School Financing, Teacher Wages and Educational Outcomes: Evidence from the Russian School System

Olga Lazareva and Andrei Zakharov[1]

Abstract

In this study we test how the level of financial resources available to schools and relative teacher wages affect educational outcomes. Russia provides a good opportunity for testing this relationship due to its high level of regional heterogeneity. We estimate these effects for two different measures of educational outcomes at different levels of school system: high stakes compulsory state exams taken by all high school graduates and international assessment tests administered to the students at the end of their compulsory part of school education. We find that the level of school financing does not have any significant effect on student outcomes. At the same time, the level of relative teacher wages has significant positive effect on both test scores. This result is robust to instrumenting relative teacher wages with regional minimum wage levels. We also provide some tentative evidence on the possible channels of this effect.

Keywords: school financing, teacher wages, educational outcomes, Russia

JEL codes: I22, J31, P36

[1] National Research University Higher School of Economics, Moscow, Russia. Corresponding author: Olga Lazareva, e-mail: olazareva@hse.ru

1. Introduction

School education is a complex and multifaceted process and its measurable educational outcomes are affected by many different factors. These may include students' innate abilities and family resources as well as various characteristics of school environment and teaching practices. One of the important factors influencing student achievement discussed in the literature is the level of school financing by the state. This is also one of the key issues in the debates about the public policy in education. However, there is no consensus in the academic literature about the effect on performance of more financial resources available to schools.

The effect of school financing should depend on how this money is spent. Since education is a human capital intensive sector a major portion of funds allocated to education are spent on teacher remuneration. Whether the size and structure of teacher remuneration influences teacher quality and efforts, the effectiveness of teachers' work and ultimately their students' outcomes is still an open question. There are a number of studies showing positive effect of higher teacher pay on teacher quality. Hendricks (2015) shows that higher teacher wages help schools to retain and attract more experienced and effective teachers. Leigh (2012) finds positive effect of teacher pay on teacher academic aptitude.

Some studies argue that it is not absolute but relative teacher wages that affect teacher quality and student educational outcomes. Hanushek et al. (2018) show that the relative position of teachers in the wage distribution affects self-selection into the teaching profession in terms of skills and that teacher skills affect student outcomes. Carnoy et al. (2009) also test the relationship between income inequality, relative teacher wages and student performance.

The purpose of our study is to test how both the absolute level of financial resources available to schools and relative teacher wages affect educational outcomes. Russia provides a good opportunity for testing this relationship for two reasons. First, school financing in Russia is decentralized. Much of the financing for schools comes from regional and municipal budgets. Due to its vast territory, Russia is characterized by significant diversity in economic and social conditions at the regional level. The eighty-five Russian regions vary considerably both in school resources and in educational outcomes. Regional inequality in economic conditions may also significantly affect educational

outcomes in addition to their effect on outcomes via school resources. Second, during the period that we study there were a number of significant changes in the educational sector. Specifically, there was a successful effort to increase the absolute level of the education budget, and, in addition, the presidential decree of 2012 set a goal of raising teacher wages to the level of average regional wages. This can be considered an exogenous shock to the size of relative teacher wages.

To test the effect of school financing and relative teacher wages, we compile the regional-level data for all Russian regions in the period of 2006-2014. As a measure of educational outcomes we take students' regional average scores on the Unified State Examination (USE). The USE has been a mandatory test for all high school graduates in Russia since 2009. We also use individual-level data from several rounds of the PISA international student assessment study. We estimate the effects of regional characteristics on educational outcomes measured by these tests. Our identification strategy relies on a fixed effects panel data model as well as an instrumental variables model where we use institutional features of teachers' labor markets to construct an instrument.

There is a long-standing debate in the literature on whether and how various school inputs including school financing affect students' educational outcomes. Empirical studies trying to answer these questions include cross-countries comparisons as well as within-country studies exploiting variation across regions or across time. In a recent survey Hanushek and Woessmann (2011) state that international evidence on the effect of school expenditures on student outcomes is weak. More robust cross-national evidence pertains to the positive effects of teacher quality and to the institutional features of school systems that affect incentives. Within-country studies also show a mixed picture. For example, Woesmann (2007) finds no significant effect of school spending on student performance in Germany, while Jackson at al. (2016) utilize a quasi-experimental setting in the US to show robust positive effects of increased school spending. They find that the positive effect was much more pronounced for children from low-income families. Similar effects of US school financing reforms on low income school districts are found in Lafortune et al. (2018). Lavy (2012) estimates positive effects of the reform in Israel that increased school financing on student outcomes. Quasi-experimental studies in Chile also show a positive effect on low-income students' learning gains from increasing the size of the voucher awarded to such students (Murnane et al. 2017).

There are also studies looking at the effect of teacher wages on educational outcomes. Loeb and Page (2000) stress that it is important to take into account alternative wage opportunities for teachers when estimating the effect of teacher wages on student performance. That is, one should look at the effect of relative teacher wages. Accounting for this, they find a significant negative effect of teacher wages on school dropout rates in US. Britton and Propper (2016) exploit centralized regulation of teacher wages in UK to test their effect on school performance. They find a positive effect of relative teacher wages on the educational results of school graduates.

Our approach is similar to these two studies in the sense that we also exploit spatial variation in educational resources to identify their effect on student outcomes. We test and compare the effects of school budget financing and relative teacher wages. We estimate these effects for two different measures of educational outcomes at different levels of school education system: high stakes compulsory state exams taken by all high school graduates and international assessment tests administered to the students at the end of their compulsory part of school education. We find that the level of school financing does not have any significant effect on student outcomes. At the same time, the level of relative teacher wages has significant positive effect on both test scores. Instrumental variable estimation confirms these results. We also provide some tentative evidence on the mechanisms that may explain this effect. It appears that growth in relative teacher wages positively affects teacher morale and motivation, and that this, in turn, could be a reason for higher student outcomes.

Our study also contributes to the literature on the factors of the quality of education in transition economies. There have been a number of studies estimating the effects of different factors on schooling outcomes in Russia. For instance, Amini and Commander (2012) used PISA and TIMSS data for this purpose. They found that test results are significantly affected by students' family characteristics as well as by institutional factors such as student-teacher ratios and indicators of school autonomy. However, none of these studies looked at the effect of school financing from regional budget or teacher wages on educational outcomes.

The rest of the paper is organized as follows. In the next section we describe the institutional context of the Russian school system. We also describe our data and provide some descriptive statistics. Section 3 presents the empirical results and robustness checks. In Section 4 we discuss possible channels. Section 5 concludes.

2. Data and the Institutional Context

2.1 School Financing

In Russia the system of general education covers eleven years: the first nine years are compulsory for all children, after that one can continue to study in high school for two more years or move into the vocational education system. The school system is predominantly financed by the government. The share of private schools in total enrollment is very low.

In the 1990s—a period of long recession—and early 2000s, general education was underfinanced as state budget revenues were low. As a consequence, teacher remuneration was low compared to the average wage in the economy[2] and the job of a school teacher was not very attractive, especially for young people. By the mid-2000s, after seven years of rapid economic recovery, the government made an effort to increase school funding levels and to raise teacher wages. The total amount of budget financing for the schools increased significantly. However, schools are primarily financed at the regional level, through the budgets of the regions. There are 85 administrative regions currently in Russia and they differ greatly in terms of economic conditions, regional budget income and expenditures, including the amount of financing for the school system[3].

In order to estimate regional differences in school financing we use Russian Treasury data for regional-level budget expenditure on general education [4] and Ministry of Education data on student enrollment by region to estimate the spending per student across regions. Further, because the cost of living varies greatly across regions, we adjust per-student education spending by regional cost of living index (as estimated by the Russian statistical office) in each of the years, 2006-2014.

As Figure 1 shows, educational spending per student adjusted for differences in the cost of living and across years increased greatly in 2006-2014—by about 40% in earl terms. A large part of this growth occurred in 2012. In that year a presidential decree was adopted mandating that teachers' wages should be raised to the level of the average regional wage. Regions had to allocate more money for teacher wages during the following few years in order to meet this target. At the same

[2] Gimpelson et al. (2015) show that there was a significant negative wage gap between higher skilled workers in the Russian public sector (including education) and the private sector in the first half of the 2000s.
[3] Regions differ in size: the size of population ranges from 43 000 people to 12 mln people (Moscow city), average is 1.7 mln people.
[4] http://www.roskazna.ru/

time, Figure 1 shows that regions vary significantly in the amount of budget school financing, and that this variation has not decreased over the period covered.

Figure 2 shows the amount of school financing is also significantly correlated with the gross regional product per capita—that is, with the level of economic development of the region. We observe the largest gap in school financial resources between the richest regions in the upper quartile and the rest of the regions. Such persistent inequality in school resources may lead to unequal access to higher quality education across Russian regions. This inequality is exacerbated by the fact that in less economically developed regions families have fewer resources (human, social, and financial) to compensate for the underfinancing of public schools.

The structure of school expenditures in the regional budgets shows that the major part of spending (about 80 percent) goes for remuneration of teachers and school administration. Thus, we should test whether regional school expenditures affect student results through teacher wages—in theory, higher wages can affect teacher motivation and possibly help in the recruiting of higher quality teachers. We use data on average regional teacher wages from Rosstat (Russian Federal State Statistics Service) and the Russian Ministry of Education. It is important to estimate relative teacher salary, as the level of pay for teachers relative to other jobs in a region influences self-selection into teaching jobs. For the existing teachers improvement in their relative standing within the wage distribution may positively affect their motivation and effort. While salaries constitute the major part of budget expenditures for schools, relative teacher wages are only weakly correlated to school financing that comes from regional budgets. Hence, these two indicators may have differential effects on educational outcome variables.

Figure 3 shows the dynamics of the average regional school wage relative to the average regional wage in the economy for the period 2004-2014. We see that this indicator has been increasing in 2008-2009 and, at a higher rate, in 2012-2013, due to the presidential decree mentioned above. Again, we observe a significant variation in teacher wage increases among regions throughout the period.

Figure 4 shows the dynamics of the relative school wages by quartiles of gross regional product per capita. Contrary to the level of school financing in Figure 2, relative teacher wages do not differ significantly by the region's level of economic development.

In order to better understand the dynamics of teacher wages over the observation period it is also important to look at the evolution of the total number of teachers and students as well as student-teacher ratios. Increases in funds going to school financing may have different effects on average teacher wages depending on whether additional money is distributed to the existing teachers or there is an expansion or reduction in the number of teachers,

Due to the demographic reasons – low fertility rates in the early 1990s – the total number of students in schools was declining during most of the 2000s. Figure 5 shows the dynamics of the total number of teachers and students as well as student-teacher ratios for the period 2004-2014 taking the levels in 2004 as 100%. The number of students in schools was decreasing up to 2009. It declined by 18 percent from 2004 to 2009. The number of teachers was declining in the beginning of this period but at a slower rate. The schools were probably reluctant to lay off teachers; public employment in general is not very flexible and slowly responds to shocks. However, after 2007 the total number of teachers declined faster than the number of students and continued to fall after the number of students stabilized. As a result, the student-teacher ratio began to increase after 2007. It increased from 11.6 in 2007 to 13.5 in 2014. Note that growth in relative teacher wages also started in 2007. Along with the increases in funds made available the school system, the decline in the number of teachers (and the concomitant rise in student-teacher ratios) have thus helped regions increase relative teacher wages. Since the student-teacher ratio may have an independent effect on student outcomes we need to control for it when estimating the effect of teacher wages on test scores.

2.3 Educational outcomes

To test the effect of school resources and teacher wages on educational outcomes, we use two measures of educational outcomes. The first is the average regional score on the Unified State Examination (USE), taken by students graduating from 11^{th} grade, the final year of secondary school. The USE was introduced in all Russian regions beginning in 2009. This is a high stakes examination—the results are accepted as an entrance exam at universities throughout the country. USE in mathematics and Russian language are compulsory for all 11^{th} grade graduates, hence we use the scores in these subjects. Unfortunately, individual-level scores for USE are not available and even scores averaged at the regional level are not uniformly reported. We had to hand collect these data from various publications from the regional educational authorities. Note that USE scores

measure educational outcomes of those students that stayed in high school after the 9th grade – they represent about 60 percent of the school age cohort.

An alternative measure of educational outcomes that covers students before they have an option to exit the school system is the results from the PISA international educational assessment. Russia has been participating in PISA since 2000. Students take this test at the age of 15 – a majority of students in Russia at this age is studying in the 9th grade. We use PISA assessment data in mathematics, science and reading for 2006, 2009, 2012 and 2015. The Russian sample for the PISA survey is more than 5000 students in each round from about 40 Russian regions. Thus, even though the PISA sample in not completely national, data from 40 regions provides enough regional variation in the data to test our hypotheses.

3. Empirical Model and Estimation Results

In this section, we test the effect of school spending per student on student achievement and the effect of the level of teacher wages on student achievement. We first do our empirical analysis at the regional level using average regional USE scores; then we estimate the impact of spending and teacher wages on test scores using student-level data from PISA.

3.1 School financing and Unified State Examination results

In this sub-section, we estimate the effect of school financing and teacher wages on the results of USE. We use regional level data described in Section 2. This is panel data for all Russian regions for the period 2009-2014. Data begins with the year 2009, as this is the year when the USE became compulsory for all high school graduates in Russia. The dependent variables – average regional USE scores in mathematics and Russian language are standardized within each year in order to account for the changes in methodology and administration procedures of the exam between years.

We estimate the following model:

$$Y_{rt}=\alpha+ \beta*W_{rt-1}+\gamma*X_{rt}+ \theta_r +\theta_t+\varepsilon_r$$

Y_r – average regional USE scores in math and Russian Language (standardized)

W_r – regional school financing per student or relative regional teacher wage

X_r – regional control variables;

θ_r - regional fixed effects, θ_t- time fixed effects

Our main explanatory variables are regional school spending per student adjusted for the regional cost of living and the average school wage relative to average wage in the region. The effect of changes in school financing or teacher wages on the quality of education and test results is likely to take several years. Changes in the teaching staff or teaching process take some time and their effect on educational outcomes likely does not occur immediately. We there test the effect of lagged school financing and teacher wages, lagging these variables up to three years.

In the regression estimates we additionally control for a number of regional characteristics which may be correlated with school financing or teacher wages, such as size of the population, the share of the urban population, regional poverty (share of population below the poverty line), within-region income inequality (decile coefficient) and gross regional income per capita (also adjusted for the cost of living). We also control for the student-teacher ratio in the regional school system and for the share of USE takers in the corresponding age cohort.[5] This share varies considerably across years and regions and it may affect average regional USE scores. For example, in a region where only the most academically strong students continue education to the 11th grade and take the USE, their exam scores on average will be higher compared to the region with a higher share of students enrolled in the academic track's grades 10-11.

Even after controlling for these regional characteristics there is a potential endogeneity problem: some unobserved or difficult to measure regional factors may affect both the amount of school financing and the educational outcomes. This could lead to a spurious correlation. This problem can be at least partly alleviated by using lagged variables for school financing. Yet, since we have panel data we can also use a panel fixed effects estimation method that accounts for all unobserved time-invariant regional heterogeneity.

Estimation results are presented in Tables 1 and 2. Table 1 shows that the level of per-student school financing generally does not significantly affect USE results (the only exception is the effect on USE results in math with a lag of three years). Test results in Russian language are also not

[5] Since we do not have data on the size of the relevant age cohort at the regional level, we proxy it by the number of 9th grade graduates in the two years previous. There is essentially universal graduation from the 9th grade in every age cohort.

significantly affected. Further, we see that regional poverty and income inequality have significant negative effects on both exam results, even after controlling for the regional level of economic development. This may indicate that inequality of opportunity in education due to family income is not compensated for by the state school system. It may also be the case that in poorer regions both families and the school system have fewer educational resources than in more economically successful regions.

The results in Table 2 show a significant positive effect of relative teacher wages on USE results both in math and in Russian language, with a lag of one to two years. From these results, it appears that it is not so much the absolute level of school financing and teacher wages that affect educational outcomes but the relative position of teachers in the regional wage distribution. It is consistent with earlier studies showing that teachers with higher skills are drawn from the upper part of the wage distribution.

3.2 School financing and PISA results

In this subsection, we estimate the effect of school financing on students' PISA performance. We use student-level data on test results in reading, math, and science for the years 2006, 2009, 2012 and 2015. As we discussed in Section 2, the PISA test is taken at the age of 15 when most of the students are in the 9^{th} grade. Since the sample is representative at the country level and the sample covers the whole age cohort before a significant part of it leaves the academic track into vocational education, PISA tests may provide a better measure of school education quality than the USE results. In addition, individual-level PISA data allow us to control for many individual and family characteristics that affect student achievement scores. One drawback of the data is that the PISA sample is not a panel but repeated cross-sections; hence, we cannot use panel data estimation methods. However, most of the regions where the tests were carried out participated in several rounds of PISA. Thus, we can add region fixed effects in the regressions in order to control for unobserved time-invariant regional heterogeneity.

We estimate the following model:

$$Y_{it}=\alpha+ \beta*W_{rt-1}+\gamma*X_{it}+\theta_r+ \theta_t+ \varepsilon_i$$

Y_i – PISA scores in math/reading/science

W_r – regional school financing per student or relative regional teacher wage

X_i – individual, family and school characteristics

Θ_r – regional fixed effects; θ_t- time fixed effects

The results of the estimation are presented in Tables 3 and 4. Only students studying in public schools are included in the estimation sample. Regressions in Table 3 have fewer observations as we only have data on regional budget expenses for 2006-2014. In these regressions, we control for student's gender, education of parents (whether at least one of the parents has higher education), number of books in the home, school size, student/teacher ratio, type of settlement, region and year fixed effects.

Results show that the amount of regional school financing per student does not have any significant effect on PISA scores in any subject. At the same time, relative teacher wages have positive and significant effects on student scores in all three subjects with the lag of one year. This is consistent with the results of estimation on regional data using USE scores. Our results therefore appear to be robust for two different measures of educational outcomes.

The PISA survey provides individual level test scores for students combined with their characteristics – location, family resources, school resources etc. This gives us an opportunity to test whether the effect of average regional teacher wages on student outcomes is different for different sub-samples of students. The important question is whether the higher teacher wages have stronger or weaker effects for students from disadvantaged backgrounds. Using the same estimation model, we estimated heterogeneous effects of teacher wages on student achievement by parents' education, family socio-economic status, and student location within the region (large city or small town or village). We did not find any significant differences in the effect of teacher wages achievement by parents' education or socio-economic status. At the same time, our results show that students living in smaller towns or villages (below 15 thousand inhabitants) benefit more from raising teacher wages than students from larger cities within the same region. Since there are fewer alternative employment opportunities for teachers in smaller settlements the same wage increase may be subjectively perceived by them as more significant and have stronger effect on their motivation.

3.3 Robustness Checks

Our main result – the positive effect of relative teacher wages on student achievement - is robust to the inclusion of region fixed effects and a set of indicators of regional economic and social conditions that might affect educational outcomes. As an additional robustness check, we conduct an instrumental variable estimation of our model. For identification, we exploit institutional features of wage setting in the public sector and minimum wage setting in Russia.

In the early 2000s, the wages in the public sector (including education) were set according to a wage grid established by the government. The lowest level of that grid was tied to the federal minimum wage. In the mid-2000s, the government gradually replaced the grid with a more flexible system that allowed some autonomy in wage setting for regional authorities and schools. Still, teacher wages were bounded from below by the level of the federal minimum wage.

In the early 2000s, the level of federal minimum wage was so low that it did not have any significant effect on teacher wages.[6] However, during the next few years, there were several sharp increases in the federal minimum wage. It doubled in 2007 and again almost doubled in 2009. Further, in 2007, regions were given the right to set regional minimum wages above the federal minimum.[7] As a result, the lower part of the wage distribution compressed and wage inequality in that part reduced significantly (Lukyanova 2011).

Since most teacher wages in the first half of 2000s fell into the lower part of the wage distribution, in a large number of regions the minimum wage started to affect the level of school wages. In 2009, the average school wage was just 2.6 times higher than the minimum wage. In a quarter of the regions, the average school wage was between 1.5 and 2 times minimum wage. By 2014, after significant increases in teacher wages, the average regional school wage was about 4 times the minimum wage. There is still a significant variation in the distance between minimum wage and average teacher wage. In 2014 in Belgorod region this ratio was 2.4 while in Magadan region it was 9 (see Figure 6). This statistic is confirmed by individual-level Russian Longitudinal Monitoring Survey (RLMS-HSE) data[8]. According to these data, in 2009 about half of the teachers received

[6] For the institutional details on minimal wage setting in Russia see Lukyanova (2016)
[7] Since regions could set minimum wages separately for public and private sector many regions decided not to set the regional minimum wage for the public sector above the federal minimum as this would require additional resources from the regional budgets.
[8] RLMS-HSE is an annual household survey on a representative sample of the Russian population. For the description and data see https://www.hse.ru/en/rlms/

wages between 75 and 200 percent of the regional minimum wage. Thus, changes in the minimum wages starting from 2007 should have significantly affected teacher wages.

While the absolute level of the federal minimum wage is the same for all regions, the relative size of the minimum wage (the ratio of the minimum wage to the average regional wage[9]) varies across regions. We use the relative minimum wage as an instrument for a relative teacher wage. It is plausible that the level of minimum wage does not affect student educational outcomes other than through its effect on teacher wages. Thus, the exclusion restriction is satisfied. We estimate a 2SLS instrumental variable regression for the effect of teacher wages with a two-year lag on USE results on region-level data. Estimation results are presented in Table 5. The F-statistics for our instrumental variable is around 18, which means that our instrument is quite strong. The effect of relative school wage with two year lag on USE scores in mathematics and Russian language is positive and significant. The IV results confirm that relative teacher wages positively affect students' educational outcomes.

We also checked whether the results are robust to the exclusion of some regions that are outliers in terms of school financing. Moscow, Saint Petersburg, and several resource-extracting (mining, petroleum) northern regions had significantly higher levels of school financing during the observed period, even after adjusting for the cost of living. Exclusion of these regions from the sample does not affect our results.

4. Discussion

Our estimates suggest that increasing school financing from the regional budgets *per se* does not noticeably improve student test scores, either on the USE test or on the PISA test. Only when additional financing leads to the improvement of the position of teachers in the regional wage distribution do we observe higher student achievement as measured by their scores on these two tests.

What are the mechanisms through which relative teacher wages may affect student results? One possibility is the self-selection of teachers. When teacher pay increases relative to other jobs, the teacher occupation becomes more attractive for higher skilled individuals. Higher skilled teachers

[9] This indicator is similar to the Kaitz Index (ratio of minimum wage to median wage) which is widely used in minimum wage literature.

should help students to achieve better educational results (Hill, Rowan, and Ball, 2005). Unfortunately, we do not have data on the composition of teacher characteristics in Russian schools to test this hypothesis. Besides, we observe a positive effect of relative teacher wages on student scores with the lag of just one-two years. This seems to be too short time period for changing teacher composition to have a significant effect.

Another potential mechanism for the observed effect is an improvement in teacher motivation or teacher morale. In the early and mid-2000s, when teacher pay was quite low, a significant share of teachers was considering quitting their jobs or switching to another occupation. As teacher surveys show, in 2007 the share of teachers considering quitting was about 40 percent. By 2014, after a significant increase in absolute and relative teacher wages, this share declined to 27 percent and teacher motivation and job satisfaction improved (Abankina 2015).

The data from the individual-level RLMS-HSE household survey also provide evidence for this argument. Figure 7 shows that teachers' satisfaction with their job pay was indeed significantly lower than for other professionals (Group 2 as defined by ISCO-2008 classification of occupations) up until 2010. In 2011-2013, the gap in satisfaction declined and finally closed in 2014.

Finally, evidence in support of this hypothesis comes from the school-level data in the PISA 2012 study. Heads of schools participating in the study were surveyed. In particular, they were asked to evaluate the level of morale of teachers in their schools. We use this data to conduct regression estimates of the effect of relative regional school wage on teacher morale (as evaluated by a school head) controlling for other regional characteristics and school size (see Table 6). We find a positive and significant relationship between the level of teacher morale and the relative teacher wages.

5. Conclusion

The policy proposals to increase the amount of budget spending on public education imply that increased spending leads to better quality of education. This, however, is far from certain. In this study, we test how both the absolute level of financial resources available to schools and relative teacher wages affect educational outcomes. Russia provides a good opportunity for testing this relationship due to the high level of regional heterogeneity. We estimate these effects for two different measures of educational outcomes at different levels of the education system: high stakes

compulsory state exams taken by all high school graduates and international assessment tests administered to the students at the end of their compulsory part of school education.

We find that increasing school financing from the regional budgets *per se* does not noticeably improve students' educational performance. Only when additional financing leads to the improvement of the position of teachers in the regional wage distribution do we observe higher student outcomes. Instrumental variable estimation confirms these results. We also provide some tentative evidence on the possible mechanisms of this effect. It appears that increases in relative teacher wages had a positive effect on teacher morale and motivation.

Positive effects of increased relative teacher wages that we estimate are relatively short term. More long-term effects are potentially larger due to the self-selection of the individuals with higher skills into the teaching profession. From the policy perspective, it is important to evaluate how the policies aimed at increasing school financing and teacher wages affect the position of teachers in general wage distribution.

References

Abankina, I. and Filatova L. 2015. Changes in Teacher Motivation after the Introduction of Efficient Contracts. *Narodnoe Obrazovanie*, 7: 99. (*in Russian*)

Amini, C. and Commander, S. 2012. Educational Scores: How does Russia Fare? *Journal of Comparative Economics*, 40 (3): 508-527.

Britton, J. and Propper, C. 2016. Teacher Pay and School Productivity: Exploiting Wage Regulation. *Journal of Public Economics*, 133: 75–89.

Carnoy, M., Brodziak, I., Luschei, T., Beteille, T., &Loyalka, P. 2009. *Teacher Education and Development Study in Mathematics (TEDS-M): Do Countries Paying Teachers Higher Relative Salaries Have Higher Student Mathematics Achievement?* Amsterdam, the Netherlands: International Association for the Evaluation of Educational Achievement (IEA).

Gimpelson V. E., Lukyanova A., and Sharunina A., 2015, Estimating the Public-Private Wage Gap in Russia: What Does Quantile Regression Tell Us? / NRU Higher School of Economics. Series WP BRP "Economics/EC". No. 104/EC/2015.

Hanushek, E. A., Piopiunik, M., and Wiederhold, S. 2018. The Value of Smarter Teachers: International Evidence on Teacher Cognitive Skills and Student Performance. *Journal of Human Resources*, forthcoming

Hanushek, E. A. and Woessmann, L. 2011. The Economics of International Differences in Educational Achievement. In Hanushek, E.A., Machin, S., and Woessmann, L. (eds.), *Handbook of the Economics of Education, Vol. 3*, pp. 89-200, Amsterdam: North Holland.

Hendricks, Matthew D., 2015, Towards an optimal teacher salary schedule: Designing base salary to attract and retain effective teachers, *Economics of Education Review*, Volume 47, Pages 143-167

Hill, H., Rowan, B., and Ball, D. 2005. Effects of Teacher Mathematical Knowledge for Teaching on Student Achievement. *American Educational Research Journal*, 42 (2): 371-406.

Jackson, C. Kirabo, Johnson, R.C., and Persico, C. 2016. The Effects of School Spending on Educational and Economic Outcomes: Evidence from School Finance Reforms. *Quarterly Journal of Economics*, 131 (1): 157–218

Lafortune, J., Rothstein, J., and Schanzenbach, D.W. 2018. School Finance Reform and the Distribution of Student Achievement. *American Economic Journal: Applied Economics*, 10 (2): 1-26.

Lavy V., 2012, Expanding School Resources and Increasing Time on Task: Effects of a Policy Experiment in Israel on Student Academic Achievement and Behavior. Cambridge, MA: NBER Working Paper No. 18369

Leigh Andrew, 2012, Teacher pay and teacher aptitude, *Economics of Education Review*, Volume 31, Issue 3, Pages 41-53

Loeb, S. and Page, M.E. 2000. Examining the Link between Teacher Wages and Student Outcomes: The Importance of Alternative Labor Market Opportunities and Non-Pecuniary Variation. *The Review of Economics and Statistics*, 82:3, 393-408

Lukiyanova A, 2016, Reforming the Minimum Wage in Russia. *Baltic RIM Economies Review,* 4: 38.

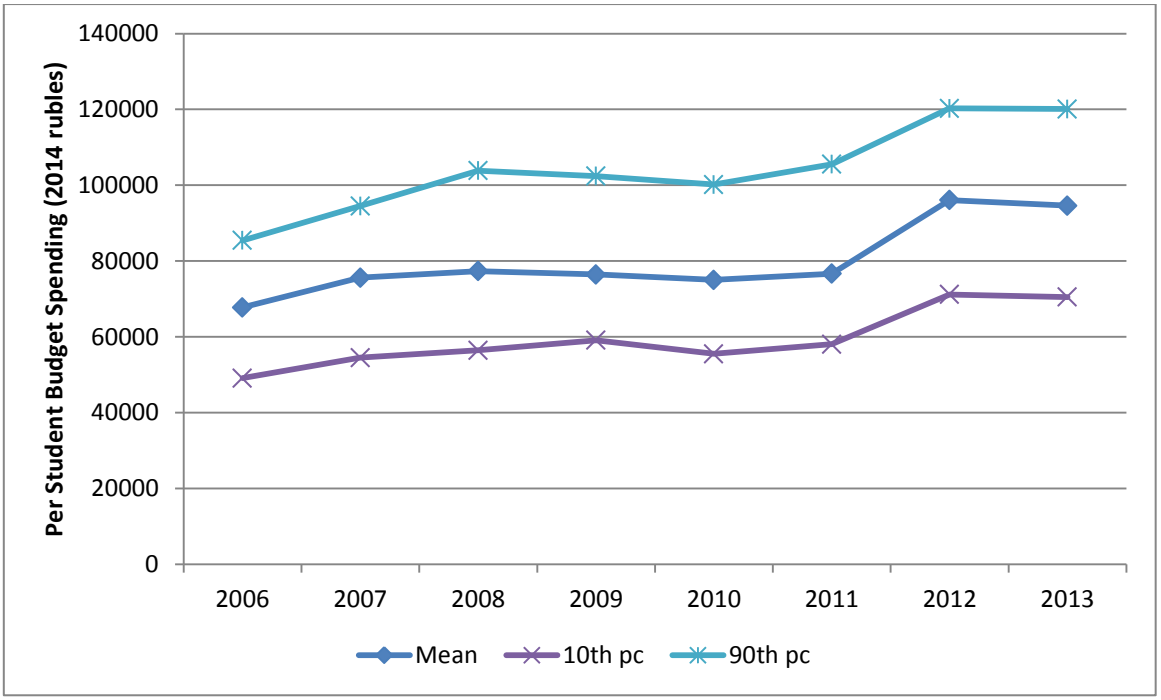
Lukiyanova A. 2011, Effects of Minimum Wages on the Russian Wage Distribution. NRU Higher School of Economics. Series EC «Economics». 2011. No. 09.

Murnane, R. J., Waldman, M.R., Willett, J.B., Bos, M.S., and Vega, E. 2017, The Consequences of Educational Voucher Reform in Chile. Cambridge, MA: NBER Working Paper No. 23550

Woessmann, L. 2007, Fundamental Determinants of School Efficiency and Equity: German States as a Microcosm for OECD Countries. IZA DP No.2880

Figures

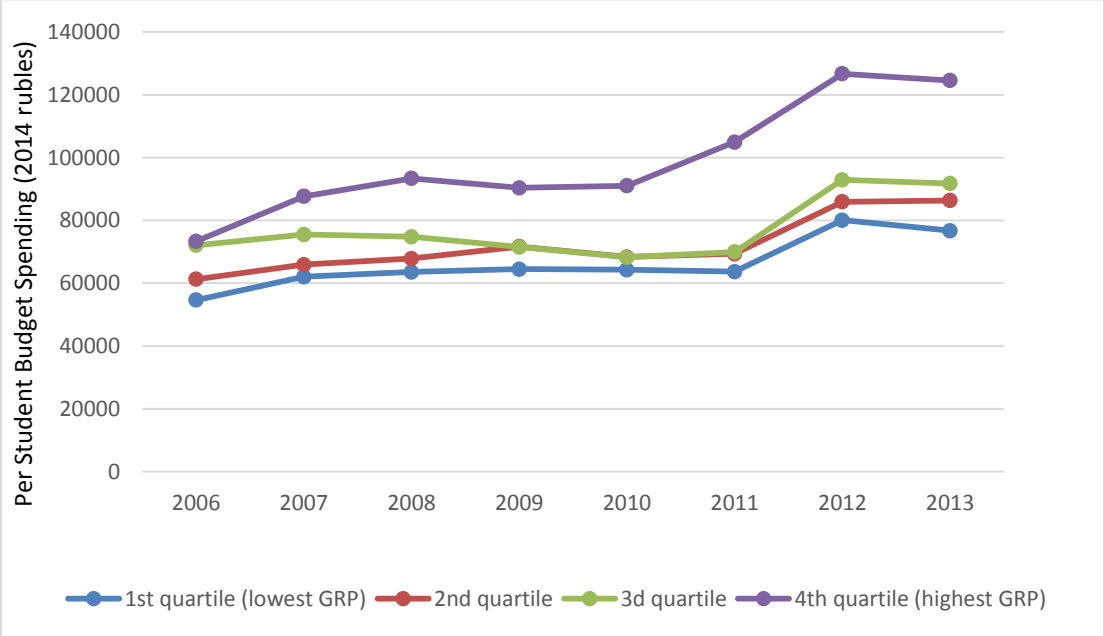
Figure 1. Regional School Budget Financing per Student, Adjusted for Regional Cost of Living 2006-2013 (2014 rubles)



Source: Russian Treasury, Rosstat.

Notes: Per student budget financing adjusted for the regional cost of living at 2014 price level

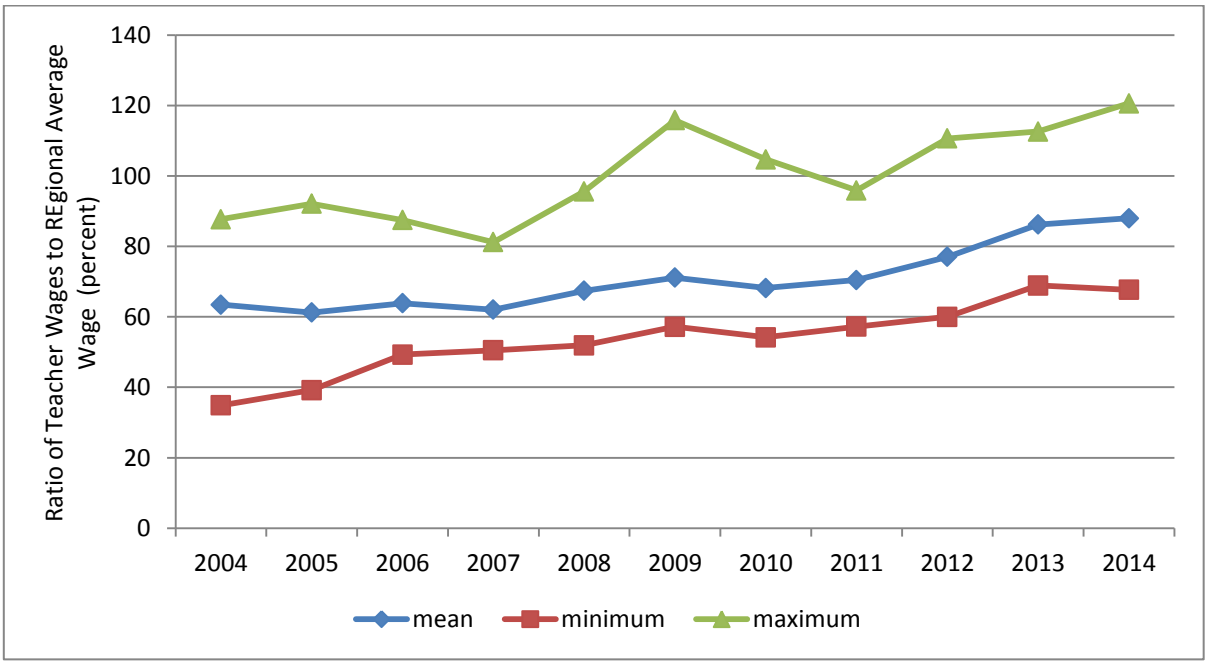
Figure 2. Per Student School Financing by GRP Quartiles, Adjusted for Regional Cost of Living 2006-2013 (2014 rubles)



Source: Russian Treasury, Rosstat.

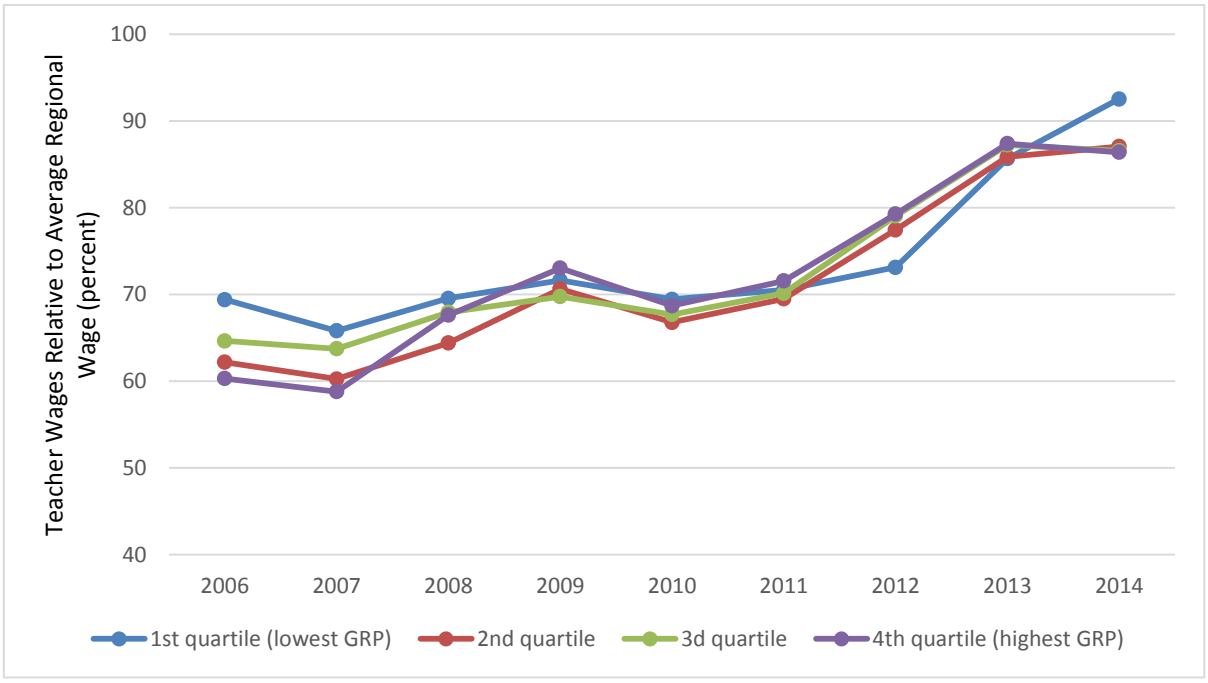
Notes: School financing adjusted for the cost of living in 2014 rubles. Autonomous *okrugs* excluded.

Figure 3. Average Regional Teacher Wages Relative to Regional Average Wage, 2004-2014 (percent)



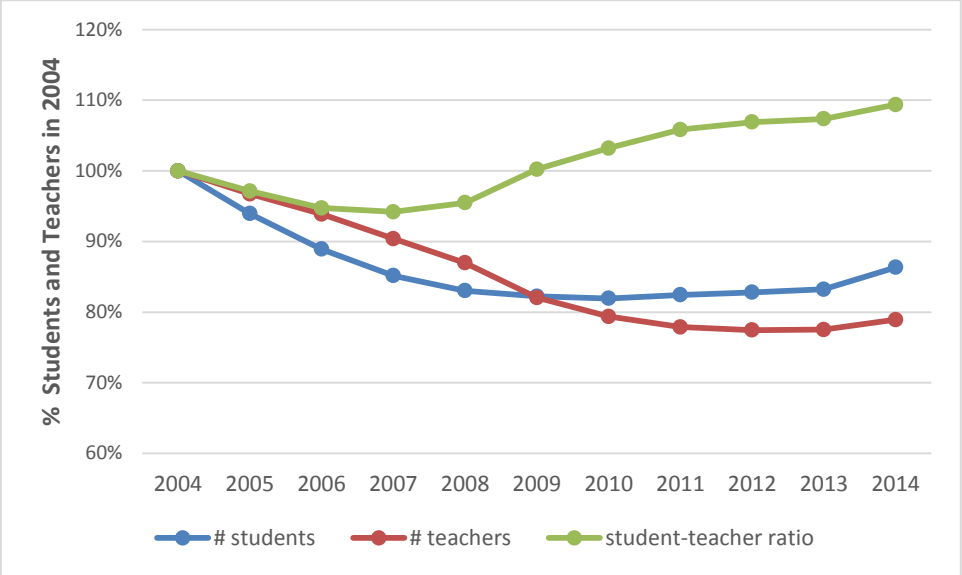
Source: Russian Ministry of Education, Rosstat

Figure 4. Teacher Wages Relative to Regional Average Wages, by GRP Quartile, 2006-2014 (percent).



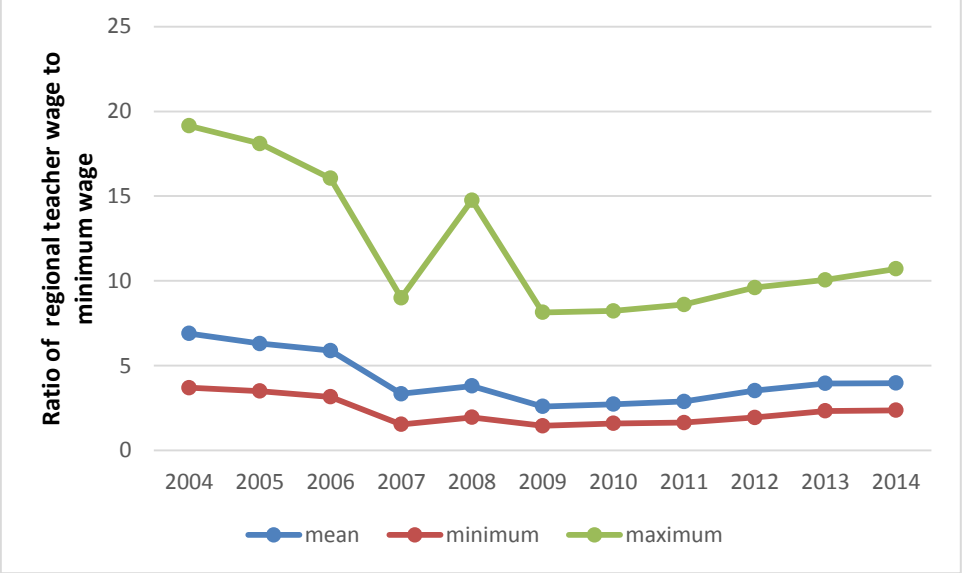
Source: Russian Ministry of Education, Rosstat

Figure 5. Number of students and teachers as percent of 2004 level



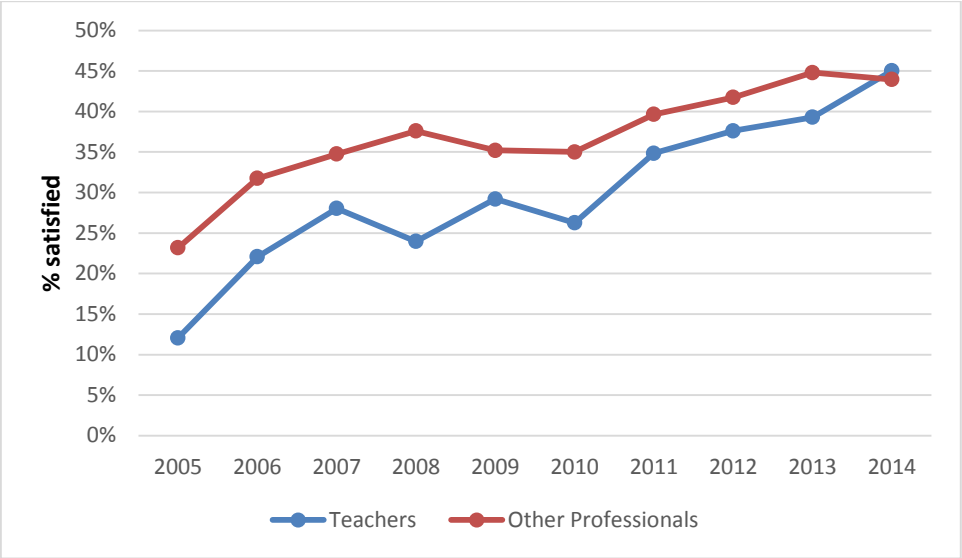
Source: Russian Ministry of Education, Rosstat

Figure 6. Regional teacher wage relative to regional minimum wage



Source: Russian Ministry of Education, Rosstat

Figure 7. Job pay satisfaction levels, RLMS data



Source: Russian Longitudinal Monitoring Survey

Notes: each data point shows the percent of mostly or absolutely satisfied with job pay.

Tables

Table 1. School Financing and Mean Regional USE Results, 2009-2014

	USE Mathematics			**USE Russian**		
Variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
logfin_perstud_lag1	-0.234			0.731		
	(0.592)			(0.540)		
logfin_perstud_lag2		0.677			0.099	
		(0.560)			(0.493)	
logfin_perstud_lag3			2.048***			0.291
			(0.683)			(0.713)
Share of USE takers	-0.423	-0.472	-0.670	-3.461***	-3.400***	-3.443***
	(1.140)	(1.146)	(1.118)	(0.791)	(0.789)	(0.763)
Student/teacher ratio	0.042	0.042	0.045	-0.086	-0.096	-0.099
	(0.115)	(0.114)	(0.118)	(0.092)	(0.094)	(0.095)
Regional poverty	-0.105**	-0.102**	-0.106**	-0.098***	-0.105***	-0.105***
	(0.050)	(0.050)	(0.051)	(0.036)	(0.038)	(0.038)
Income inequality	-0.273**	-0.270**	-0.270**	-0.119*	-0.128*	-0.127*
	(0.123)	(0.124)	(0.122)	(0.068)	(0.067)	(0.066)
Log GRP per capita	-0.495	-0.505	-0.702	-1.113*	-1.071*	-1.107*
	(0.640)	(0.652)	(0.639)	(0.655)	(0.642)	(0.614)
Log population	3.869	3.808	3.689	2.072	2.041	1.907
	(3.715)	(3.724)	(3.761)	(2.855)	(2.853)	(2.786)
Share urban pop.	0.015	0.010	0.038	-0.014	-0.010	-0.006
	(0.116)	(0.116)	(0.122)	(0.062)	(0.061)	(0.063)
Constant	-41.505	-50.633	-63.594	-16.132	-9.001	-9.024
	(50.269)	(51.091)	(52.168)	(41.904)	(44.676)	(45.013)
N	395	395	395	403	403	403
adj. R^2	0.023	0.027	0.070	0.173	0.166	0.167

Notes: Fixed effects panel regressions for 2009-2014. Region and year fixed effects included. USE scores are standardized within each year. School financing per student is adjusted for the regional minimum living standards. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2. Relative Teacher Wages and USE results, 2009-2014.

	USE Mathematics			**USE Russian**		
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Rel school wage_lag1	-0.004			0.020**		
	(0.009)			(0.009)		
Rel school wage_lag2		0.028**			0.023***	
		(0.013)			(0.008)	
Rel school wage_lag3			0.015			0.005
			(0.009)			(0.006)
Share of USE takers	-0.390	-0.743	-0.418	-3.511***	-3.374***	-3.379***
	(1.116)	(1.148)	(1.139)	(0.809)	(0.828)	(0.803)
Student/teacher ratio	0.043	0.046	0.044	-0.083	-0.099	-0.098
	(0.115)	(0.109)	(0.117)	(0.084)	(0.094)	(0.097)
Regional poverty	-0.103**	-0.103**	-0.098*	-0.099***	-0.100***	-0.102**
	(0.050)	(0.048)	(0.050)	(0.035)	(0.036)	(0.039)
Income inequality	-0.273**	-0.257**	-0.259**	-0.116*	-0.103	-0.120*
	(0.124)	(0.122)	(0.124)	(0.067)	(0.065)	(0.068)
Log GRP per capita	-0.479	-0.689	-0.537	-1.168*	-1.153*	-1.070*
	(0.668)	(0.633)	(0.626)	(0.626)	(0.632)	(0.637)
Log population	3.816	2.666	2.978	2.479	0.805	1.627
	(3.708)	(3.601)	(3.725)	(2.783)	(2.798)	(2.810)
Share urban pop.	0.009	0.024	0.023	0.008	-0.004	-0.005
	(0.116)	(0.117)	(0.120)	(0.059)	(0.058)	(0.062)
Constant	-42.945	-27.802	-33.107	-16.170	7.941	-2.867
	(50.207)	(48.407)	(50.540)	(40.820)	(42.796)	(42.571)
N	395	395	395	403	403	403
adj. R^2	0.023	0.053	0.031	0.191	0.201	0.167

Notes: Fixed effects panel regressions for 2009-2014. Region and year fixed effects included. USE scores are standardized within each year. School financing per student is adjusted for the regional minimum living standards. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3. School Financing and PISA results, 2006-2015

	Mathematics		**Reading**		**Science**	
Variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
logfin_perstud_lag1	-43.911		-8.821		-11.923	
	(29.920)		(25.761)		(27.930)	
logfin_perstud_lag2		-18.975		14.027		-1.959
		(25.965)		(21.940)		(22.919)
Female	-7.403***	-7.281***	31.939***	32.011***	-4.197**	-4.060**
	(1.889)	(1.914)	(1.740)	(1.751)	(1.684)	(1.720)
Parent higher educ.	22.045***	22.076***	19.438***	19.461***	19.407***	19.479***
	(2.149)	(2.158)	(1.876)	(1.864)	(1.916)	(1.918)
School size	2.853	2.080	9.117**	8.672**	4.847	4.411
	(4.359)	(4.445)	(3.840)	(3.905)	(3.552)	(3.579)
Student/teacher ratio	-1.321**	-1.290**	-0.795	-0.783	-0.684	-0.672
	(0.613)	(0.616)	(0.540)	(0.545)	(0.501)	(0.493)
N	14462	14532	14462	14532	14462	14532

Notes: Other variables included in regression: number of books at home, program, location, regional fixed effects. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4. Relative teacher wage and PISA results

	Mathematics		**Reading**		**Science**	
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Rel school wage_lag1	0.719**		0.542*		0.567**	
	(0.291)		(0.301)		(0.247)	
Rel school wage_lag2		-0.135		0.072		0.043
		(0.317)		(0.306)		(0.280)
Female	-9.133***	-9.145***	31.131***	31.126***	-5.893***	-5.899***
	(1.458)	(1.452)	(1.568)	(1.562)	(1.510)	(1.502)
Parent higher educ.	18.175***	18.332***	17.450***	17.572***	17.375***	17.502***
	(1.852)	(1.849)	(1.410)	(1.432)	(1.485)	(1.503)
School size	3.837	3.348	9.904***	9.406***	4.714	4.217
	(3.627)	(3.805)	(3.090)	(3.282)	(2.970)	(3.115)
Student/teacher ratio	-1.414**	-1.375**	-0.875**	-0.855*	-0.836*	-0.814*
	(0.551)	(0.573)	(0.437)	(0.464)	(0.432)	(0.440)
N	18989	18989	18989	18989	18989	18989

Notes: Other variables included in regression: number of books at home, program, location, regional fixed effects. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5. Relative teacher wages and USE results, IV 2SLS estimation

	USE Mathematics	**USE Russian**
	(1)	*(2)*
Rel school wage_lag2	0.130***	0.090***
	(0.038)	(0.032)
Share of USE takers	-3.192**	-5.008***
	(1.492)	(0.948)
Student/teacher ratio	-0.302***	-0.219***
	(0.072)	(0.062)
Poverty	0.027	0.002
	(0.025)	(0.019)
Income inequality	0.059	-0.006
	(0.066)	(0.058)
Log GRP per capita	0.035	0.001
	(0.355)	(0.247)
Log population	0.205	0.077
	(0.176)	(0.118)
Share urban popul	0.002	0.018**
	(0.013)	(0.009)
Moscow	-4.120**	-0.723
	(1.759)	(1.170)
Saint Petersburg	0.587	1.621***
	(0.682)	(0.448)
Caucasus regions	0.907	-0.843***
	(0.616)	(0.321)
Constant	-8.744*	-3.265
	(4.768)	(3.638)
N	395	403
adj. R^2	.	0.219
F-stat for IV	18	17.2

Notes: Notes: IV 2SLS regressions for 2009-2014. Year fixed effects included. USE scores are standardized within each year.

Standard errors clustered by region in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6. Relative teacher wage and teacher morale

	Teacher morale
Relative teacher wage	0.019*
	(0.010)
Log GRP per capita	-0.204
	(0.156)
Regional population	-0.065
	(0.051)
Poverty level	0.027
	(0.022)
Share of urban population	-0.002
	(0.005)
School size	0.055
	(0.106)
N	218

Notes: Dependent variable is teacher morale as evaluated by school head in PISA 2012 survey of schools. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$