1.549	-7.456
	(-1.95)	(-3.00)	(-3.54)	(-3.65)	(-0.40)	(-1.78)
school type	13.43***	12.54***	12.19***	11.99***	8.494***	7.830***
	(14.54)	(12.64)	(12.10)	(11.28)	(4.02)	(3.80)
N	4571	4471	1636	1581	2935	2890
R^2	0.29	0.27	0.32	0.31	0.04	0.04

Type school dummy are positive and significant in all samples, so we can conclude that studying in lyceums, gymnasiums and specialized schools really matter in the case of EIT results.

Another interesting result is that the ratio of pensioners teachers are significant and negative in urban area, however, ratio of young teacher are significant and negative in rural area. It runs counter with our expectations. However, there are several reasons for that. The best young teacher goes to urban schools, however the worth goes to rural schools. That is why ratio of young teacher are not significant in urban samples. On the other hand, in urban schools' students demand for more progressive and interactive studying. That is why if there are a lot of pensioners in urban school, parents and children will not chose that school with high probability. This self-selection creates the situation when ratio of pensioners has very significant and high in magnitude negative effect on the performance of students. But it is a question for further papers for the finding the truth reason of our estimation results.

Teacher-to-classroom ratio are not significant for urban samples but are significant for rural area. There are negative relation with EIT results in rural area. More teacher per class in rural schools associated with lower performance of students, that is something counterintuitive.

Then, we estimate the same model for Math and Ukrainian History as the dependent variable.

Table 7. Results of 6 models for EIT on Math as dependent variable.

	All samples, 2016	All samples, 2017	Urban, 2016	Urban, 2017	Rural, 2016	Rural, 2017
log(SPP)	95.87***	63.19*	158.2**	160.7**	58.63	3.009
	(3.70)	(2.28)	(2.72)	(2.71)	(1.51)	(0.08)
log(SPP)^2	-4.728**	-2.750	-8.385*	-7.935*	-2.704	0.378
	(-3.14)	(-1.75)	(-2.30)	(-2.22)	(-1.21)	(0.17)
class size	1.453***	1.502***	1.016***	1.438***	1.236***	1.257***
	(8.84)	(9.08)	(4.03)	(5.49)	(4.74)	(4.36)
Teacher-to-classroom	-3.737**	-3.634*	-1.278	-4.898	-4.500**	-3.215
	(-2.62)	(-2.37)	(-0.48)	(-1.79)	(-2.72)	(-1.68)
school size	0.0144***	0.0140***	0.0153***	0.0154***	0.00762	0.00419
	(8.67)	(8.81)	(8.72)	(9.14)	(1.49)	(0.86)
ratio young teachers	3.540	-5.311	-3.685	-0.203	6.022	-5.867
	(0.89)	(-1.18)	(-0.55)	(-0.03)	(1.24)	(-1.11)
ratio pensioners	-4.361	-8.165*	-7.833	-4.874	-3.381	-9.778
	(-1.08)	(-2.02)	(-1.41)	(-0.86)	(-0.66)	(-1.85)
school type	11.53***	12.11***	12.51***	12.71***	0.519	6.294*
	(9.69)	(10.46)	(10.11)	(9.44)	(0.19)	(2.49)
N	4303	4155	1625	1576	2678	2579
R^2	0.21	0.20	0.25	0.25	0.03	0.04

There are a lot of variables not significant in the Math case. It could be partially explained by the fact that Math is not high demand subject to EIT in rural area (Math is not obligate EIT subject, unlike Ukrainian language) and it could be just one student in school that take the Math. It means that there are a lot of factors that are influenced just for one student, so our model is not explain a lot in rural area. The proof of that is quite low of R-square.

Our key variable – spending per pupil are not significant in rural area. This partially supports our hypothesis that spending per pupil is less meaningful for school performance in rural area. There are significant in urban area with positive sign for log(SPP) and with negative sign for quadratic form. It is similar for model with Ukrainian language as dependent variable. However, the rural results show that there is no effect on performance of spending per pupil.

One variable is significant in all 6 models. Coefficient of class size has positive sign and relatively high in magnitude.

For rural area in 2016 year there is also significant teacher-to-classroom ratio. With more teacher per class there is low performance, that is echoed with result of UkrAvg model. If it is a more teachers per class in rural area from year to year it does not mean increasing number of teachers in schools, more often it is decreasing the number of classes in school. So, this surprising result could also be explained by low competition between teachers and pupils in rural area.

In the model with dependent variable Ukrainian History there is spending's per pupil being insignificant in 2016 year for rural area and significant for 2016 year.

Table 8. Results of 6 models for EIT on Ukrainian History as dependent variable.

	All samples, 2016	All samples, 2017	Urban, 2016	Urban, 2017	Rural, 2016	Rural,2017
log(SPP)	33.08*	67.39***	88.52	134.6**	4.932	57.58**
	(2.11)	(4.29)	(1.75)	(3.25)	(0.21)	(2.69)
$log(SPP)^2$	-1.369	-3.211***	-4.270	-6.846**	-0.002	-2.878*
	(-1.49)	(-3.61)	(-1.35)	(-2.74)	(-0.00)	(-2.39)
class size	0.864***	0.978***	0.913***	0.883***	0.449**	0.519***
	(9.01)	(10.13)	(4.88)	(5.27)	(2.76)	(3.31)
Teacher-to-classroom	-2.296**	-3.304***	-3.215	-3.756*	-1.151	-1.953*
	(-3.18)	(-4.32)	(-1.56)	(-2.06)	(-1.08)	(-1.98)
school size	0.0117***	0.0103***	0.0112***	0.0101***	0.00405	0.00520
	(10.19)	(9.94)	(8.82)	(8.76)	(1.27)	(1.88)
ratio young teachers	-3.587	-3.285	-1.503	-1.385	-4.588	-3.974
	(-1.47)	(-1.31)	(-0.32)	(-0.28)	(-1.56)	(-1.38)
ratio pensioners	-3.544	-6.176**	-11.15**	-8.856*	-0.314	-5.354
	(-1.41)	(-2.71)	(-2.85)	(-2.53)	(-0.10)	(-1.85)
school type	10.49***	9.129***	9.616***	9.106***	5.804***	5.042***
	(13.12)	(12.24)	(10.41)	(10.64)	(3.47)	(3.59)
N	4542	4434	1634	1579	2908	2855
R^2	0.23	0.24	0.27	0.27	0.02	0.03

So, after 3 model with 3 different dependent variables we find that spending per pupil are significant for urban area with positive sign for log(SPP) and negative sign for quadratic form. However, we find that spending per pupil are not significant in general for rural area, excluding 2017 year for HistAvg and UkrAvg model. So, we want to see this effect in detail in quantile model.

We also did the postestimation test for heteroskedasticity. For all samples and urban sample, we found heteroskedasticity, so we use robust of errors for them.

5.2 Quantile model

In the basic model we find that there is no clear effect of spending per pupil on performance in rural area. In the 2016 there is no effect, however in 2017 it is.

We use quantile model to estimate the effect in detail, comparing primary with 2 key variables as class size and teacher-to-class ratio. There are significant variables in rural area for almost all models.

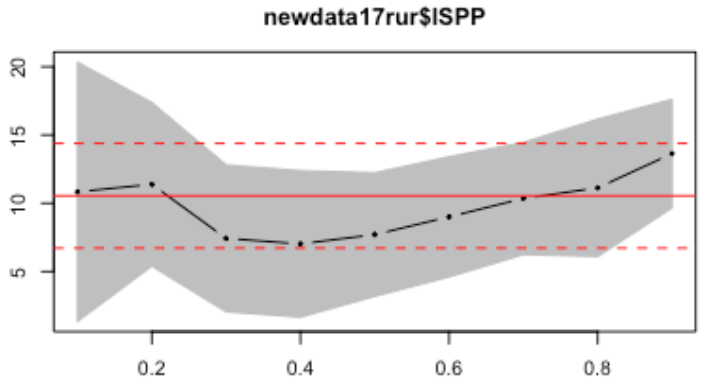

Figure 4. Effect of spending per pupil in different percentile of UkrAvg.

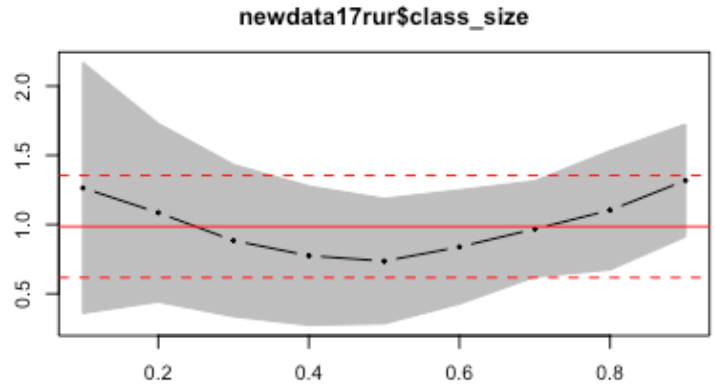

Figure 5. Effect of class size in different percentile of UkrAvg.

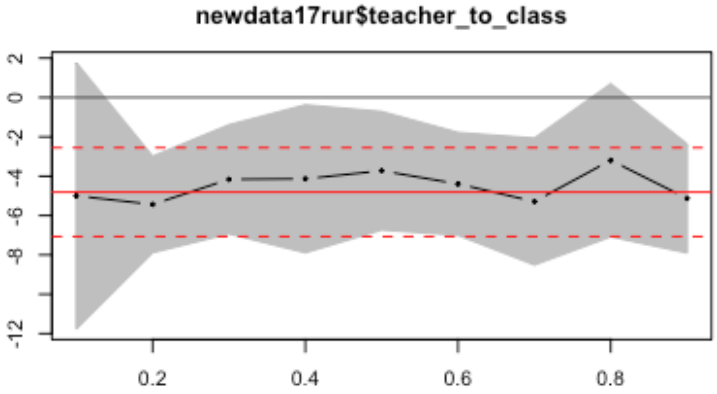

Figure 6. Effect of teacher-to-class ratio in different percentile of UkrAvg.

We see, that log(SPP) is significant almost in all percentile. That is mean that spending per pupil is matter for result of Ukrainian language EIT in 2017 for rural area. However, there is interesting hump-shape relation. For average performed school the magnitude of effect is lowest, and for the best performed school the magnitude is the largest.

Take a look some small and bad performed rural school. Even small increasing of spending should have some effect on the performance, because it could be 1 teacher for 2 or even 3 subjects. For average rural school the additional amount of spending has less marginal effect. And for example, for base school (Oporna school) increasing spending could mean increasing of school size, so the results look quite logical.

The variables class size and teacher-to-classroom ratio are also significant almost in all percentiles. Moreover, there is also hump-shape relation in class size. The class size matter more for the worst and best performed schools, where teacher-to-classroom have constant negative effect.

Chapter 6

CONCLUSIONS

In this paper we estimate the effect of school spending per pupil on the performance of graduates from Ukrainian schools in 2016 and 2017. Our dependent variables are external testing from Ukrainian language, Mathematics and Ukrainian history, while explanatory variables include spending per pupil in the school, number of students, average class size, the characteristics of pedagogical and other quantitative characteristics of schools.

This study shows that our results are not intuitively expected at all. The main finding is that payroll spending per pupil has a little relation to results of external testing in a rural schools. At the same time spending per pupil in urban schools has a significant relationship with performance almost in all specifications. Higher payroll spending per pupil in urban area is related to higher EIT results before an optimal point, after that the higher payroll spending per pupil is associated with lowering the result.

Furthermore, there are other unexpected findings. Namely, a larger share of young teachers in rural schools is negatively associated with EIT results of graduates. It could mean that we have some problems with pedagogical education for the last years. We also checked the relationship between the share of pensioners in schools and EIT results of graduates and found the significant negative relationship in the urban sample but not in the rural one. So, young teachers has negative effect on performance in rural area and old teachers has negative effect in urban area.

A school type dummy is significant in all samples and specifications. It implies that graduates of specialized schools and gymnasiums are better prepared for

exams due to self-selection of students and their parents. Students with better preparation before schools have more chance to get the place there.

The next interesting issues is a class size. In our model it is the main factor for performance in rural areas. That is why policymakers should care about those factors more than about increasing the number of teachers or spending per pupil in general. Moreover, increasing class size help the reduce school spending per pupil. According to our estimation results for 2017 for all schools (both rural and urban), a school with 1 more pupil in the class had better EIT Ukrainian language results on average by 1.54 points from 200. The similar effect has an increase in the number of students in school. A school with 100 more pupils had on average 1.5 points more in EIT of Ukrainian language.

These findings can be a good guidance for the Ministry of Science and Education in the process of implementing the new Law "On education". The policymakers can use the optimum level of spending per pupil as policy threshold. Our findings suggest that a small school with a small class is not just costly for communities, but it creates a non-competitive environment. And a non-competitive environment is one of the reasons for bad performance of students. That is why the study can also be a guide for local communities that have small schools.

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