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Making Education Work: School Autonomy, Performance and Social Capital

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Abstract

Autonomy of schools is often considered to be improving school performance, however, there is some evidence that there could be conditional factors for such relationship. The study addresses two questions: what effect does school autonomy have on school performance? And does income inequality affect the relationship between school autonomy and performance in post-Soviet region? The study is based upon new public management and social capital theories, uses PISA test data across more than 1500 schools and multi-level modeling to answer the question. The results of the study suggest that, first, school autonomy may have a negative effect on school performance and, second, performance of schools is dependent on amount of social capital in the country: autonomy of schools in countries with more social capital has positive effect on performance, while autonomy of schools in countries with less social capital brings negative effect for school performance.

Index

List of Tables and Figures

Tables

Figures

1. Introduction

Increasing autonomy of schools is a phenomenon which can be attributed to many countries in all parts of the world. Throughout the XX century it has spread out across all continents. After Franco's death Spain granted more responsibilities to schools (Fiske, 1996), while on the other side of the world, in Brazil, the shift towards more school autonomy took place during 90-s to increase education attainment rates (Derqui, 2001). Attempting to reach more efficiency, Zimbabwe has also granted more autonomy to schools (Fiske, 1996 and Chikoko, 2006). Such a shift towards more autonomy is mainstream and pushed forward by such international institutions as World Bank (SABER, 2015; Bonal, 2002). Despite the direction that the educational policies across the world are shifting to, academia points out the ambiguity of the autonomy. On one hand, school autonomy can increase the performance through allowing tailoring school policies to the needs of the constituencies the schools serving and increasing efficiency (Fuchs and Woessmann, 2004; Galiani et al., 2005), easing decision-making procedures (Barrera-Osorio, Tazeen and Patrinos, 2009) and facilitating monitoring of the implementation of the decisions within schools (Junaid Kamal et al., 2005). On the other hand, change towards autonomy may bring school performance down in presence of particular conditions by increasing transaction costs, opening opportunities for corruption and making accountability difficult (see Galiani et al., 2005 for an example on Argentina). Such conditions can be income inequality (Fertig, 2003) and economic development in a country (Hanushek et al., 2013) or lack of accountability mechanisms in a school (see OECD, 2011 on standardized tests). However, countries where school autonomy was deployed also significantly differ in terms of the amount of social capital, and its impact on relationship between school autonomy and performance is not discussed either by international institutions promoting the change or the academia. This paper is a step towards this direction and, first, addresses the question of the effect of autonomy on performance in schools, and then investigates the impact of a potential moderating factor, social capital in a society, on the relationship between school autonomy and performance.

The paper addresses the research question by making a connection between New Public Management approach and social capital theory and by applying multi-level modeling technique based on the data from PISA test (OECD, 2015). The analysis uses two levels of analysis – school- and

country- levels. The model includes variables on test scores, social capital levels, degree of autonomy and school accountability, average social-economic background of students and controls for ownership type and school area. The results of the study have a direct practical relevance as they can serve as a policy advice for educational reforms. It is especially important in light of the World Bank and alike institutions' policies on education in their beneficiary countries. By initiating a discussion on the role of social capital, this paper will help decision-makers creating more tailored policies which take into account specificities of the countries they work in. Additionally, the paper makes a contribution to a theoretical body of research on school autonomy, extending the scope of the studies and introducing a theory of social capital which was not considered previously in studies of effects of school autonomy on school performance. The paper makes first steps in establishing this link and invites other scholars for further investigation on this matter.

The notion of autonomy of schools can refer to several concepts, thus, it is important to clarify the matter in a framework of this paper. As World Bank reports (SABER, 2013), autonomy of schools is a form of management schools in which schools are provided with the authority to do decision-making in relation to their activities, including but not limited to hiring and firing of personnel management budget, evaluation of teachers and teaching practice. This paper considers autonomy in formation of school curriculum and hiring and firing teachers. The choice is dictated by the fact that these two indicators vary in terms of the type of autonomy they capture: one is dedicated to school management and another – to teaching activities. The variation will allow broader conclusions on the effects of autonomy on performance.

The sample used in the study consists of eight countries from post-Soviet region. The countries are an appropriate choice for study of the research question because they, on the one hand differ a lot on social capital dimension (where Azerbaijan has the highest social capital in the sample, and Moldova- the lowest). On the other hand, choosing these countries is a good way to control for many other factors which can affect the performance in schools. The countries in the post-Soviet region have common historical developments, they are similar in political, economic and social dimensions. Also many countries in the region undergone similar educational reforms meeting conditions of loans provided by international institutions (Silova, 2009). Educational systems in the countries in the sample are, in fact, rather similar (see more information in the appendix). All countries, except for Georgia, have at least nine compulsory grades. Generally, after the ninth grade pupils can choose to continue with upper secondary education or to go for a vocational education track. Most of countries also have a

large proportion of schools operating in minority languages, where the prevalent language is Russian, and in most cases education is provided free of charge. These similarities ensure comparability of schools across the sample. To understand the notion of school autonomy, it is important to give an outline of the phenomenon both worldwide and in the studied region. The following section of the introduction will reflect how the school autonomy was spreading around the world and why governments were turning to such measure.

1.1. School autonomy across the world and in the Post-Soviet region

Tolofari (2005) suggests that the move towards more autonomy in public sector has originated in the Great Britain, as long time ago as in nineteenth century, and followed by the USA in 1930-s. The Industrial Revolution has brought reflections of the changes into public sector, which then spread beyond the UK borders (Whitty, 1997). Major transformations around the world, however, have happened at the end of the XX century. Santibanez (2007) reports that the change towards greater autonomy has happened in many countries, and among those are Australia (where the reform took place in 1970-s), Brazil (1982 and 1998), The Netherlands (1992) and Mexico (2001). The list of countries is diverse and shows that a shift towards decentralization in education took place both in developed and developing countries across the continents.

The changes have also taken place in the post-Soviet countries which have experienced both political and economic transition in the 90-s. It also got reflected into the transformation of the education systems in the region and mirrors the trends towards more school autonomy which could be observed in other parts of the world. After the collapse of the Soviet Union, the governments went for a number of structural changes and shared authority in decision making with lower levels of administration (Eklof et al., 2004). Overall, the period is characterized by the principles of pluralism and decentralization and Silova (2009) argues that school reform was aimed at reflecting new principles of democracy and market economy.

The shift for granting more autonomy to schools was pursued for both political and economic reasons. Zajda (2003) argues that in order to decrease the pressure on national budgets, the governments have spread the responsibilities over education policies and budget formulation across the regional authorities and further down the administrative ladder. Zajda (2007) suggests considering autonomy in education as a shift towards "greater efficiency in cost saving, global competitiveness, technological supremacy, social change and accountability" (Zajda, 2007:202). Thus, one of the reasons for granting schools more autonomy is the idea that existing school structures are not flexible

enough for fitting the needs of students and their parents. He argues that in Eastern Europe, as well as in other developing countries, there has been a trend towards decentralization in education sector due to more democratic and accountable practices, assumed by autonomy, more responsiveness to the local needs and boosting amount of funds available to a school by introducing competition in the sector (Zajda, 2007:8).

Thus, autonomy in schools is spread all over the world, while the start of the processes dates back to the 19th century. The measures were undertaken for various reasons, however, were generally considered as increasing transparency, accountability and participation of important stakeholders in school management. The process has come to the post-Soviet region considerably later, however, followed the same path as in other parts of the globe.

To further investigate the research questions this paper, first, introduces theoretical framework in Chapter 2, then highlights methodology used in the study in Chapter 3, proceeds with description of empirical analysis in Chapter 4 and then presents the results of the study.

2. Theoretical underpinnings

2.1. New Public Management

To understand the role of school autonomy for performance, it is, first, important to dig deeper into the New Public Management, which current paper develops on. The approach rests on several theoretical underpinnings. The New Public Management is closely related to three theories, which are the basis for the mechanisms of the effects of autonomy on performance: public choice, agency theories and transaction costs economics. The first of those, Public Choice theory applies economics to political science field and assumes that individuals are rational and selfish, thus, policies need to be done having this in mind. The policies need to be considered, according to the public choice theory, in terms of efficiency and equilibrium (Buchanan and Tollison, 1984). Bringing this to the questions of school autonomy and performance, it is possible to argue that granting schools autonomy is based on the assumption that the principals and other decision-making bodies within school are rational and will do everything in their power to increase efficiency of the school. Speaking in terms of the autonomy for decisions in curriculum and personnel management, it would imply that autonomy allows school choosing the best fitting course choices for the student pool and most qualified personnel for attracting more and better students and, thus, receiving more funds. This, in turn, may improve performance.

Decisions of the similar kind on the higher level would not provide the same efficiency, because school administration is on the grassroots level, and more aware of the ways to make the curriculum and personnel fit more efficient. Thus, this mechanism is based on ability of autonomous actors within schools to tailor the curriculum and to choose best fitting teachers for higher efficiency.

Transaction costs economics gives insights into how established relationships between actors can reduce transactions costs – costs related to search for trusted partners, establishing partnerships and for cooperation, as well as ex-post monitoring of the contract enforcement (Tolofari, 2005). If one, following King and Ozler (1998), considers schools as any other business, then it is possible to see the system of costs which are involved into decision-making processes undergoing in schools. School autonomy decreases the amount of transaction costs involved into decision-making process: schools which have the autonomy can reach agreements internally and externally faster, as the actors on the lower level of administration are more familiar to each other and transaction costs for establishment of the partnerships and reaching agreements are lower. It, in turn, would increase efficiency and school performance by allocating resources to the areas which are most relevant for school performance. Thus, this mechanism is based on the premise of easier decision-making procedures in schools which possess autonomy.

As for the agency theory, Eisenhardt (1989) explains it as applied at "employer-employee, lawyer-client, buyer-supplier, and other agency relationships" (Eisenhardt, 1989: 60). He argues that the relationships are potentially under danger of asymmetry of information. As the agents are self-interested individuals, they may act not as they seem to do for their principals. They may do so because they may pursue different from principals' goals and there are few ways for the principals to monitor the agent. As an implication for the educational sector, in schools which have more autonomy principals (being it the principal, parental or teachers board or all of the above) would find it easier to monitor the agents and to track whether their decisions are being implemented, and whether the curriculum is being put in place as designed. In terms of personnel management school autonomy allows choosing the teachers which fit in terms of the vision of the school operation and development and that may ease the monitoring. Thus, this mechanism is based on the premise of monitoring the agents by the principals.

Literature widely discusses the effects of the autonomy. Generally speaking, New Public Management scholars consider increase in a degree of autonomy as one of the measures for a more efficient public sector functioning (Tolofari, 2005), as it brings public sector closer to the needs of the

territory it is governing (Filmer and Esceland, 2002). Schools which have obtained autonomy in school management policies demonstrate higher performance: for example, academy schools in the UK achieve higher scores in standardized tests due to different incentives structure to improve the performance comparing to other schools (McGinn and Welsh, 1999; Machin and Vernoit, 2011). Clark (2009) also suggests that schools which were able to use their funds to attract the best teachers managed to achieve the best test scores. Apart from the impact of teachers, curriculum is also emphasized to be playing a role in determining school performance. Hoxby and Rockoff (2004) show that US charter schools, which have autonomy in decisions over curriculum perform on average better, since they are able to tailor it according to the students' needs. Another study on American schools (Hannaway and Carnoy, 1993) also suggests that the schools which were more autonomous due to pressure for inclusion of minorities in decision-making perform better.

New Public Management in educational sector is a mainstream approach and pushed for by the international institutions, such as World Bank (SABER, 2015). However, does granting autonomy works the same way everywhere? The next section will discuss social capital theory and how low social capital may disrupt the relationship between school autonomy and performance.

2.2. Social capital

Putnam et al. (1993) in their classical work on governance in Italy argue that cooperation and lack of enforced coercion make institutions more efficient. They refer to the transaction costs theory which was mentioned above and argue that bigger social capital, thus, stronger informal institutions lead to lower transaction costs and, similarly, higher efficiency of public sector (see also Welzel, Inglehart, and Deutsch, 2005). How to define social capital? Putnam et al. (1993) give the following definition: "features of social organization, such as trust, norms, and networks, that can improve the efficiency of society by facilitating coordinated actions" (Putnam et al. (1993: 167). According to him, it is easier to work in society where social capital is higher. The studies following the Putnam's book have investigated the influence of the above-mentioned components on various socio-economic phenomena, including educational sector. Gamarnikow and Green (1999) argue that successful outcomes in education are predetermined by the presence of social capital. In reference to Putnam's famous study on Italian politics, they write: "networks of civic engagement constitute a key element of social capital which operates to enhance institutional performance in the production of collective goods, such as education and health" (Gamarnikow and Green, 1999: 8).

Social capital then may have an impact on the relationship between school autonomy and performance. Social capital may have an effect on all three mechanisms through which the above mentioned relationship can work. Social capital enhances linkages between people and makes interaction smoother, increasing positive effect of autonomy on performance. It, as literature below will demonstrate, increases information flow, eases communication and solidarity, enhancing the mechanisms outlined in previous chapter. On the other hand, societies with low social capital make it difficult for autonomy to work in the predicted direction. Decision-makers of schools in such societies may find it difficulties with finding reliable information for taking efficiency-motivated decisions. They may also find it harder to come to an agreement with other actors involved in decision-making process and also may also experience difficulties with monitoring agents. These conditions require additional efforts and resources spent by the decision-making actors, which, in turn, distract from dedicating those to students. This is expected to decrease the performance, and make school autonomy an ineffective measure in societies with low social capital.

The literature provides support for the argument on importance of social capital for school performance. Pil and Leanna (2009) find that higher levels of social capital bring higher performance of the students because of the frequency and quality of interactions and understanding in learning process, as well as, particularly, in class discussions. In their earlier study, Lean and Pil (2006) also argue that linkages with external to school actors provide access to key external providers of resources. Carbonaro (1998) suggests that social capital, manifested as frequent interaction between students' parents increases the information flow and makes it easier to monitor children. Also, parents become able to judge upon the values which could be transferred from their child's friend' parents to their own child, and "filter" the unwanted people. Similarly, better information flow between parents and school administration is able to provide better fitting school policies when the school is given autonomy, thus, increasing school achievements in standardized tests (Sun, 1998). Social capital also increases trustworthiness and solidarity (Hao and Bonstead-Bruns,1998), which, in turn, make decision-making process easier and increase levels of compliance, leading to higher efficiency of school and better performance. Higher amount of social capital also improve climate in school, which Ho (2005) argues to contribute to the school performance.

Overall, social capital is found to have an effect on school performance by scholars in the field. However, literature does not extensively elaborate on the role of social capital specifically for the relationship between autonomy and performance. Next chapter will address this question empirically.

Based on the theoretical literature, it is hypothesized that higher levels of social capital boosts positively the effect of school autonomy on performance, while lower levels of social capital in a society turn down positive effect of autonomy on performance.

3. Methodology of the study

Thus, the *research question* of the thesis is what is the effect of school autonomy on school performance? And what is the effect of social capital on this relationship?

There are three *hypotheses*; the first hypothesis concerns the overall effect of autonomy over the school performance, while two others are focused on the moderating effect of social capital.

(a) the greater autonomy of the school brings better school performance.

(b) the lower is social capital in a country, the smaller is the positive effect of school autonomy on school performance.

(c*) the higher is social capital in a country, the greater is the positive effect of autonomy of schools on school performance.*

Below is the model which is going to be used for the analysis, where (I) is school level and (II) is state level variables.

$$\textit{school performance(I)} = \beta 1 * \textit{school autonomy(I)} + \beta 2 * \textit{social capital(II)} + \beta 3 * \textit{school autonomy} * \textit{social capital} + \beta 3 * \textit{school external accountability(I)} + \beta 4 * \textit{average socio-economic status of families in school(I)} + \beta 5 * \textit{average education of parents in school(I)} + \beta 6 * \textit{rural/urban location(I)} + \beta 7 * \textit{school ownership(I)} + \beta 8 * \textit{country economic development (II)}$$

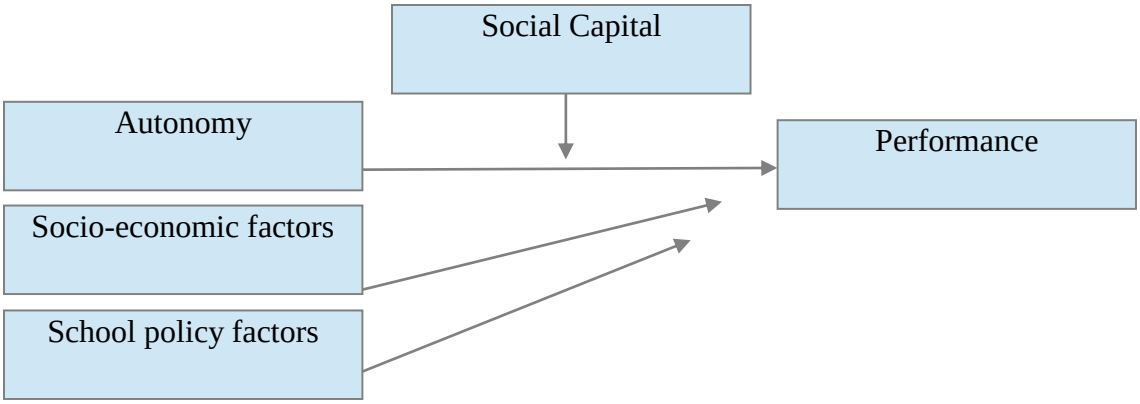

Figure 1. Multi-level model

The dependent variable is school performance. It is a school-level variable, which is operationalized as an average student test scores for schools for math classes. The choice of using math scores was made because it, along with reading, is a major subject in all of the school curricula, however, has more advantages over using reading scores due to the linguistic issue present in the schools in the region. As was mentioned in the introduction, there are a lot of minority schools in the region, which operate in a different than national language, thus, the results may not be consistent across and within the countries. This variable originally exists only on the individual student level in the dataset, thus individual values were combined into averages per school for the analysis.

The main *independent variable* is autonomy of a school. The variable is operationalized in two ways: as autonomy in decisions related to forming curriculum and autonomy in decisions on hiring teachers, because these indicators provide highest variance in the type of decisions delegated to the school. Such choice covers both what students are taught and what kind of personnel teaches them. The indicators are based on the answers to the questionnaires given out to the principals of schools participating in PISA. Each of the variables is recoded as a dummy ("0"- responsibility solely lies on the shoulders of municipal, regional or national authorities, "1" – responsibility solely belongs to an actor within a school, be it principal, teachers or board of parents).

Another important *independent variable* is level of social capital in a country. There is a lot of controversy in the literature on how to operationalize the concept of social capital. Bjornskov (2006) criticizes the use of indices which combine all three elements proposed by Putnam (1993), being trust, norms and networks, as he argues that those describe distinct features of societies and combination of those do not lead to meaningful indices. He comes to a conclusion that social trust alone serves as a

driver for good governance in societies. Newton (2001) also argues that social trust is the most important element in the definition of social capital. Van Deth (2003), in turn, through meta-analysis reports that social trust is among the most common ways to measure social trust (see also Knack, 2002, and de Mello, 2004). Thus, for the purpose of this paper, social trust is used for narrowing down the concept of social capital. It is operationalized using variable from World Value, wave 6 (2015) and European Value Surveys, wave 4 (2015): "Generally speaking, would you say that most people can be trusted or that you need to be very careful in dealing with people?". The answers were recoded as "1"- most people can be trusted, "0" - need to be very careful.

There are also a number of *control variables*. First, as was pointed out by the literature mentioned in the introduction it is important to take into consideration how accountable the school to the external authorities. PISA dataset contains a question on presence of standardized tests as a measure of student assessment. It is coded as a dummy, where "0"- no standardized tests present in the school and "1"- school uses standardized tests for student assessment. Another control variable is an average socio-economic background of the students in the school. One could argue that wealthier schools may perform better just due to the fact that they have more resources both in school and at students' homes, instead of being affected by autonomous school policies. Controlling for this will allow teasing out the effect of autonomy. The variable is continuous and is operationalized by averaging student-level answers from student questionnaire ("How many computers do you have at home?") per school as a proxy for socio-economic background. Another socio-economic variable used is GDP per capita to account for a country-level wealth of schools. A variable on average educational level of parents in school is also included, because it may determine average student achievements in a school. It is an ordinal variable and operationalized from 1 to 6, corresponding to the OECD recognized levels of education. Finally, variables on rural or urban location (where "1"- the school is located in a city, "0"- in a rural area) and public or private ownership of the school (where "1"- the school is private, "0"- public) are also accounted for.

A study addressing this question would consider interplay of structural conditions (amount of social capital in the country) and chosen policies (in the direction of more or less autonomy for schools) in explaining and predicting school performance. To address the abovementioned research question it is possible to use the data from Program for International Student Assessment (PISA) test (PISA, 2015). This large dataset includes extensive information both on student and school levels of analysis, contents not only information on performance but also various socioeconomic indicators

necessary for controlling the results. The test is conducted across more than 60 countries among the 15 year-olds. The test is conducted in three subjects: reading, math and science (PISA, 2015). PISA is largely used in the literature on school performance; however, it has various limitations. The major one relevant for this study is that since PISA is held across eight countries there may be a danger that the translations of the test questions do not mean the same across the languages of the test conducted everywhere, and measured concepts can be different across different contexts (Mazzio and van Davier, 2008).

The *method* chosen for hypothesis testing is statistical analysis, namely multi-level modeling. This method is the most appropriate here as it provides the best treatment for the hierarchical data, which is structured as layers. Multi-level modeling allows taking into account the variance among the different groups. Additionally, from a statistical point of view ignoring clusters of data and not using multi-level modeling violates the assumption of error independence. The data will be tested using intraclass correlation test, since usually clustered data has a significant correlation within groups, thus increasing the chance of Type I error if not accounting for such between group differences. In this particular case, there are two levels of analysis in this study: country and school levels. The focus is one the school level instead of the individual level because the focus of this study are school policies and it is investigated how different school policies affect the performance of the school in terms of academic achievements. Interaction effect has been included for accounting the interplay and conditioning of the effect of social capital in the country on relationship between school autonomy and performance. Multi-level modeling allows providing a test for such cross-level interaction effect (Western 1998; Steenbergen and Bradford, 2002).

There are eight countries in the *sample*, which were part of the Soviet Union previously and are currently present in the OECD study: Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Lithuania, Latvia, Moldova, and Russian Federation. This sample, as was mentioned already in the introduction, was chosen because of methodological considerations. All countries have experienced radical transformations, both political and economic, which has got reflected at similar structure of educational sectors. The sample, thus, from one point of view includes very similar countries, which, however, differ in their amount of social capital in the societies. For example, Azerbaijan scores as 0,45, and Latvia as 0,26 on social trust variables with a scale from 0 to 1. Finally, the countries in the sample demonstrate developed educational institutions (Smolentseva, 2012) which bring high involvement rates, while experience transitional effects of many political and economic institutions in the countries

(Pickles and Smith, 2005). Thus, the sample in the same time demonstrates variance in the social capital, but also allows controlling for a large set of factors due to regional specificities. The PISA dataset under consideration is from 2009 as it includes the most countries in the region of interest.

Such research design has a number of limitations. This study has a limited scope for further inference of the analysis results. It focuses on a particular geographical region with a large set of common social and economic characteristics. This can be limiting factor for generalization of the findings to other countries outside of the sample. Additionally, PISA data used in this study also consists of the estimation of test scores for the students participated. This is so because according to the methodology of OECD, students who take part in the tests do not answer all the questions for the tested subjects, but only randomly selected ones. The scores for the answered questions are then analyzed and average scores estimated for other questions which the student was not given. This, of course, is a limitation of the data as it does not provide a clear but only approximate picture of student abilities in tested subjects. Additionally, focusing only on social trust is rudimentary measure of social capital, although a quiet common one in the literature on this topic. Finally, the operationalization of concepts includes a lot of averaged variables from student-level indicators, which led to a loss of information, due to lack of other data for operationalization of the same concepts.

4. Empirical Analysis

Below descriptive statistics is presented in Table 1. It shows that the average level of education of the students' parents in schools is equal to a value of 5,1, which corresponds to ISCED 5B educational program[1]. Also, countries in the sample demonstrate below OECD average performance in math (the mean is 421.14). Average number of computers belonging to students in schools in the sample own is below 1 and most of the schools in the sample are from small towns or villages and vast majority is public schools. Descriptive statistics also show that the countries in the sample range significantly in terms of GDP per capita (the minimum is 570,30$, the maximum is 8573,00). Most of the schools in the sample are autonomous in matters related to hiring of teachers (mean is equal to 0,82), and have considerable autonomy in relation to decisions on curriculum in school (mean is 0.58).

[1] "[such] programmes are typically shorter than those of tertiary-type A and focus on practical, technical or occupational skills for direct entry into the labour market, although some theoretical foundations may be covered in the respective programmes. They have a minimum duration of two years full-time equivalent at the tertiary level" (OECD, 2015).

Table 1. Descriptive statistics

	N	Minimum	Maximum	Mean	Standard Deviation
Hiring Autonomy	1448	0,00	1,00	0.82	0.38
City School	1448	0,00	1,00	0.43	0.5
Number Computers	1448	1,00	4,00	1.67	0.6
Curriculum Autonomy	1448	0,00	1,00	0.58	0.49
GDP	1448	570,30	8573,00	4162.64	2810.71
Trust	1448	29,10	41,70	0.3	0.09
Parents' Education	1448	2,91	6,00	5.1	0.49
Math Score	1448	203,58	669,41	421.14	68.16
Private School	1448	0,00	1,00	0,03	0,16
Standardized Tests	1448	0,00	1,00	0.92	0.28

Note: Values after removal of missing values. The indicated mean value for highest level of parents' education is a median as the variable is ordinal.

The variables were checked for correlation between them and it showed that there is moderate correlation between GDP per capita and an average number of computers, as both are controls for social-economic factors (see Table 2 below). Such relationship between the variables will be taken into account at the stage of modeling the data by removing correlated variables and observing whether coefficients change.

Table 2. Correlation table

	Hiring autonomy	City School	Number Computers	Curricular autonomy	GDP	Social capital	Parent's Education	Private School	Standardized Tests
Hiring Autonomy	1								
City School	0.06**	1							
Number Computers	-0.18***	-0.3***	1						
Curricular Autonomy	0.1***	-0.003.	-0.01	1					
GDP	0.25***	0.14***	-0.56***	0.11***	1				
Social Capital	-0.14***	0.07***	0.2***	0.09***	0.12***	1			
Parent's Education	0.03	0.39***	-0.19***	-0.01	-0.04	0.21***	1		
Private School	0.04*	0.15***	-0.07**	-0.001.	-0.06	0.01	0.14***	1	
Standardized Tests	-0.08***	0.02	0.003.	-0.02	-0.09***	0.01.	0.03	0.01	1

Below is the figure demonstrating the mean differences in math test scores by country. It shows that the means in test scores averages ranges from about 330 (in Kyrgyzstan) to almost 500 (in Lithuania).

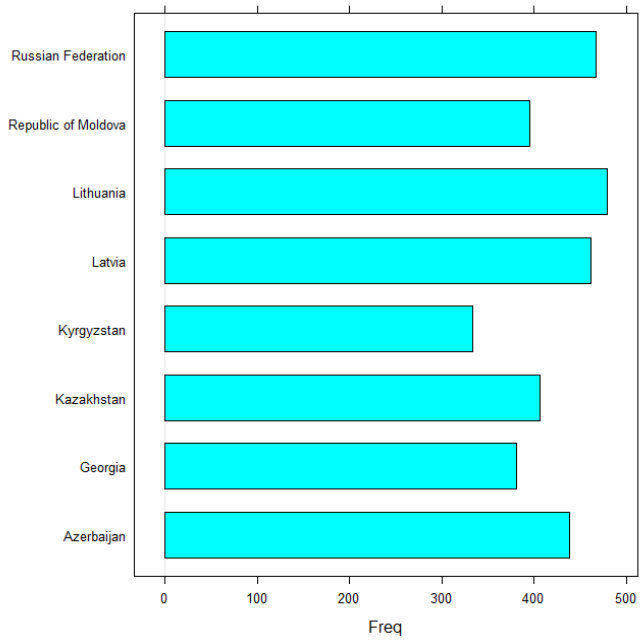

Figure 2. Plot of country differences in math test scores per school

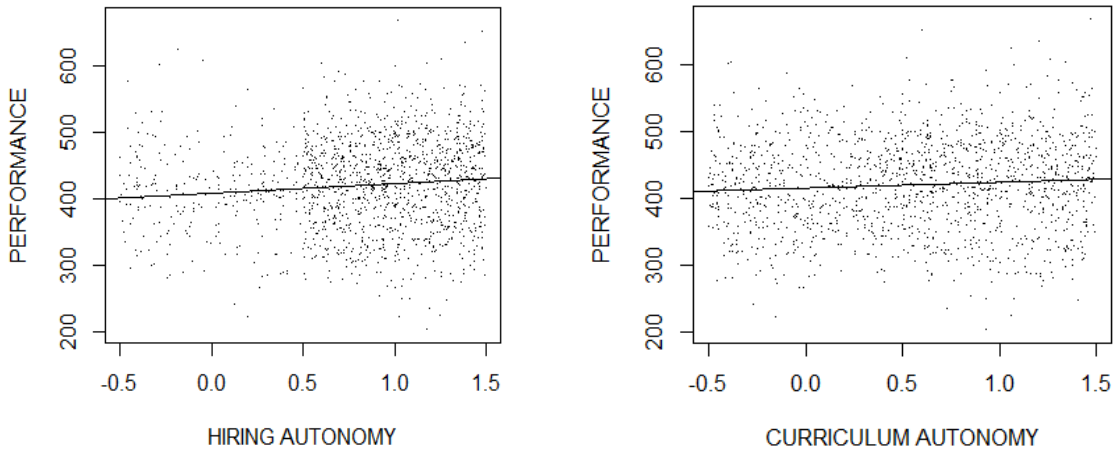

Figure 3. Scatterplot of the pooled data (with jittering).

Figure 3 shows distribution of cases along the dimensions of math test scores and school autonomy, operationalized as dummies for hiring and curriculum autonomy. It shows that when pooled, there is a sign of positive relationship between the two variables, thus, it is possible to suggest that autonomy on average may have a positive effect on school performance in schools in a post-Soviet

region. However, when divided by country, the picture changes.

Below Figure 4 demonstrates that there is mixed evidence for relationship between school autonomy and performance in post-Soviet countries.

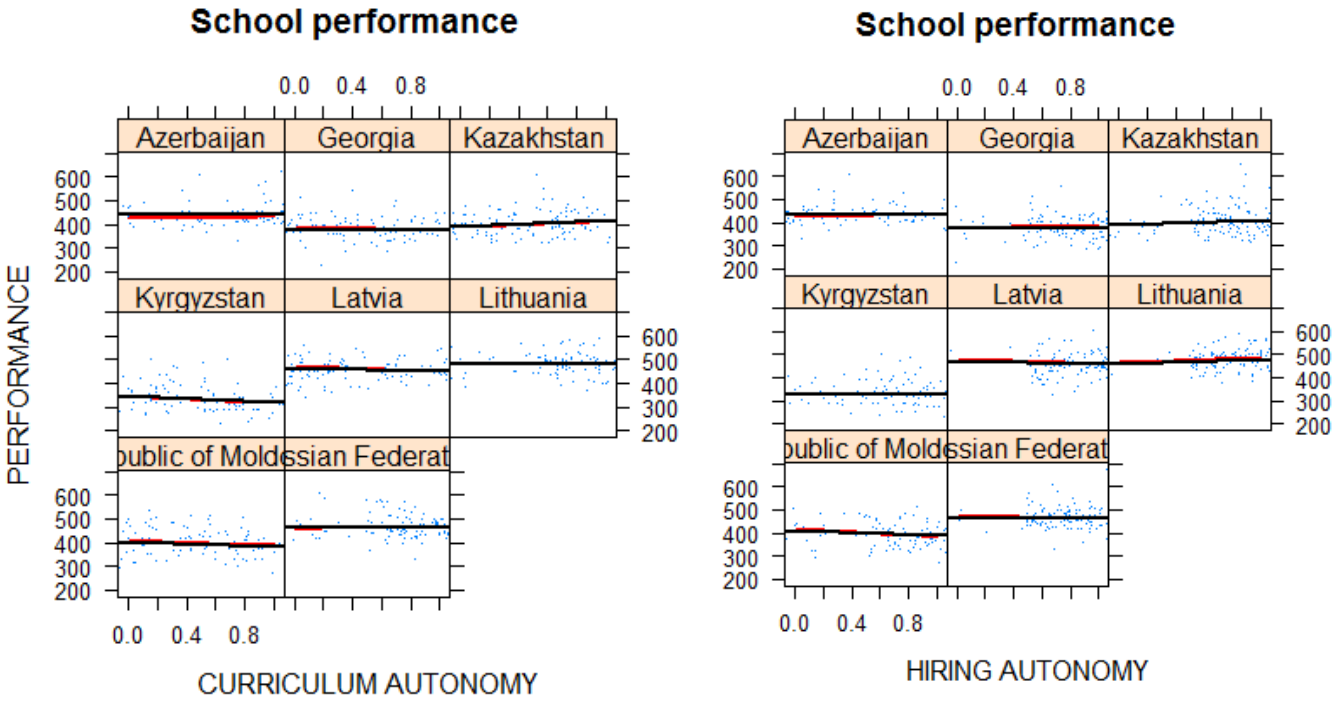

Figure 4. Separate plots by country for school autonomy and school performance (with jittering).

Particularly, Figure 4 shows that the correlation between the two variables becomes less evident once separated by country and for some countries (Moldova, for example) the relationship may be negative. These plots, however, do not take into account control variables, and variable on social capital, which is the focus of this study, thus, further investigation is required for drawing conclusions.

What is also important to notice is that there is a variation in autonomy in schools within countries. It is unusual since national policy is expected to define the autonomy level in schools, making the sample of schools within each country more homogeneous. There are, however, several explanations for this variation. First possible explanation is that principals who fill-in PISA questionnaires interpret the questions in different ways, and autonomy in decisions may refer to a school's discretion to make a choice among possible options set by a higher authority or to an actual right to make their own decision (Maslowski et al., 2007; Orazem et al., 2004). The variance can also be explained by informal institutions, which are a common phenomenon in the region (Welter and

Smallbone, 2011). The informal relations between school principals and, for example, municipal authorities can define how much authority is given to the principal, despite the national policy. Finally, the variance can be explained by the fact that in some countries there are specific types of schools which have more autonomy than others. For example, in Russia since 2006 a school can become autonomous if it wants to upon authorization by a municipality (Gosudarstvennaya Duma, 2006). Unfortunately, the data set does not include indicators for controlling this, the analysis will be done using data which has such variation within countries.

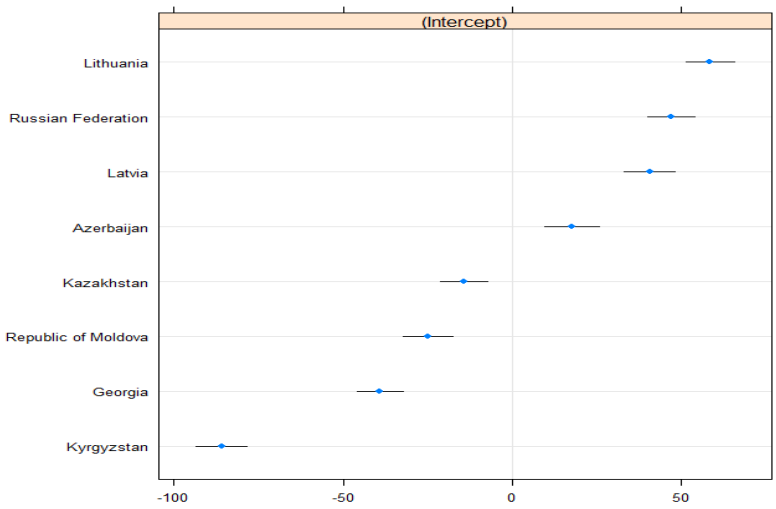

Figure 5. Random intercept model.

There are two sets of models which were produced, based on two ways of operationalization of the main independent variable, school autonomy (Table 3 and 4 below). First table presents analysis results for hiring autonomy in schools, while Table 4 is dedicated to the curriculum autonomy. The multi-level analysis was performed in a step-wise manner, including predictor variables in two stages. At first, variables which are related to structural and school policy-level factors were included. Then, variables which are related to socio-economic profile of school were included instead. Finally, full model is also presented, followed by an OLS pooled regression model. As was suggested in Aguinis et al. (2013), "rescaling predictors is common when conducting multilevel analysis to help in the interpretation of results". Thus, to ease interpretation of the model, and, specifically, of interaction effects, independent variables were grand-mean centered.

The decision on whether to include random or fixed effects in the model was taken during the analysis. On one hand, the plots for bivariate relationships demonstrate that there is a small variance

across the countries in the sample (see Figure 8-12) for several variables, such as average level of parents' education per school, for example. It suggested testing whether random slopes are needed for those variables. Inclusion of several of them and comparison of the change in Log-Likelihood showed that inclusion of random effects for pupils' socio-economic background and parents' education provide the best fitting model (Log-Likelihood is -7484.188 comparing to fixed effect model -7530.714 for hiring autonomy, and -7481.352 comparing to -7527.6 for curriculum autonomy). On the other hand, random intercept was also included for several reasons. First, Figure 5 above demonstrates a plot for random intercept model, which shows that there are differences in intercepts across the countries in the sample, which gives a hint that there should be random intercept included into the model. Second, during the analysis ANOVA test was run to test whether inclusion of random intercept adds up to the explanatory power of the model, and it was significant both statistically and substantially. Finally, and most importantly, intraclass correlation coefficient is equal to 0.49, which suggests that 49% of variance in school performance can be explained by belonging to a particular country. This is a very high number, which shows that the schools in the same countries are very much similar to each other in terms of the test scores. It can be explained by the fact that schools are strongly embedded within the same educational systems, and could be influenced by country-specific economic realities. This also provides support for the choice of the statistical method, as Steenbergen and Bradford (2002) suggest that high intraclass correlations radically increase a chance of Type I error if not using multi-level modeling. Random intercept can take hold of such high within group correlation, thus, it was included.

Table 3. Regression analysis results for math scores, hiring school autonomy

	MLM					OLS
Variable	I (hiring)	II (hiring)	III (hiring)	IV (hiring)	V (hiring)	VI (hiring)
Fixed effects						
Intercept	360.47*** (16.61)	468.65*** (16.37)	422.04*** (21.1)	422.47*** (21.06)	407.52*** (17.55)	416.61*** (7.77)
School autonomy	-1.68 (3.84)	-0.44 (3.39)	-0.78 (3.4)	-0.93 (4.01)	0.02 (3.3)	-18.58*** (3.6)
Parents' education		26.18*** (2.96)	26.31*** (2.97)	26.25*** (2.97)	29.93*** (9.16)	19.27*** (3.13)
Computers		-30.48*** (2.97)	-30.04*** (2.94)	-30.03*** (2.93)	-34.56*** (6.86)	-24.03*** (3.10)
GDP	0.01*** (0.00)		0.01** (0.00)	0.01** (0.00)	0.01*** (0.00)	0.01*** (0.00)
Social capital	-36.92 (97.34)		-8.12 (118.2)	-22.72 (121.03)	-15.23 (60.81)	26.05 (26.05)
Standardized test	6.26 (4.81)		-0.54 (4.25)	-0.53 (4.25)	-0.50 (4.13)	-1.1 (4.67)
City school		7.46*** (2.68)	7.52*** (2.68)	7.39*** (2.69)	7.39*** (2.65)	14.17*** (2.95)
Private school		23.27*** (7.34)	23.48*** (7.34)	23.34*** (7.34)	28.73*** (7.12)	22.21** (8.07)
School autonomy: Social capital				22.50 (28.52)	8.82 (27.8)	-108.28*** (29.95)
Random effects						
Intercept	26.04 (2931)	43.14 (1861)	31.73 (1007)	31.66 (1003)	38.38 (1473.2)	
Residual	50.14 (2514)	44.14 (1948)	44.15 (1950)	44.16 (1950)	42.43 (1800.3)	
Computers					17.14 (293.7)	
Parents' education					24.32 (591.6)	
Log-Likelihood	-7727.91	-7541.89	-7535.295	-7530.714	-7484.188	R^2= 0.48
N groups	8					
N observations	1448					

Note: the values are parameter estimates and standard errors in parentheses for fixed effects. The values for random effects are standard deviations and variance in parentheses. *p<0.1, **p<0.05, ***p<0.01.

Table 4. Regression analysis results for math scores, curriculum school autonomy

	MLM					OLS
Variable	I (curriculum)	II (curriculum)	III (curriculum)	IV (curriculum)	V (curriculum)	VI (curriculum)
Fixed effects						
Intercept	361.34*** (16.75)	468.9*** (16.27)	422.10*** (21.14)	421.49*** (21.06)	408.35*** (17)	403.77*** (7.68)
School autonomy	-3.93 (2.8)	-1.12 (2.47)	-1.16 (2.47)	-1.11 (2.47)	-0.06 (2.38)	1.71 (2.68)
Parents' education		26.15*** (2.97)	26.27*** (2.97)	26.56*** (2.97)	30.25*** (9.09)	17.3*** (3.15)
Computers		-30.46*** (2.92)	-30.03*** (2.97)	-29.9*** (2.93)	-34.39*** (6.68)	-23.87*** (3.12)
GDP	0.01*** (0.00)		0.01** (0.00)	0.01** (0.00)	0.01*** (0.00)	0.01*** (0.00)
Social capital	-33.76 (98.93)		-6.91 (118.73)	-45.57 (119.06)	-43.71 (60.67)	-75.69*** (22.44)
Standardized test	6.4 (4.8)		-0.47 (4.25)	-0.22 (4.24)	-0.28 (4.12)	0.77 (4.73)
City school		7.43*** (2.68)	7.48*** (2.69)	7.19*** (2.68)	7.18*** (2.65)	13.66*** (2.99)
Private school		23.34*** (7.33)	23.51*** (7.33)	23.96*** (7.32)	29.06*** (7.1)	19.82** (8.15)
School autonomy: Social capital				69.02*** (25.04)	53.03** (24.27)	81.29*** (28.16)
Random effects						
Intercept	26.49 (701.6)	43.21 (1867)	31.89 (1017)	31.75 (1008)	36.41 (1326)	
Residual	50.11 (2511)	44.14 (1948)	44.15 (1949)	44.05 (1940)	42.36 (1794.7)	
Computers					16.56 (274.4)	
Parents' education					24.11 (581.3)	
Log-Likelihood	-7727.332	-7542.114	-7535.529	-7527.6	-7481.352	R^2=0.47
N groups	8					
N observations	1448					

Note: the values are parameter estimates and standard errors in parentheses for fixed effects. The values for random effects are standard deviations and variance in parentheses. *p<0.1, **p<0.05, ***p<0.01

Comparison between tables 3 and 4 demonstrates that there is no significant difference between results for multi-level models with school autonomy in personnel management and curriculum. For both tables models V which include random slopes provide the best fit, Log-Likelihoods are the lowest for those models. Analyzing the results one can conclude that on average higher parents' education in school predicts higher average test score in math subject per school. This result is both statistically and substantially significant. Also schools in which student pool has a better socio-economic background perform on average worse ($\beta \approx -35$, $p<0.05$). Inclusion of variable on presence of standardized tests did not show the results which were identified in the academic literature, the indicator was neither substantially nor statistically significant, and school autonomy indicators did not change their coefficients after the inclusion of the variable. Finally, the results also show that schools which are located in cities or towns perform better on math test, as well as do private schools. As for the country-level variables, the analysis shows that the countries with a higher GDP per capita have their schools performing on average slightly better ($\beta=0.01$, $p<0.05$). Having in mind the results of the correlations analysis between independent variables, it was decided to remove correlated variables one after another from the model. Nevertheless, after removal of a variable GDP, other estimators and their statistical significance remained the same. Thus, since the variable is necessary theoretically, it was left in the model.

It is possible to note that for almost all models school autonomy has a small negative effect on school performance. Nevertheless, once the model on hiring autonomy includes random slopes, the coefficient for school autonomy becomes positive (see Table 3). It was decided to do a robustness check to clarify this ambiguity, and school autonomy was also operationalized as a sum of dummies for all dimensions in PISA questionnaire: "responsibility of student admission", "responsibility of hiring teachers", "responsibility of textbook use", "responsibility of course content" and "responsibility of courses offered". The scale was used as another way of operationalization of the school autonomy variable. The results of the analysis shows that all coefficients keep approximately the same values and school autonomy remains its negative sign, though it is still statistically insignificant ($p=0.22$). Thus, it is possible to conclude that there may be an evidence that school autonomy may have a slight negative effect on school performance in post-Soviet region, however, since the result is not statistically significant, for making stronger conclusions more research needs to be done. Possible negative effect can be referred to underdeveloped institutes in the country and lack of strong culture of accountability

and transparency, as suggested by Galiani et al. (2008). As was mentioned previously, they argued that giving more autonomy to schools may be harmful in countries where there are big chances and possibilities for opportunistic behavior, cronyism and corruption.

The tables also differ in coefficients for the interaction between school autonomy and performance. Both coefficients are positive, however, only interaction term for curriculum autonomy is statistically significant (β=53.03, $p<0.05$). For a robust check, a scale of dummies on different dimensions of autonomy mentioned above was again used for running the model. The results demonstrate that, interaction effect is both statistically and substantially significant in predicting math scores (β=19.15, $p<0.05$) when using the scale variable on school autonomy. Thus, the interaction effect between social capital and school autonomy may be important not only in the case of responsibilities for curriculum design, but for other forms of autonomy as well.

As for the interpretation of the interaction effect, the coefficient of the interaction term shows the difference in coefficient for curriculum autonomy between two countries which differ by one point in social capital. Having in mind the grand-mean centering of the variables, the interpretation goes as following (Hayes, 2006). For the schools in countries which are one point of social capital higher than the average, the coefficient for curriculum autonomy is equal to -0.06+(53.03)= 52,97. On the other hand, for the schools in countries which are one point of social capital below the average, the coefficient for curriculum autonomy is equal to -0.06-(53.03)= -53,09. Thus, substantially, the effect of school autonomy on performance is positive in countries with more social capital, while in countries with lower social capital autonomous schools may be disadvantaged, as school autonomy has a negative effect on performance in those countries. This provides support for the hypotheses of this study and underlines importance of social capital for specific type of school autonomy.

Finally, random effects show that there is significant variation between countries. Full list of random effects per country is presented at the Table 5 in the appendix. Overall, social-economic background of students per school and average parents' education vary from positive to negative across the sample which also provide support for the choice of inclusion of random slopes into the model.

Tables 3 and 4 also present results for a pooled OLS regression model. As was previously observed with plots, when the observations are pooled together, the relationship between curriculum autonomy and performance appears to be positive and statistically significant, while hiring autonomy is negatively correlated with school performance. Presence of standardized test for a model on curriculum autonomy also turns to be positive, although remains statistically insignificant. Interaction effect turns

out to be negative for pooled regression model for hiring autonomy. Nevertheless, using OLS model violates the assumption of errors independence, and as intra-class correlation coefficient demonstrated, observations within groups are inter-related, thus, OLS is not an appropriate measure.

Overall, the results of the analysis suggest that school autonomy might be negatively related to school performance, however, further investigation is needed for stronger conclusions as current analysis showed that only school autonomy variables are not statistically significant for predicting math scores. Most important result of this analysis is that schools in countries with higher social capital benefit from higher curriculum autonomy and perform better. On the other hand, more autonomous schools in curriculum design in countries with lower social capital demonstrate worse results in math tests.

5. Conclusions

This study was set to investigate the issues of school autonomy and performance and also the role of social capital for this relationship. The New Public Management approach which had become popular in XX century all over the world pushed the governments towards granting more autonomy to institutions in educational sector. It was and is widely believed that giving more autonomy to schools will increase their performance. However, literature also gives pointers for some conditional factors for such relationship. Social capital is one of the least researched ones. This study was aimed at covering this gap and investigating the role of social capital in post-Soviet countries for the relationship of school autonomy and performance.

The findings showed that social capital has a moderating effect on the relationship between school autonomy, particularly in curriculum-related decisions, and performance. Specifically, countries with higher social capital enjoy on average greater benefits of curriculum autonomy on school performance, while in countries with lower social capital the effect of school autonomy becomes negative for the performance. It can be regarded as evidence for the (b) and (c) hypotheses, outlined in Chapter 3. The study showed that social capital is an important conditional factor for the relationship between autonomy and school performance. The mechanisms of how social capital moderates the effect of school autonomy on performance shall further be tested, however, academic literature suggests that, generally speaking, social capital is advantageous for the effects of school autonomy. Social capital assists the information flow, intensifies linkages between actors and smooths the interaction between individuals for effective tailoring of curriculum and choice of fitting personnel in

schools, enhances the decision-making process and eases monitoring of agents by principal (s).

The study have several limitations, thus, the results need to be taken with caution. The main one is that the analysis was based on the data on school autonomy received from the principals, who may have different interpretations of both wording of the questions asked and of their own power for decision-making. Thus, the indicators which were obtained this way may be biased. Also, as was described in methodology chapter, social capital concept is operationalized through an indicator on social trust, which is although a common way to operationalize the concept, nevertheless, captures it only partially. The results, finally, may be difficult to infer to other countries since the sample used in the study includes similar countries which have a lot of common historic, social and political features.

The results of this study have several theoretical implications. First, the study demonstrated that the post-Soviet region countries do not fit into the New Public Management approach. The analysis suggested that educational institutions in the region may not benefit from greater autonomy, thus, the theory is not applicable everywhere. In this way, the study gives a hint that there may be a contradiction with a majority of studies in the field (for example, discussed in Chapter 2 Hoxby and Rockoff, 2004; Zajda, 2006). Second, it, in opposite provides support to a body of literature which states that there are moderating factors for the relationship between the school autonomy and school performance (for example, Hanushek et al., 2013; Galiani et al., 2005). As mentioned in the introduction, Galiani et al. (2005) argue school autonomy may play a negative role in the educational performance in countries with weak institutions and underdeveloped cultures of accountability. The results of this study may be an evidence for such conclusions. Additionally, the paper also contradicts the results for the role of standardized tests for the school performance. Despite the common evidence for its positive role, schools in the post-Soviet region do not experience either positive or negative effect of the presence of such tests on math test scores.

This study may also be useful for the policy-makers in the countries included in the analysis. The main conclusion which can be drawn from the results of this study is that granting autonomy may not be the best idea for the educational systems in the countries in post-Soviet region which are by low social capital. Policy-wise, the shift towards granting greater autonomy in the region may need to be delayed until the point when social capital grows in the country and more policy efforts need to be put for generating social capital. Also, the results of the study suggest that school autonomy policies are beneficial in the countries with more social capital. In fact, more social capital brings a large positive effect for school performance.

The study had added both to the theoretical body of research and provided insights for policy-action. However, there is a lot to researcher further in this subject. Particularly, it has to be noted that the study can and should be further expanded for a larger sample of countries, for more definitive conclusions on the role of social capital for school autonomy and performance. Also, further research could focus more on the accountability and the institutional development, as another possible driver of autonomy and performance in schools.

Overall, the studies like present one do provide more insights on conditionality of new public management approach and both challenge and enrich body of academic literature on school autonomy. Post-Soviet region demonstrates that there are a lot of shades to the application of the approach in educational sector, and those need to be further addressed and researched. The wave of new public management swapped across all parts of the world, however, there is now some evidence that at least in some places giving more autonomy to schools may not bring the desired results.

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7. Appendix

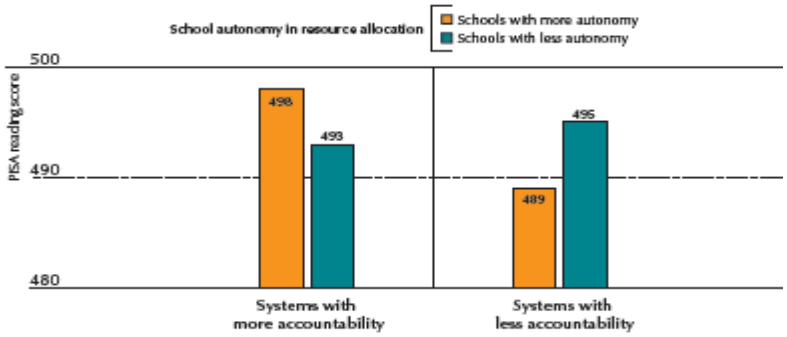

Figure 6. Complex relationship between policies and performance. Source: OECD (2011).

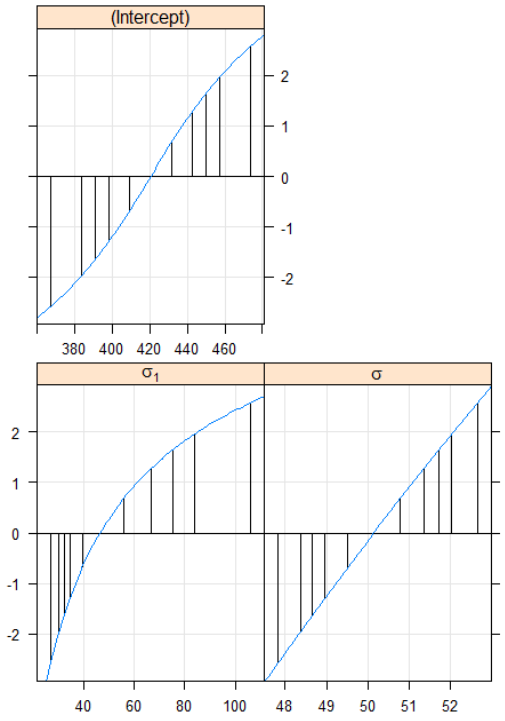

Figure 7. Profile zeta plots.

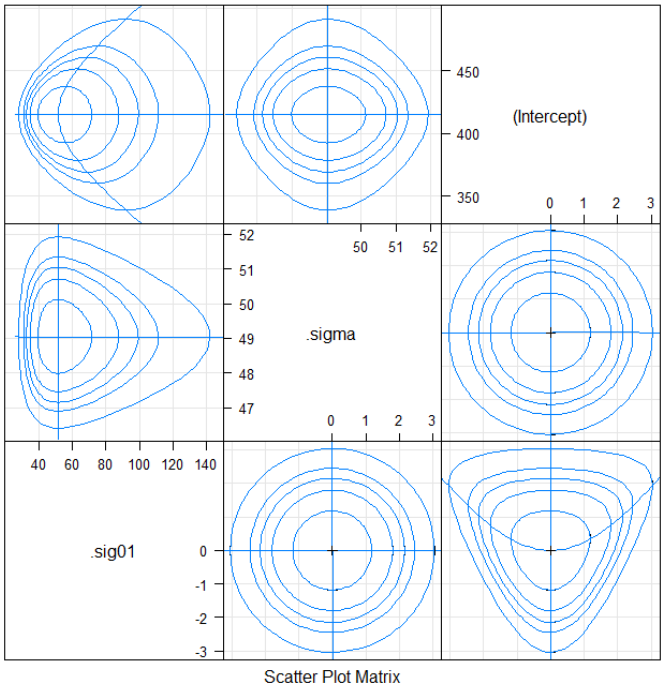

Figure 8. Profile pairs plot

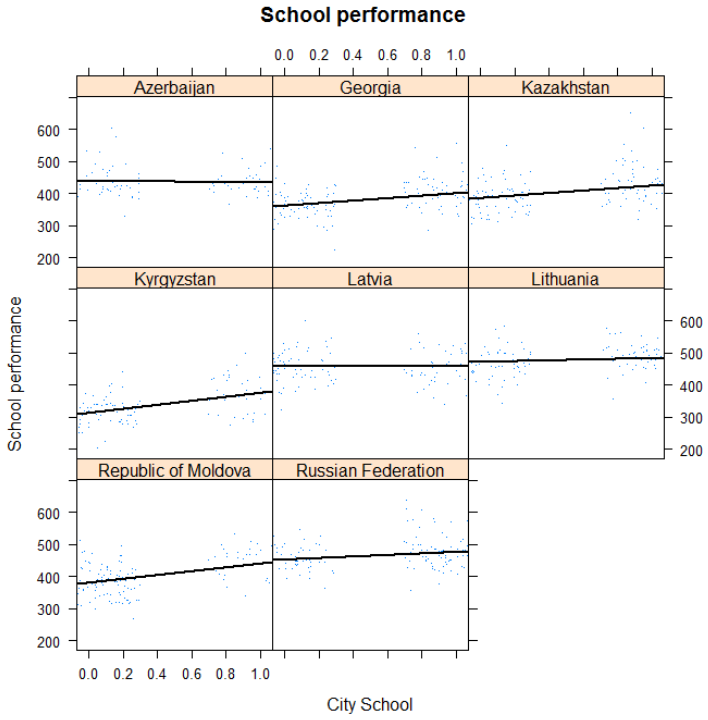

Figure 9. School performance vs. City school by country (with jittering)

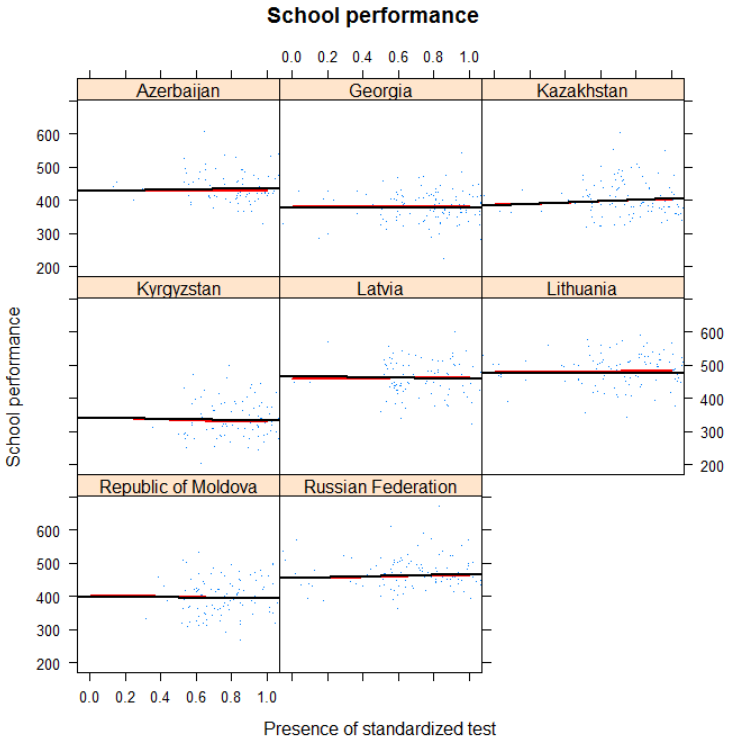

Figure 10. School performance vs. Presence of standardized tests by country (with jittering)

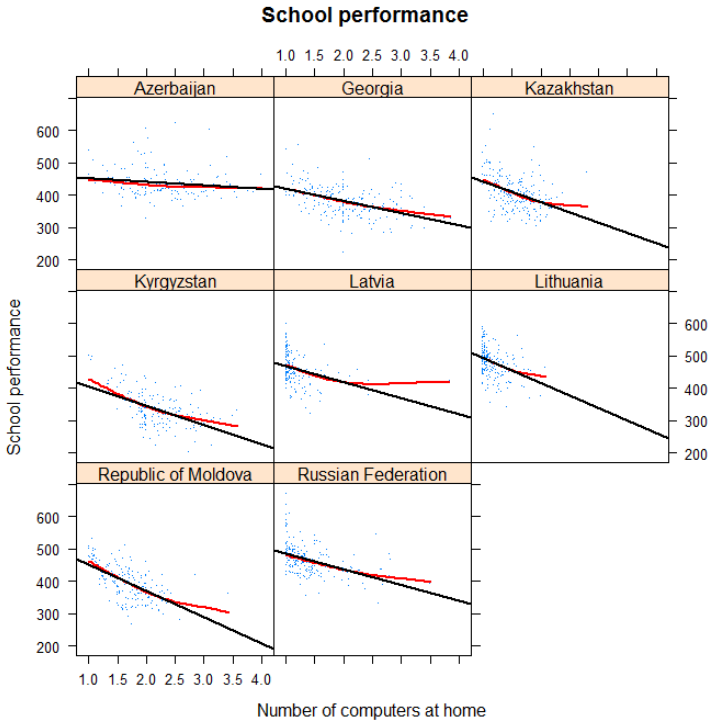

Figure 11. School performance vs. Average number of computers at home by country (with jittering)

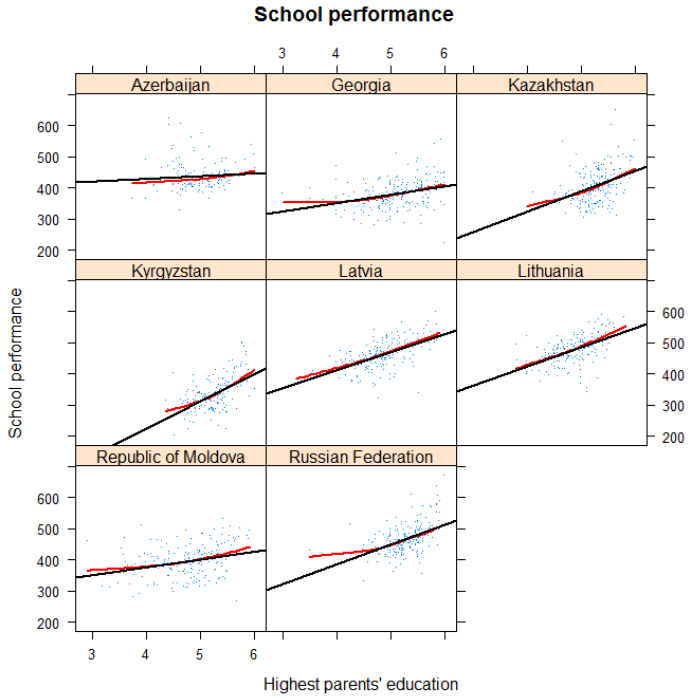

Figure 12. School performance vs. Highest parents' education by country (with jittering)

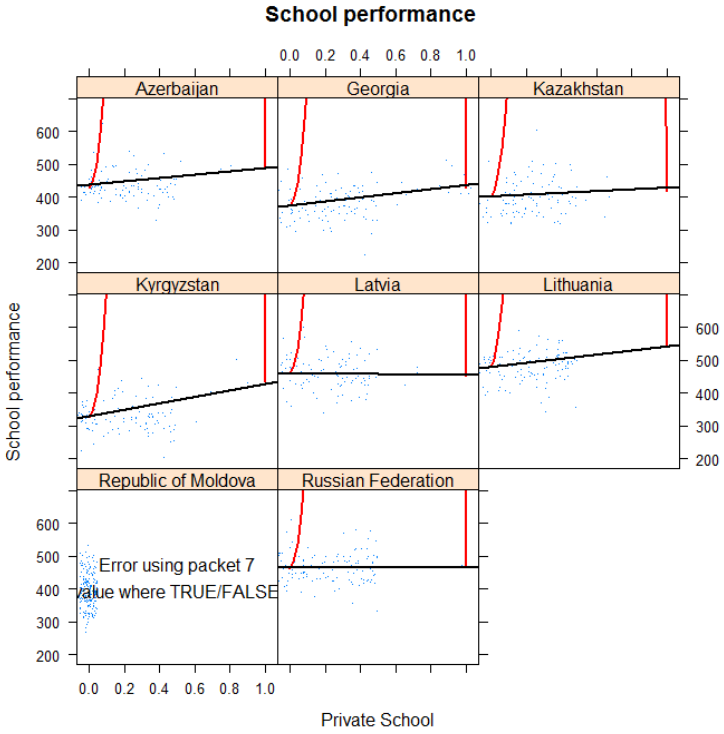

Figure 13. School performance vs. Private school by country (with jittering). Note: there is little variation within the countries, which causes errors.

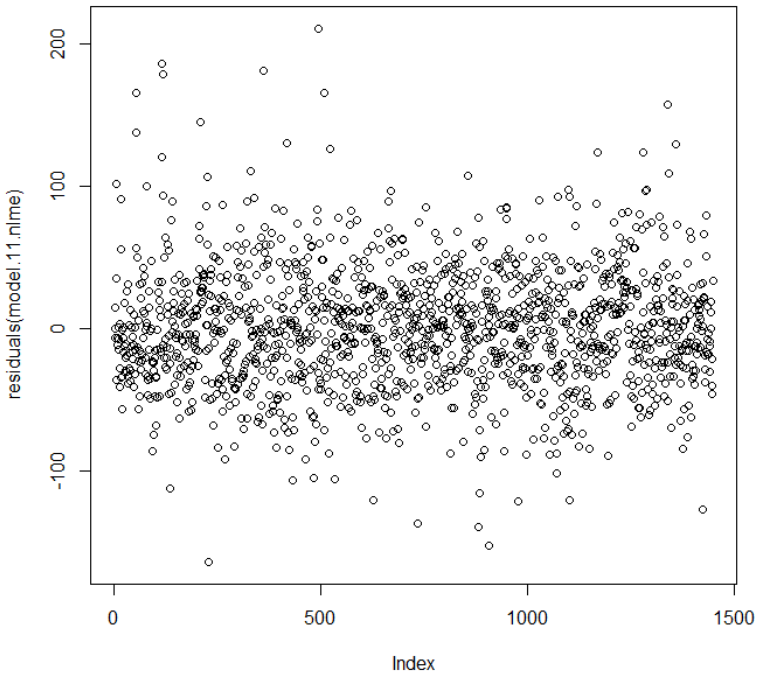

Figure 14. Residuals' diagnostics: residuals

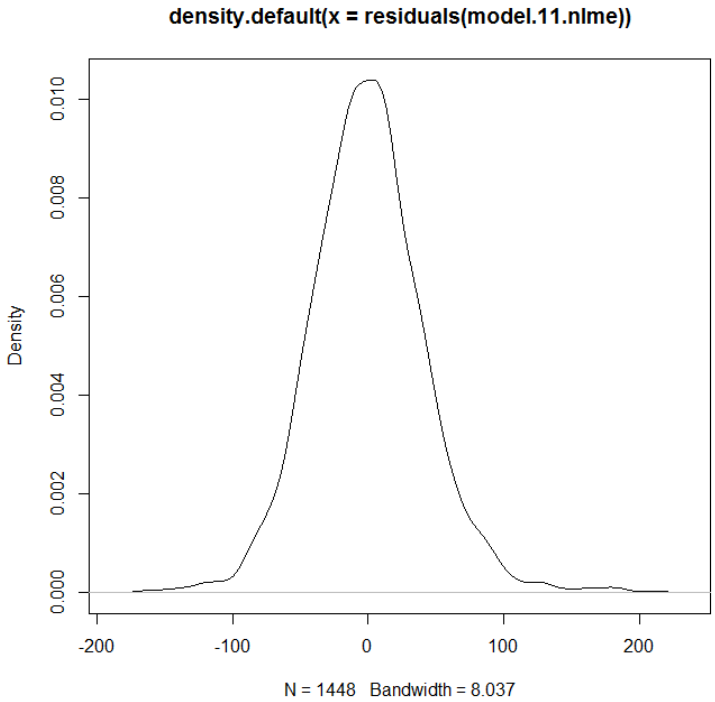

Figure 15. Residuals' diagnostics: density

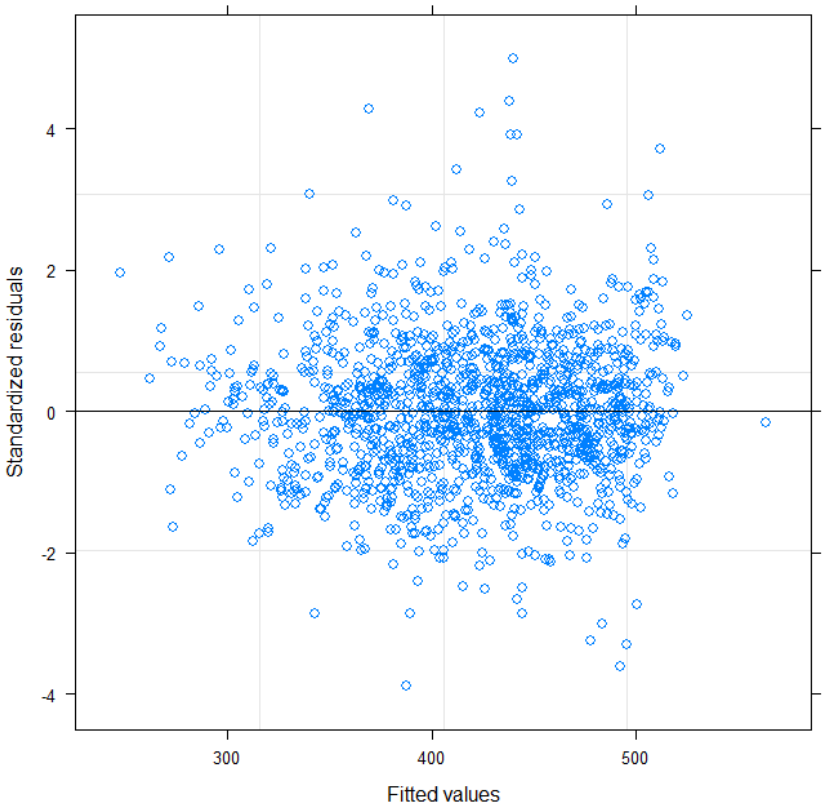

Figure 16. Residuals' diagnostics: standardized residuals vs. fitted values

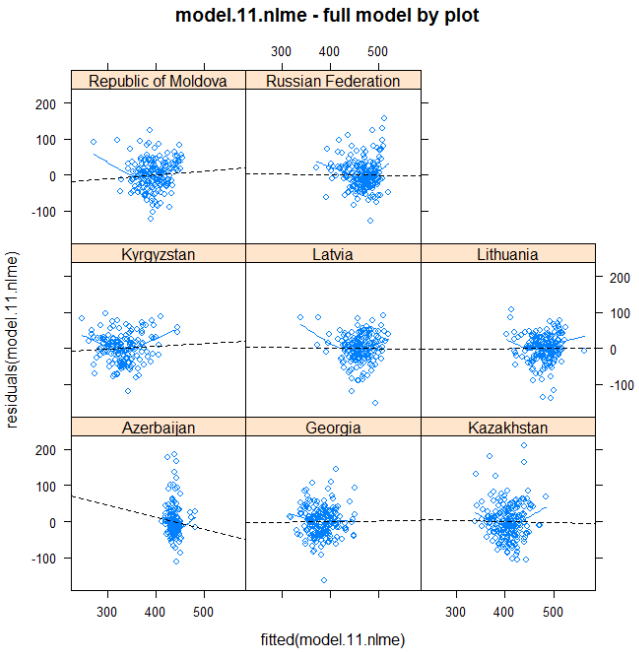

Figure 17. Residuals' diagnostics: residuals vs. fitted values by country

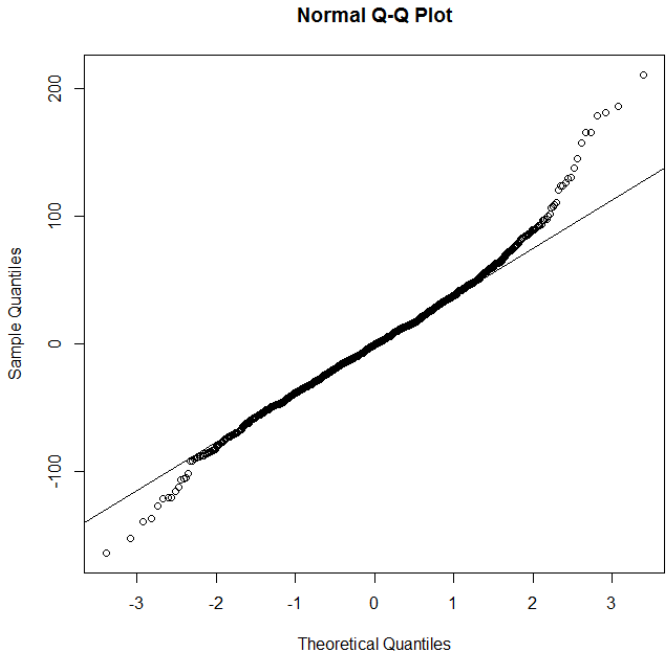

Figure 18. Residuals' diagnostics: residuals vs. fitted values by country

Table 5. Random effects of full models

	Curriculum autonomy			Hiring autonomy		
	Intercept	Computers	Parents' education	Intercept	Computers	Parents' education
Azerbaijan	4.05	23.99	-35.58	6.27	23.73	-36.15
Georgia	-4.80	6.22	-19.80	-2.8	5.86	-19.76
Kazakhstan	-31.05	1.49	11.35	-29.28	0.8	11.85
Kyrgyzstan	-8.02	-5.04	22.57	-8.47	-4.83	22.08
Latvia	-17.37	2.54	18.08	-18.41	2.57	18.19
Lithuania	-16.62	-1.004	18.68	-15.55	-1.52	18.81
Republic of Moldova	76.73	-29.31	-25	71.55	-27.97	-25.01
Russian Federation	-2.92	1.09	9.69	-3.29	1.35	9.99

Appendix 2. R code

```
library(arm)
library(foreign)
library(Hmisc)
library(Zelig)
library(ZeligMultilevel)
library(plotrix)
library(nlme)
library(lme4)
library(car)
library(arm)
library(multilevel)
library(beepr)
library(corpcor)
library(GPArotation)
library(psych)
pisa.data <- read.spss("school_subset_trimmed100.sav", to.data.frame=TRUE)
summary(pisa.data)
describe(pisa.data)
pisa.data <- na.omit(pisa.data)
attach(pisa.data)
STAND_TEST <- scale(STAND_TEST0, center = TRUE, scale = FALSE)
COMP_HOME <- scale(COMP_HOME0, center = TRUE, scale = FALSE)
HISCED1 <- scale(HISCED10, center = TRUE, scale = FALSE)
SOCCAP <- scale(SOCCAP0, center = TRUE, scale = FALSE)
pisa.data <- cbind(pisa.data,  STAND_TEST, COMP_HOME, HISCED1)
pisa.data <- cbind(pisa.data, SOCCAP)
summary(pisa.data)

# Scatterplot of pooled data (with jittering)
plot(jitter(HIRE_SCHOOL_DUMMY, factor=2.5), jitter(MATH_AVER1, factor=2.5), pch=".",
    ylab="PERFORMANCE",
    xlab="HIRING AUTONOMY")
abline(lm(MATH_AVER1~HIRE_SCHOOL_DUMMY))

plot(jitter(COURSE_SCHOOL_DUMMY, factor=2.5), jitter(MATH_AVER1, factor=2.5), pch=".",
    ylab="PERFORMANCE",
    xlab="CURRICULUM  AUTONOMY")
abline(lm(MATH_AVER1~COURSE_SCHOOL_DUMMY))

# separate plots and regression lines: separate models/no pooling
xyplot(MATH_AVER1~HIRE_SCHOOL_DUMMY | COUNTRY, data=pisa.data, main="School
performance",
  ylab="PERFORMANCE",
```

```
  xlab="HIRING AUTONOMY",
  panel=function(x, y){
    panel.xyplot(jitter(x, factor=2.5), jitter(y, factor=2.5), pch=".")
    panel.loess(x, y, span=1, lwd=2, col="red")
    panel.lmline(x, y, lty=1, lwd=2)
    }, as.table=TRUE
  )

xyplot(MATH_AVER1~COURSE_SCHOOL_DUMMY | COUNTRY, data=pisa.data, main="School
performance",
  ylab="PERFORMANCE",
  xlab="CURRICULUM AUTONOMY",
  panel=function(x, y){
    panel.xyplot(jitter(x, factor=2.5), jitter(y, factor=2.5), pch=".")
    panel.loess(x, y, span=1, lwd=2, col="red")
    panel.lmline(x, y, lty=1, lwd=2)
    }, as.table=TRUE
  )

###### Baseline Models: Intercept-Only ######

# school performance by country

### Fixed effects model: without intercept

model.1 <- lm(MATH_AVER1 ~ factor(COUNTRY) - 1, pisa.data)
summary(model.1)
display(model.1, digits=3, detail=TRUE) #('arm' library: more useful for tables)

### Random intercept model
model.2 <- lmer(MATH_AVER1 ~ 1 + (1|COUNTRY), pisa.data)
summary(model.2)
#fixef(model.2)
#ranef(model.2)
dotplot(ranef(model.2, condVar=TRUE))
qqmath(ranef(model.2, condVar=TRUE))
#coef(model.2)

# ICC: Intraclass Correlation Coefficient:
ICC1(aov(MATH_AVER1 ~ COUNTRY, pisa.data))
# -> 49% of variance in 'school performance' can be 'explained' by country membership

# Confidence interval for model parameters: re-fitting model using ML criterion (LR Test)
model.2.ci <- profile(model.2)
summary(model.2) #display model again (for easier comparison)
confint(model.2.ci)
```

```
# plot of signed square root of LR test statistic for each parameter value
  # indicates sensitivity of the model fit to changes in parameters
  # comparison to quantiles of standard normal distribution
xyplot(model.2.ci, aspect = 1.3)
  # vertical lines delimit 50%, 80%, 90%, 95% and 99% confidence intervals
xyplot(model.2.ci, absVal = TRUE)
  # profiled deviance (absolute square root value)

# Profile pairs plot: how parameters influence each other
  # conditional estimates of parameters while holding parameter constant at certain values
  # contours (circles) correspond to 2-D marginal confidence regions at particular confidence levels,
  # based on interpolated contours of two-dimensional profiled deviance function
  # profile traces (vertical & horizontal contour lines): conditional estimates
splom(model.2.ci)

###### Explanatory Models 1: Intercepts & Slopes with single IV ######
# School performance by school autonomy by country
### Pooled regression model
model.3 <- lm(MATH_AVER1 ~ COURSE_SCHOOL_DUMMY, pisa.data)
summary(model.3)
display(model.3, digits=3, detail=TRUE)
#diagnostics
plot(density(residuals(model.3))) #kernel density plot
par(mfrow=c(2,2))
plot(model.3)
par(mfrow=c(1,1))
residualPlots(model.3)
qqPlot(model.3)

### Fixed effects model

model.4 <- lm(MATH_AVER1 ~ COURSE_SCHOOL_DUMMY + factor(COUNTRY) - 1, pisa.data)
display(model.4, digits=3, detail=TRUE)
#diagnostics
par(mfrow=c(2,2))
plot(model.4)
par(mfrow=c(1,1))
residualPlots(model.4)
qqPlot(model.4)
anova(model.3,model.4)

model.5 <- lm(MATH_AVER1 ~ HIRE_SCHOOL_DUMMY, pisa.data)
summary(model.5)
display(model.5, digits=3, detail=TRUE)
#diagnostics
```

```
plot(density(residuals(model.5))) #kernel density plot
par(mfrow=c(2,2))
plot(model.5)
par(mfrow=c(1,1))
residualPlots(model.5)
qqPlot(model.5)

### Fixed effects model

model.6 <- lm(MATH_AVER1 ~ HIRE_SCHOOL_DUMMY + factor(COUNTRY) - 1, pisa.data)
display(model.6, digits=3, detail=TRUE)
#diagnostics
par(mfrow=c(2,2))
plot(model.6)
par(mfrow=c(1,1))
residualPlots(model.6)
qqPlot(model.6)
anova(model.5,model.6)


# Additional level-1 predictors

### Plotting the bivariate relationships

# Plot of School performance by area | country
xyplot(MATH_AVER1 ~ CITY | COUNTRY, data=pisa.data, main="School performance",
  ylab="School performance",
  xlab="City",
  panel=function(x, y){
    panel.xyplot(jitter(x, factor=1.5), jitter(y, factor=2.5), pch=".")
    panel.lmline(x, y, lty=1, lwd=2)
    }, as.table = TRUE
  )

# Plot of School performance by ownership type | country
xyplot(MATH_AVER1 ~ SC02Q01 | COUNTRY, data=pisa.data, main="School performance",
  ylab="School performance",
  xlab="Private",
  panel=function(x, y){
    panel.xyplot(jitter(x, factor=1.5), jitter(y, factor=2.5), pch=".")
    panel.lmline(x, y, lty=1, lwd=2)
    }, as.table = TRUE
  )


# Plot of School performance by standardized test | country
```

```
xyplot(MATH_AVER1 ~ STAND_TEST0 | COUNTRY, data=pisa.data, main="School performance",
  ylab="School performance",
  xlab="Presence of standardized test",
  panel=function(x, y){
    panel.xyplot(jitter(x, factor=2.5), jitter(y, factor=2.5), pch=".")
    panel.loess(x, y, span=1, lwd=2, col="red")
    panel.lmline(x, y, lty=1, lwd=2)
    }, as.table = TRUE
  )

# Plot of School performance by socio-economic background | country
xyplot(MATH_AVER1 ~  COMP_HOME0 | COUNTRY, data=pisa.data, main="School performance",
  ylab="School performance",
  xlab="Number of computers at home",
  panel=function(x, y){
    panel.xyplot(jitter(x, factor=2.5), jitter(y, factor=2.5), pch=".")
    panel.loess(x, y, span=1, lwd=2, col="red")
    panel.lmline(x, y, lty=1, lwd=2)
    }, as.table = TRUE
  )

# Plot of School performance by parent's education | country
xyplot(MATH_AVER1 ~  HISCED10 | COUNTRY, data=pisa.data, main="School performance",
  ylab="School performance",
  xlab="Highest parents' education",
  panel=function(x, y){
    panel.xyplot(jitter(x, factor=2.5), jitter(y, factor=2.5), pch=".")
    panel.loess(x, y, span=1, lwd=2, col="red")
    panel.lmline(x, y, lty=1, lwd=2)
    }, as.table = TRUE
  )

#Follow-up with formal statistical tests: separate OLS regression models

summary(lmList(MATH_AVER1 ~ STAND_TEST0 | COUNTRY, data=pisa.data))
plot(intervals(lmList(MATH_AVER1 ~ STAND_TEST | COUNTRY, data=pisa.data)))
summary(lmList(MATH_AVER1 ~ COMP_HOME0 | COUNTRY, data=pisa.data))
plot(intervals(lmList(MATH_AVER1 ~ COMP_HOME | COUNTRY, data=pisa.data)))
summary(lmList(MATH_AVER1 ~ HISCED10 | COUNTRY, data=pisa.data))
plot(intervals(lmList(MATH_AVER1 ~ HISCED1 | COUNTRY, data=pisa.data)))
summary(lmList(MATH_AVER1 ~ CITY | COUNTRY, data=pisa.data))
plot(intervals(lmList(MATH_AVER1 ~ CITY | COUNTRY, data=pisa.data)))
summary(lmList(MATH_AVER1 ~ SC02Q01| COUNTRY, data=pisa.data))
plot(intervals(lmList(MATH_AVER1 ~ SC02Q01 | COUNTRY, data=pisa.data)))

#curriculum autonomy
```

```
model.8.lme4 <- lmer(MATH_AVER1 ~ COURSE_SCHOOL_DUMMY + STAND_TEST +SOCCAP
+ GDP+(1 | COUNTRY), pisa.data)
summary(model.8.lme4)
display(model.8.lme4, digits=3, detail=TRUE)  #better for fit statistics: Deviance, AIC, BIC
#fixef(model.8.lme4)
#ranef(model.8.lme4)
dotplot(ranef(model.8.lme4, condVar=TRUE), scales=list(x=list(relation='free')))
#coef(model.8.lme4)

model.8.nlme <- lme(fixed = MATH_AVER1 ~ COURSE_SCHOOL_DUMMY +STAND_TEST
+GDP +SOCCAP,
                random = ~ 1 | COUNTRY, pisa.data)
summary(model.8.nlme)
intervals(model.8.nlme)
#fixef(model.8.nlme)
#ranef(model.8.nlme)
plot(ranef(model.8.nlme))
#coef(model.8.nlme)

model.9.lme4 <- lmer(MATH_AVER1 ~ COURSE_SCHOOL_DUMMY +  HISCED1 +
COMP_HOME0 + CITY + SC02Q01 +(1 | COUNTRY), pisa.data)
summary(model.9.lme4)
display(model.9.lme4, digits=3, detail=TRUE)  #better for fit statistics: Deviance, AIC, BIC
#fixef(model.9.lme4)
#ranef(model.9.lme4)
dotplot(ranef(model.9.lme4, condVar=TRUE), scales=list(x=list(relation='free')))
#coef(model.9.lme4)

model.9.nlme <- lme(fixed = MATH_AVER1 ~ COURSE_SCHOOL_DUMMY + HISCED1 +
COMP_HOME0 + CITY + SC02Q01,
                random = ~ 1 | COUNTRY, pisa.data)
summary(model.9.nlme)
intervals(model.9.nlme)
#fixef(model.9.nlme)
#ranef(model.9.nlme)
plot(ranef(model.9.nlme))
#coef(model.9.nlme)

model.10.lme4 <- lmer(MATH_AVER1 ~ COURSE_SCHOOL_DUMMY +  HISCED1 +
COMP_HOME0 + CITY + SC02Q01 + STAND_TEST +GDP +SOCCAP + (1 | COUNTRY),
pisa.data)
summary(model.10.lme4)
display(model.10.lme4, digits=3, detail=TRUE)  #better for fit statistics: Deviance, AIC, BIC
#fixef(model.10.lme4)
#ranef(model.10.lme4)
```

```
dotplot(ranef(model.10.lme4, condVar=TRUE), scales=list(x=list(relation='free')))
#coef(model.10.lme4)

model.10.nlme <- lme(fixed = MATH_AVER1 ~ COURSE_SCHOOL_DUMMY + HISCED1 +
COMP_HOME0 + CITY+ SC02Q01 + STAND_TEST +GDP +SOCCAP,
                random = ~ 1 | COUNTRY, pisa.data)
summary(model.10.nlme)
intervals(model.10.nlme)
#fixef(model.10.nlme)
#ranef(model.10.nlme)
plot(ranef(model.10.nlme))
#coef(model.10.nlme)

model.11.lme4 <- lmer(MATH_AVER1 ~ COURSE_SCHOOL_DUMMY +  HISCED1 +
COMP_HOME0 + CITY + SC02Q01 + STAND_TEST +GDP +SOCCAP +
COURSE_SCHOOL_DUMMY:SOCCAP +(1 | COUNTRY), pisa.data)
summary(model.11.lme4)
display(model.10.lme4, digits=3, detail=TRUE)  #better for fit statistics: Deviance, AIC, BIC
#fixef(model.10.lme4)
#ranef(model.10.lme4)
dotplot(ranef(model.10.lme4, condVar=TRUE), scales=list(x=list(relation='free')))
#coef(model.10.lme4)

model.11.nlme <- lme(fixed = MATH_AVER1 ~ COURSE_SCHOOL_DUMMY + HISCED1 +
COMP_HOME0 + CITY+ SC02Q01 + STAND_TEST +GDP +SOCCAP
+COURSE_SCHOOL_DUMMY:SOCCAP,
                random = ~ 1 | COUNTRY, pisa.data)
summary(model.11.nlme)
intervals(model.10.nlme)
#fixef(model.10.nlme)
#ranef(model.10.nlme)
plot(ranef(model.10.nlme))

model.12.lme4 <- lmer(MATH_AVER1 ~ COURSE_SCHOOL_DUMMY +  HISCED1 +
COMP_HOME0 + CITY + SC02Q01 + STAND_TEST +GDP +SOCCAP +
COURSE_SCHOOL_DUMMY:SOCCAP +(1+COMP_HOME0 + HISCED1 | COUNTRY), pisa.data)
summary(model.11.lme4)
display(model.10.lme4, digits=3, detail=TRUE)  #better for fit statistics: Deviance, AIC, BIC
#fixef(model.10.lme4)
#ranef(model.10.lme4)
dotplot(ranef(model.10.lme4, condVar=TRUE), scales=list(x=list(relation='free')))
#coef(model.10.lme4)

model.13.nlme <- lme(fixed = MATH_AVER1 ~ COURSE_SCHOOL_DUMMY + HISCED1 +
COMP_HOME0 + CITY+ SC02Q01 + STAND_TEST +GDP +SOCCAP
+COURSE_SCHOOL_DUMMY:SOCCAP,
```

```
                random = ~ 1 + COMP_HOME0 + HISCED1| COUNTRY, pisa.data)
summary(model.11.nlme)
intervals(model.11.nlme)
fixef(model.11.nlme)
ranef(model.11.nlme)
plot(ranef(model.10.nlme))
#coef(model.10.nlme)
#coef(model.10.nlme)

model.14.lm <- lm(MATH_AVER1 ~ COURSE_SCHOOL_DUMMY + HISCED1 + COMP_HOME0
+ CITY+ SC02Q01 + STAND_TEST +GDP +SOCCAP +COURSE_SCHOOL_DUMMY:SOCCAP,
              pisa.data)
summary(model.11.lm)
intervals(model.10.nlme)
#fixef(model.10.nlme)
#ranef(model.10.nlme)
plot(ranef(model.10.nlme))
#coef(model.10.nlme)

#hiring autonomy

model.15.lme4 <- lmer(MATH_AVER1 ~ HIRE_SCHOOL_DUMMY + STAND_TEST +SOCCAP +
GDP+(1 | COUNTRY), pisa.data)
summary(model.15.lme4)
display(model.15.lme4, digits=3, detail=TRUE)  #better for fit statistics: Deviance, AIC, BIC
#fixef(model.15.lme4)
#ranef(model.15.lme4)
dotplot(ranef(model.15.lme4, condVar=TRUE), scales=list(x=list(relation='free')))
#coef(model.15.lme4)

model.15.nlme <- lme(fixed = MATH_AVER1 ~ HIRE_SCHOOL_DUMMY +STAND_TEST +GDP
+SOCCAP,
                random = ~ 1 | COUNTRY, pisa.data)
summary(model.15.nlme)
intervals(model.15.nlme)
#fixef(model.15.nlme)
#ranef(model.15.nlme)
plot(ranef(model.15.nlme))
#coef(model.15.nlme)

model.16.lme4 <- lmer(MATH_AVER1 ~ HIRE_SCHOOL_DUMMY +  HISCED1 + COMP_HOME0
+ CITY + SC02Q01 +(1 | COUNTRY), pisa.data)
summary(model.16.lme4)
display(model.16.lme4, digits=3, detail=TRUE)  #better for fit statistics: Deviance, AIC, BIC
#fixef(model.16.lme4)
#ranef(model.16.lme4)
```

```
dotplot(ranef(model.16.lme4, condVar=TRUE), scales=list(x=list(relation='free')))
#coef(model.16.lme4)

model.16.nlme <- lme(fixed = MATH_AVER1 ~ HIRE_SCHOOL_DUMMY + HISCED1 +
COMP_HOME0 + CITY + SC02Q01,
                random = ~ 1 | COUNTRY, pisa.data)
summary(model.16.nlme)
intervals(model.16.nlme)
#fixef(model.16.nlme)
#ranef(model.16.nlme)
plot(ranef(model.16.nlme))
#coef(model.16.nlme)

model.17.lme4 <- lmer(MATH_AVER1 ~ HIRE_SCHOOL_DUMMY +  HISCED1 + COMP_HOME0
+ CITY + SC02Q01 + STAND_TEST +GDP +SOCCAP + (1 | COUNTRY), pisa.data)
summary(model.17.lme4)
display(model.17.lme4, digits=3, detail=TRUE)  #better for fit statistics: Deviance, AIC, BIC
#fixef(model.17.lme4)
#ranef(model.17.lme4)
dotplot(ranef(model.17.lme4, condVar=TRUE), scales=list(x=list(relation='free')))
#coef(model.17.lme4)

model.17.nlme <- lme(fixed = MATH_AVER1 ~ HIRE_SCHOOL_DUMMY + HISCED1 +
COMP_HOME0 + CITY+ SC02Q01 + STAND_TEST +GDP +SOCCAP,
                random = ~ 1 | COUNTRY, pisa.data)
summary(model.17.nlme)
intervals(model.17.nlme)
#fixef(model.17.nlme)
#ranef(model.17.nlme)
plot(ranef(model.17.nlme))
#coef(model.17.nlme)


model.18.lme4 <- lmer(MATH_AVER1 ~ HIRE_SCHOOL_DUMMY +  HISCED1 + COMP_HOME0
+ CITY + SC02Q01 + STAND_TEST +GDP +SOCCAP + HIRE_SCHOOL_DUMMY:SOCCAP +(1 |
COUNTRY), pisa.data)
summary(model.18.lme4)
display(model.18.lme4, digits=3, detail=TRUE)  #better for fit statistics: Deviance, AIC, BIC
#fixef(model.18.lme4)
#ranef(model.18.lme4)
dotplot(ranef(model.18.lme4, condVar=TRUE), scales=list(x=list(relation='free')))
#coef(model.18.lme4)

model.18.nlme <- lme(fixed = MATH_AVER1 ~ HIRE_SCHOOL_DUMMY + HISCED1 +
COMP_HOME0 + CITY+ SC02Q01 + STAND_TEST +GDP +SOCCAP
+HIRE_SCHOOL_DUMMY:SOCCAP,
```

```
                random = ~ 1 | COUNTRY, pisa.data)
summary(model.18.nlme)
intervals(model.18.nlme)
#fixef(model.18.nlme)
#ranef(model.18.nlme)
plot(ranef(model.18.nlme))

model.19.lme4 <- lmer(MATH_AVER1 ~ HIRE_SCHOOL_DUMMY +  HISCED1 + COMP_HOME0
+ CITY + SC02Q01 + STAND_TEST +GDP +SOCCAP + HIRE_SCHOOL_DUMMY:SOCCAP
+(1+COMP_HOME0 + HISCED1 | COUNTRY), pisa.data)
summary(model.19.lme4)
display(model.19.lme4, digits=3, detail=TRUE)  #better for fit statistics: Deviance, AIC, BIC
#fixef(model.19.lme4)
#ranef(model.19.lme4)
dotplot(ranef(model.19.lme4, condVar=TRUE), scales=list(x=list(relation='free')))
#coef(model.19.lme4)

model.19.nlme <- lme(fixed = MATH_AVER1 ~ HIRE_SCHOOL_DUMMY + HISCED1 +
COMP_HOME0 + CITY+ SC02Q01 + STAND_TEST +GDP +SOCCAP +
AUTONOMY_DUMMY_SUM:SOCCAP,
                random = ~ 1 + COMP_HOME0 + HISCED1| COUNTRY, pisa.data)
summary(model.19.nlme)
intervals(model.19.nlme)
#fixef(model.19.nlme)
ranef(model.19.nlme)
plot(ranef(model.19.nlme))
#coef(model.19.nlme)
#coef(model.19.nlme)

model.20.lm <- lm(MATH_AVER1 ~ HIRE_SCHOOL_DUMMY + HISCED1 + COMP_HOME0 +
CITY+ SC02Q01 + STAND_TEST +GDP +SOCCAP +HIRE_SCHOOL_DUMMY:SOCCAP,
              pisa.data)
summary(model.20.lm)
intervals(model.20.nlme)
#fixef(model.20.nlme)
#ranef(model.20.nlme)
plot(ranef(model.20.nlme))
#coef(model.20.nlme)



model.21.nlme <- lme(fixed = MATH_AVER1 ~ AUTONOMY_DUMMY_SUM + HISCED1 +
COMP_HOME0 + CITY+ SC02Q01 + STAND_TEST +GDP +SOCCAP +
AUTONOMY_DUMMY_SUM:SOCCAP,
                random = ~ 1 + COMP_HOME0 + HISCED1| COUNTRY, pisa.data)
summary(model.21.nlme)
```

```
intervals(model.21.nlme)
#fixef(model.21.nlme)
ranef(model.21.nlme)
plot(ranef(model.21.nlme))
#coef(model.21.nlme)
#coef(model.21.nlme)

#residual diagnostics
plot(residuals(model.13.nlme))
plot(density(residuals(model.13.nlme)))
plot(model.13.nlme)
xyplot(residuals(model.13.nlme)~fitted(model.13.nlme) | COUNTRY, data=pisa.data,
main="model.13.nlme - full model by plot",
   panel=function(x, y){
     panel.xyplot(x, y)
     panel.loess(x, y, span = 0.75)
     panel.lmline(x, y, lty = 2)  # Least squares broken line
     }
   )
qqnorm(residuals(model.13.nlme))
qqline(residuals(model.13.nlme))

plot(residuals(model.19.nlme))
plot(density(residuals(model.19.nlme)))
plot(model.19.nlme)
xyplot(residuals(model.19.nlme)~fitted(model.19.nlme) | COUNTRY, data=pisa.data,
main="model.19.nlme - full model by plot",
   panel=function(x, y){
     panel.xyplot(x, y)
     panel.loess(x, y, span = 0.75)
     panel.lmline(x, y, lty = 2)  # Least squares broken line
     }
   )
qqnorm(residuals(model.19.nlme))
qqline(residuals(model.19.nlme))
```

Appendix 3. Educational systems in selected post-Soviet countries.

1. Latvia

The country was faced with a rapid change in the economy after the Fall of the Soviet Union. In Latvian educational system there are 11 compulsory years: two are on pre-school level and 9 years are in secondary school. The 15 years-olds which were tested for PISA score are in the part of educational system which is compulsory.

Another important feature of Latvian educational system is the presence of minority schools. Russian language is a language of instruction in most of such schools (there are also other minority languages: Polish, Hebrew, Belarusian, Ukrainian, Estonian, and Lithuanian (Eurydice, 2015) and for a long time they have had an equal footing among other schools. However, as the Council of Europe reports, "Latvian is currently being introduced as the main teaching language in secondary schools"(Council of Europe, 2008: 42), thus, several subjects have to be taught in Latvian, regardless whether this is a minority school or not.

2. Lithuania

The educational system is similar to the one in Latvia. Compulsory education in Lithuania is until the pupils reach the age of 16 years old. The education on this level is free of charge (Eurydice, 2015). Although educational policy development and implementation are under jurisdiction of the Ministry of Education in Lithuania, "Lithuanian education system is decentralized. The state's and municipalities' institutions participate in the education process, the schools and other education institutions have a possibility to take decisions on its management, education content and means." (Ministry of Education and Science of the Republic of Lithuania, 2004). Second prevalent language of instruction is Russian (in 2003, 30 465 of learners chose Russian as a language of instruction as opposed to Lithuanian - 505 086).

3. Moldova

In Moldova compulsory education is until 15 years old. At this age, the students are expected to write a Bacalaureat exam, after which they can choose to either continue education in lyceum, "which provides students with the basic theoretical knowledge and a broad general cultural background needed to continue their studies at the higher educational level or in technical and vocational education institutions or in an institution of general secondary education (UNESCO, 2010).

4. Russian Federation

Only 9 years of education are compulsory in Russia: primary and lower secondary education. The 15 year-olds completing the PISA score fall into this category. "By 2003 85% of all public and private establishments of secondary education had received a state license allowing them to charge fees for their activities" (Nordic Recognition Network, 2005). There is a recently introduced nation-wide state exam at the end of lower secondary education level.

5. Georgia

According to the 1997 Law on Education, primary education (grades 1-6) is compulsory, while other levels of secondary education are provided free of charge (UNESCO, 2010). According to UNESCO, additionally, since 2005 any citizen of Georgia whose native language is not Georgian is entitled to receive education in their language. The most prevalent minority languages are Russian,

Armenian and Azerbaijani. According to the statistics of UNESCO, "in 2007 there were 2284 public and 257 private general education schools in the country" (UNESCO, 2010). Since only six grades are compulsory, the pupils who participated in the PISA test are those who have chosen to continue education by choice.

6. Azerbaijan

Secondary education (grades 1-11) is provided for free and is obligatory. Ministry of Education is responsible for development of education policies. There is also nation-level commission responsible for the admission of students to specialized secondary schools. Students in 9th grade (15 years old) sit an examination, according to UNESCO: "At the end of grade 9, students had to sit three examinations, two set up by Ministry of Education and one by the class teacher" (UNESCO, 2010).

7. Kazakhstan

According to the new reform on education, compulsory education has been increased up to 12 years. "While compulsory education is free by law, in practice parents and communities often bare a portion of the cost of schooling, through textbooks, supplies, school fees, school meals and, in some cases, school maintenance" (UNICEF, 2009). On the local level there are departments of education which are responsible for the execution of the national strategy. After completion of basic secondary education, after the 9th grade, pupils receive an examination certificate. After completion of that, they can choose to continue their education in vocational education institution. According to the UNESCO statistics, in 2004 74% of schools were located in rural areas. There are several languages of instruction in Kazakhstan: Kazakh, Russian, Uigur, Uzbek and Tajik.

8. Kyrgyzstan

The compulsory education in Kyrgyzstan is 9 grades. It is provided free of charge, as well as the following two years of studies. After completion of compulsory part of secondary education pupils can choose to follow a vocational track. Vast majority of the schools are rural, for example, in 2004 rural schools counted to 1694 schools against 351 urban ones. The most prevalent minority languages which the schools taught in 2004 were Russian, Uzbek and Tajik (UNESCO, 2010).