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How can Bulgaria improve its education system?

An analysis of PISA 2012 and past results

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Education Global Practice
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Abbreviations & Acronyms

ESCS	Economic, Social, and Cultural Status
ECA	Europe and Central Asia
EU	European Union
GDP	Gross domestic product
OECD	Organization for Economic Co-operation and Development
OLS	Ordinary least squares
PIRLS	Progress in International Reading Literacy Study
PISA	Programme for International Student Assessment
RIF	Re-centered influence functions
TIMSS	Trends in International Mathematics and Science Study
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organization
VET	Vocational education and training

Executive Summary

Bulgaria's performance on all three disciplines of the PISA[1] 2012 was slightly better than its PISA 2000 performance, after having dropped between 2000 and 2006. The improvements post-2006 were greater in reading and math than in science. In the latest PISA (2012), Bulgarian students scored an average of 34 points more on reading and 26 points more on math than in 2006. This represents gains equivalent to almost one year of schooling in reading and a little more than half a year of schooling in math. Despite the recent improvement in achievement, Bulgaria has not made significant progress since 2000 and its performance gap with the OECD accounts for more than one year of schooling. Moreover, around 39 percent of 15-year-old students in Bulgaria are considered functionally illiterate, as they are not able to understand and analyze what they read. Similarly, about 44 percent of Bulgarian students are considered functionally innumerate.

The improvements in performance between 2006 and 2012 promoted shared prosperity, but equality of opportunities is still a major challenge. The gains in Bulgaria's education system between 2006 and 2012 were such that students in the bottom 40 percent of the socioeconomic status made improvements comparable to those of average students (that is, the average score of all students who took the PISA). However, a persistent challenge is the PISA score differentials between students in the highest and lowest socioeconomic quintiles. For instance, in math the difference is approximately 115 points, much higher than OECD standards. Moreover, in Bulgaria, students' predetermined individual characteristics play a disproportionately high role in explaining PISA scores. Gender, age, and socioeconomic status[2] account for almost one-third of students' differences in reading performance. This reflects the low equality of students' educational opportunities, as an important share of performance is predefined by students' backgrounds, potentially limiting social mobility.

In fact, disaggregating students' PISA scores across a number of variables — e.g., location and ethnicity — shows that large inequalities exist in Bulgaria's education system. Students living in urban areas score as high as 90 points more (or more than two years of schooling) than students in rural areas. There are discrepancies for linguistic minorities as well: Bulgarian-speaking students perform the equivalent of three years of schooling higher in reading and two years of schooling higher in math and science than students who speak a foreign language at home.

Peer characteristics and school segregation are the key drivers of the Bulgarian education system's performance. In Bulgaria, peer characteristics explain more of the differences in PISA test scores than do individual characteristics. That is, the performance of a child on the PISA test depends more on the type of his or her classmates than on his or her own individual factors. This is because the system sorts students into schools populated by other students with similar socioeconomic status, rendering Bulgaria with one of the most stratified educational systems among PISA participating countries.

Disparities in performance by school type are large and are exacerbated by the early streaming of students. In Bulgaria, students are streamed into either general profiled or vocational tracks after they take a high-stakes national exam at age 13. The consequence is that most students in general profiled schools, which have a very low share of disadvantaged students, tend to fare quite well. General profiled school students tend to come from families with higher socioeconomic status and interact with similarly better off peers. But over half of Bulgaria's 15-year-old student population struggles in the worse performing vocational or general non-profiled schools. The analysis of the learning gap between general profiled and vocational education students in Bulgaria shows that socioeconomic status and peer effects explain most of the differences in student outcomes for low-, medium-, and high-achieving pupils.

The effects of Bulgaria's 2007 school autonomy reform on student achievement are mixed and worse than expected. The 2007 governance reform in Bulgaria was a major effort that delegated several responsibilities to school principals—particularly in setting teacher salaries, handling student assessment and admission, undertaking more financial responsibilities, and determining textbook use and course contents. Results of the reform vary by type of autonomy. On one hand, the results show that principals' greater autonomy in the allocation of resources (such as policies regarding teachers or budget decisions) had a moderately positive impact on all students' performance (6 PISA points on average), and especially that of low-achieving students. This impact was stronger in urban than in rural areas. On the other hand, the impacts of principals' greater curriculum and assessment responsibilities on students' PISA performance were slightly negative, especially in rural areas. Finally, the analysis showed the importance of the quality of educational resources as a key driver of the student performance increase since 2006.

An in-depth analysis into math and reading skills shows imbalances in performance in Bulgaria. PISA rotates the in-depth assessment of skills by subject area each time it is administered. PISA 2009 focused on reading, while PISA 2012 focused on math; PISA 2015 will focus on science. Compared with the combined math performance, results in Bulgaria show slightly higher variation across subscale assessments than is found in OECD countries. Students performed better in problems related to space and shape and algebra, and not as well in problems related to data and statistics. In reading, students performed better with more traditional text than with text contained in sample lists, graphs, or diagrams. Moreover, the PISA subscale assessments reveal that Bulgarian students are not good at relating information presented in a text to their own experiences.

The main areas in which Bulgaria can further improve its educational system involve:

1 **Delaying the tracking[3] of students to reduce segregation in schools.** Bulgaria streams its students into general profiled, general non-profiled, and vocational education schools when they are 13 years old through a high-stakes exam. Existing admission policies on a number of primary schools suggest that this mechanism leads to sorting as early as grade 1. Most countries do this at a later stage, usually when students are 16 years old. A recent World Bank report (2013a) found that the prospective of high-stakes exams creates incentives for parents to invest in private tutoring to help their children increase their scores, leading to sorting among families, which raises important equity concerns. Indeed, PISA score differences between the three streams are fully explained by socioeconomic background and peer effects. Moreover, early tracking hampers the skill development and future long-term employability of students in vocational schools, as they will lack the basic reading and math skills needed for success in a dynamic and rapidly changing labor market. Finally, alternatives to the high-stakes exam that implicitly select students into schools more randomly could further reduce segregation based on students' abilities.

2 **Continue improving the quality of educational resources to ensure that all students learn in an environment with books, lab equipment, and technological hardware and software.** The analysis of the improvement in performance in math and reading between 2006 and 2012 shows that the two key drivers were the evolution of students' socioeconomic status and the improved quality of educational resources. The impact of educational resources was especially important for low-achieving students, indicating a low-hanging fruit for improving the quality and equity of the education system. Continuation of this would include better provision of lab equipment, computer and software materials, library materials, and instructional materials and/or the renovation of buildings and grounds.

3 **Encouraging longer pre-primary education for all children.** Pre-primary education increases school readiness and has a positive and significant effect on the student achievement of Bulgarian 15-year-olds. This study found that attending at least two years of preschool education raises low achievers' scores by up to 10 points and the scores of those who speak a different language at home by up to 19 points. In Bulgaria, the pre-primary gross enrollment rate for children aged three to six is 84 percent, but disadvantaged students and minorities still face challenges in accessing this education stage. Promoting early childhood education for all is critical, as cognitive and character skills gaps start opening during early life and inequalities in access to pre-kindergarten perpetuate learning gaps across income groups.

4 **Learning from successful schools to improve accountability mechanisms for schools country-wide, particularly in rural areas.** There is a need to further understand: (i) why the autonomy reform did not function as expected; (ii) why the reform was more successful in urban areas; and (iii) why PISA scores were positively affected by greater autonomy in the management of school resources, but not by greater autonomy in curriculum development and assessment. Learning from successful schools could help the Government of Bulgaria augment the impact of the reform in rural areas over the coming years.

5 **Reevaluating the curriculum and assessment framework to better align student learning to the envisaged country goals.** PISA results shed light on Bulgaria's large discrepancies with other countries within different reading and math skills. PISA results present a good opportunity to engage in an in-depth debate about a curriculum and assessment framework reform, as well as how to better align the education system with national social and economic development goals.

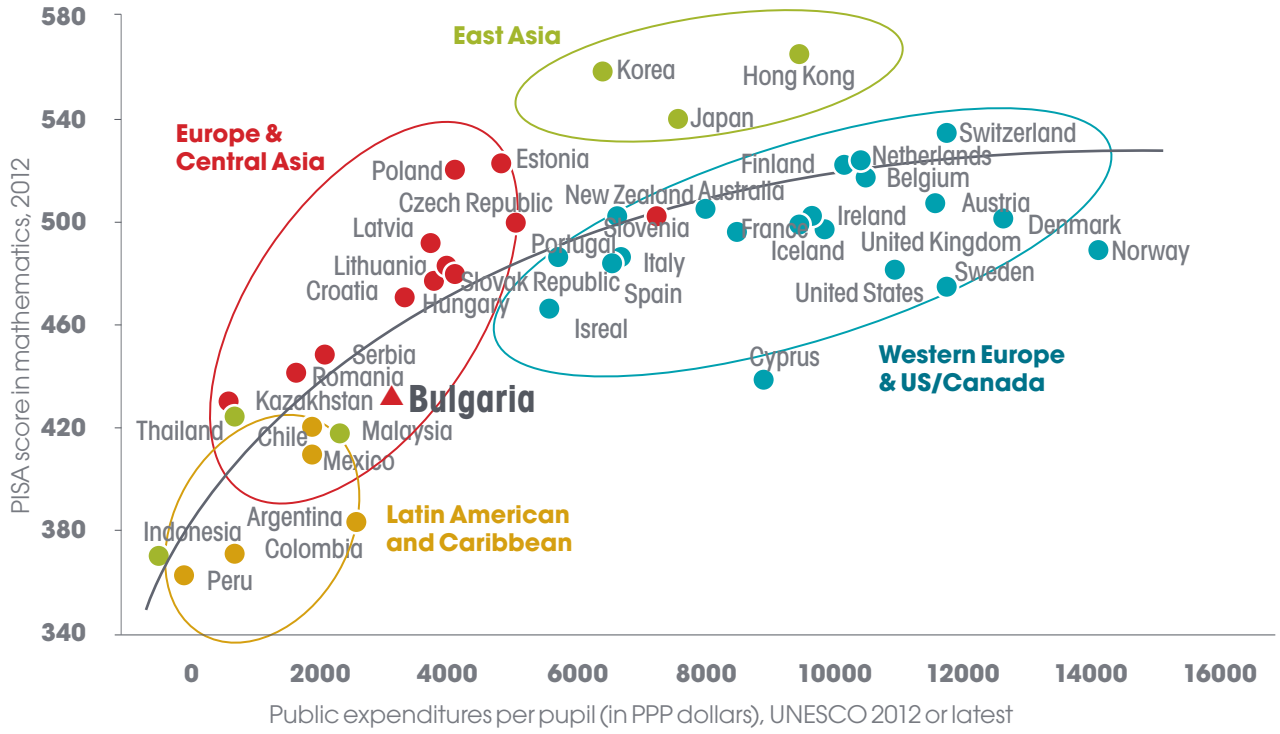
6 **Promoting effective classroom management and strengthening teaching practices.** The analysis shows that a class that is orderly and has fewer disruptions to students is more conducive to learning and therefore improves PISA scores. The government could use classroom observation methods and international best practices on classroom management to help teachers identify opportunities to improve their performance in the classroom. Teacher development programs could be implemented to improve management techniques in the classroom for the current and future teaching workforce, yielding rapid improvements in the quality of learning.

1. Why is PISA important? An Overview of Bulgaria's Performance on the PISA

Education and skills are critical for the development of both countries and individuals. International evidence suggests that quality of education is one of the most important determinants of long-term economic growth.[4] Hanushek and Woessman (2007 and 2012) looked at a wide range of student assessment surveys from 1960 onward, including the Trends in International Mathematics and Science Study (TIMSS), the Programme for International Student Assessment (PISA), and the Progress in International Reading Literacy Study (PIRLS). They estimated that an improvement of 50 points in PISA scores would imply an increase of 1 percentage point in the annual growth rate of GDP per capita.[5] Top-quality education systems are also associated with democratic governments. Beyond economic growth, education improves the living standards of individuals, as the more educated are able to acquire more and higher-order skills, making them more productive and employable and extending their labor market participation over their lifetime, which in turn leads to higher earnings and better quality of life. Formal schooling also contributes to development of socio-emotional skills like attention, motivation, self-confidence, and physical and emotional health, all important determinants of socioeconomic mobility. Individuals equipped with more education and skills are better prepared to become civically engaged, improve the democratic capital of their country, and create and make use of opportunities. Education is a key ingredient for reducing inequality and increasing shared prosperity. The analysis of detailed data is critical for understanding the determinants of education quality and can play an important role in shaping effective evidence-based education policy. The PISA database is a great resource in the pursuit of this analysis.

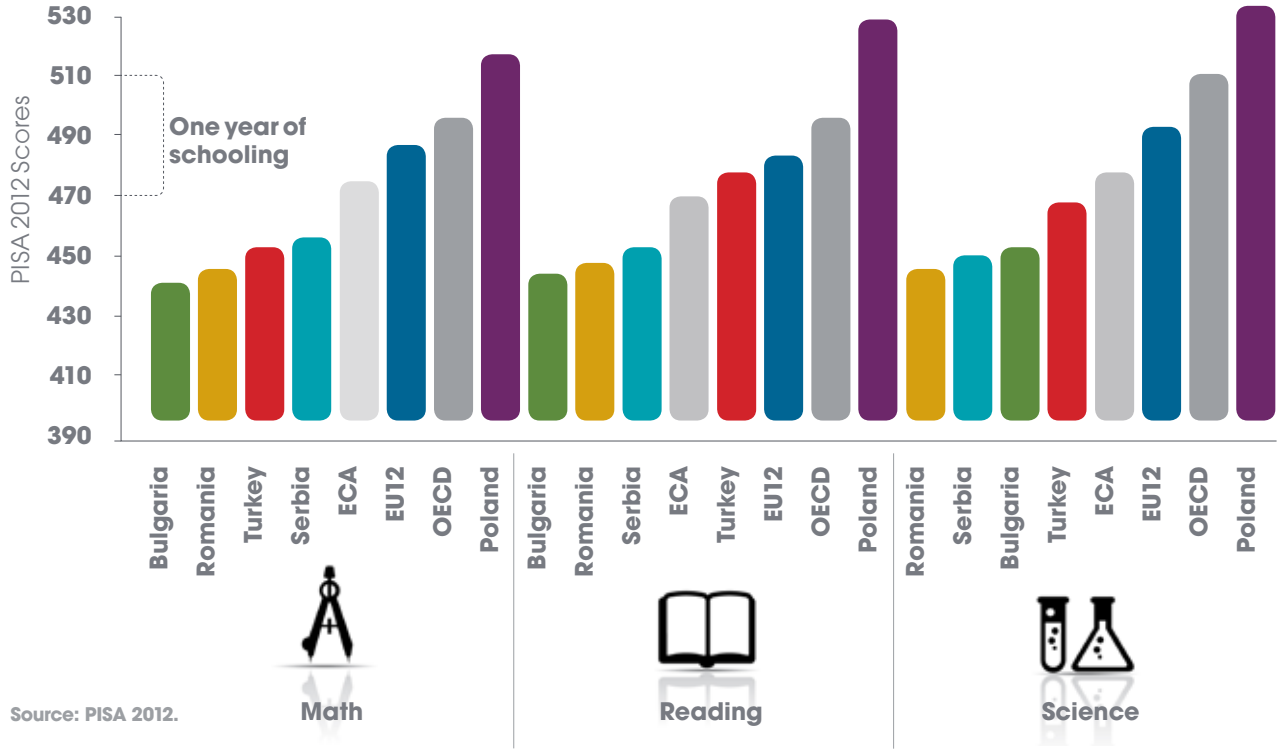
PISA is a tool for measuring education quality across countries. Introduced in 2000 by the Organisation for Economic Co-operation and Development (OECD), PISA is a worldwide study of 15-year-old school students' performance on three different disciplines: math, science, and reading. PISA focuses on the competence of students and their ability to tackle real-life problems in those three disciplines and emphasizes skills that are critical for individuals' personal and professional development. PISA only assesses students who are in the education system, making it the most internationally comparable snapshot available of a country's education system. However, if dropout rates are high, the results may not be representative of a country's cohort of 15-year-olds. PISA's scoring system is standardized so that the mean score for each discipline among OECD countries in year 2000 is 500 points, with a standard deviation of 100 points. According to OECD, 40 points in PISA is equivalent to what students learn in one year of schooling.[6] Bulgaria's education system (Box 1) was assessed in the PISA rounds of 2000, 2006, 2009, and 2012. Bulgaria's participation in PISA allows us to benchmark it with other countries, measure the extent to which the country has succeeded in promoting education quality, and gauge whether system inequities have been reduced over time.

Figure 1 PISA scores and public expenditures per pupil



Source: PISA 2012 and UNESCO 2012. Note: The curve represents a logarithmic approximation of the scatter plots.

Figure 2 PISA 2012 scores for Bulgaria and comparator countries versus ECA and OECD averages



Source: PISA 2012.

BOX 1 BULGARIA'S EDUCATION SYSTEM

Bulgaria has a population of 7,36 million people (2011), with three large ethnic groups. Those of Bulgarian ethnicity comprise 85 percent of the population; those of Turkish ethnicity, 9 percent; and those of Roma ethnicity, 5 percent. The education system serves over 1.2 million students from pre-primary school through tertiary education. According to UN estimates, Bulgaria's school-age population is projected to shrink by 10 percent between 2015 and 2030, reflecting the impact of low fertility and migration.

Bulgaria's education system consists of four levels. Pre-primary education is offered to children between three and six (or seven) years old and since 2010, two years of pre-schooling are compulsory, starting from age five. Basic education comprises grades 1 to 8, usually starts at age seven, and is offered by state, municipal, and private school providers. Although lower secondary does not end until the end of grade 8, most students change schools after grade 7, once they take a high-stakes exam that streams students into general profiled schools, vocational education and training (VET) schools, or general non-profiled schools. Upper secondary education is provided by non-profiled, profile-oriented, and technical (vocational) schools. General profiled schools (often referred as "elite schools") offer general education with additional focus on a selected subject (e.g., a foreign language, mathematics, information and communication technologies (ICT), etc.). General non-profiled schools provide education without extra focus on a given subject, while vocational schools incorporate vocational subjects into the curriculum, often at the expense of time allocated to general curriculum subjects. Education is compulsory for students up to the age of 16.

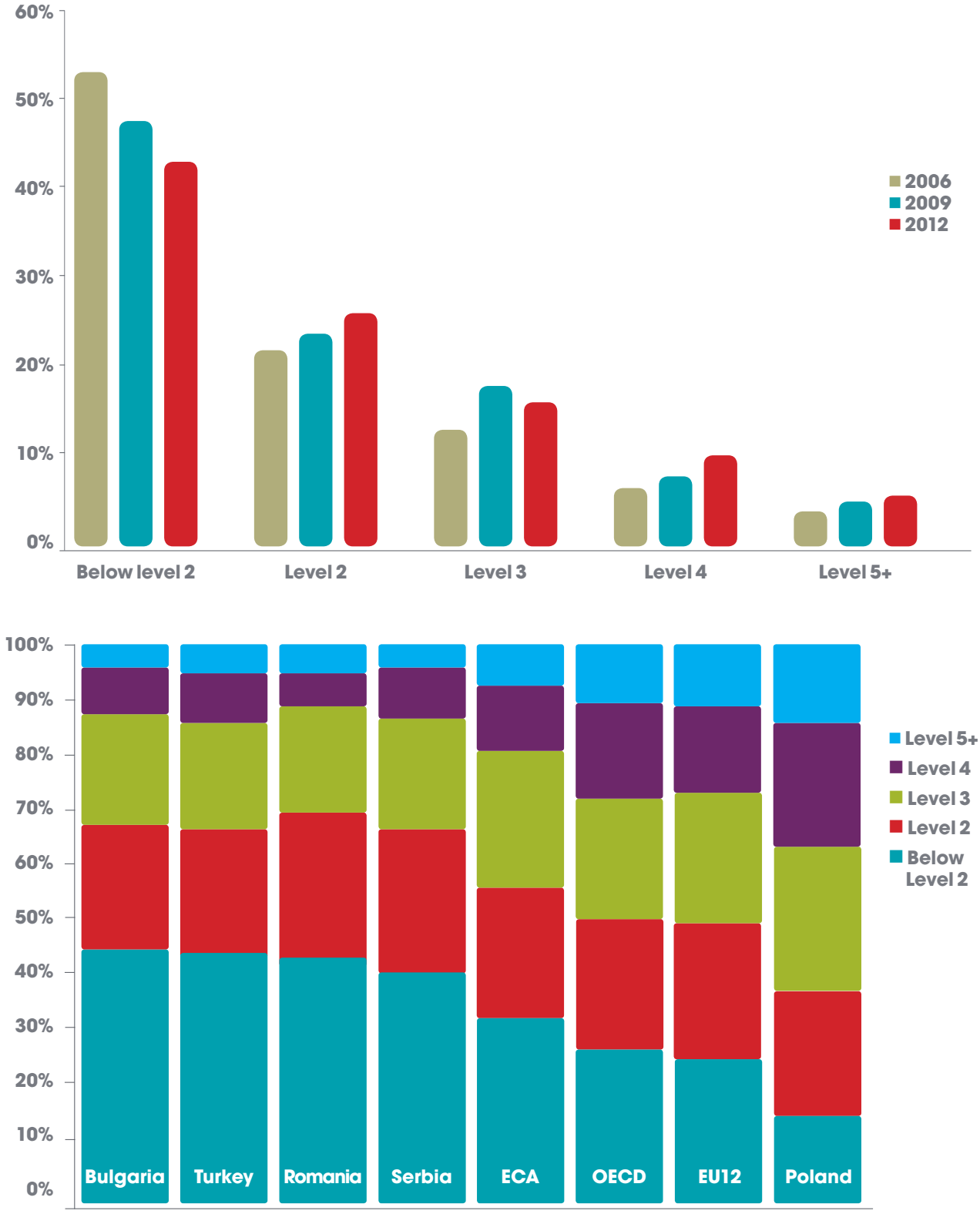
Source: National Statistical Institute and Ministry of Education, Youth and Science, and World Bank (2014).

Bulgaria's performance is slightly below what should be expected given its current level of public expenditure per student (Figure 1). In addition, Bulgaria's performance is worse than expected given its income level. Comparator countries like Serbia, Romania, and Turkey performed better than Bulgaria on PISA 2012. While a certain level of financial resources is important to ensure access to a minimum standard of quality, higher levels of expenditures and development do not necessarily imply better learning outcomes. In the case of upper-middle-income countries like Bulgaria, more investment can still help improve quality, but additional policy efforts are needed to take education quality to the next level and make the improvement sustainable.

Bulgaria has not made significant progress in achievement since 2000. Bulgaria's performance on PISA 2012 recovered to levels slightly above those of 2000, after having dropped between 2000 and 2006 (Table 1). On PISA 2000, Bulgarian students' performance in science was substantially better than in reading and math. The drop in 2006 was more acute for math and reading, and the recovery in these disciplines was stronger between 2006 and 2012.

Bulgaria's performance is worse than that of regional comparator countries (Figure 2). Despite its improved performance since 2006, Bulgaria's scores are still lower than those in many Europe and Central Asia (ECA) region countries, and its math and reading scores lag 30 points behind the ECA average. While PISA score changes in Bulgaria between 2000 and 2012 were not statistically significant, countries such as Turkey and Poland carried out sustained and systemic reforms and saw their scores go up by 30 (Turkey) to 40 (Poland)

Figure 3 Distribution of students by proficiency level in math: (a) Bulgaria's progress in 2006-2012; (b) Bulgaria and comparators in 2012



Source: PISA 2006, 2009, and 2012.

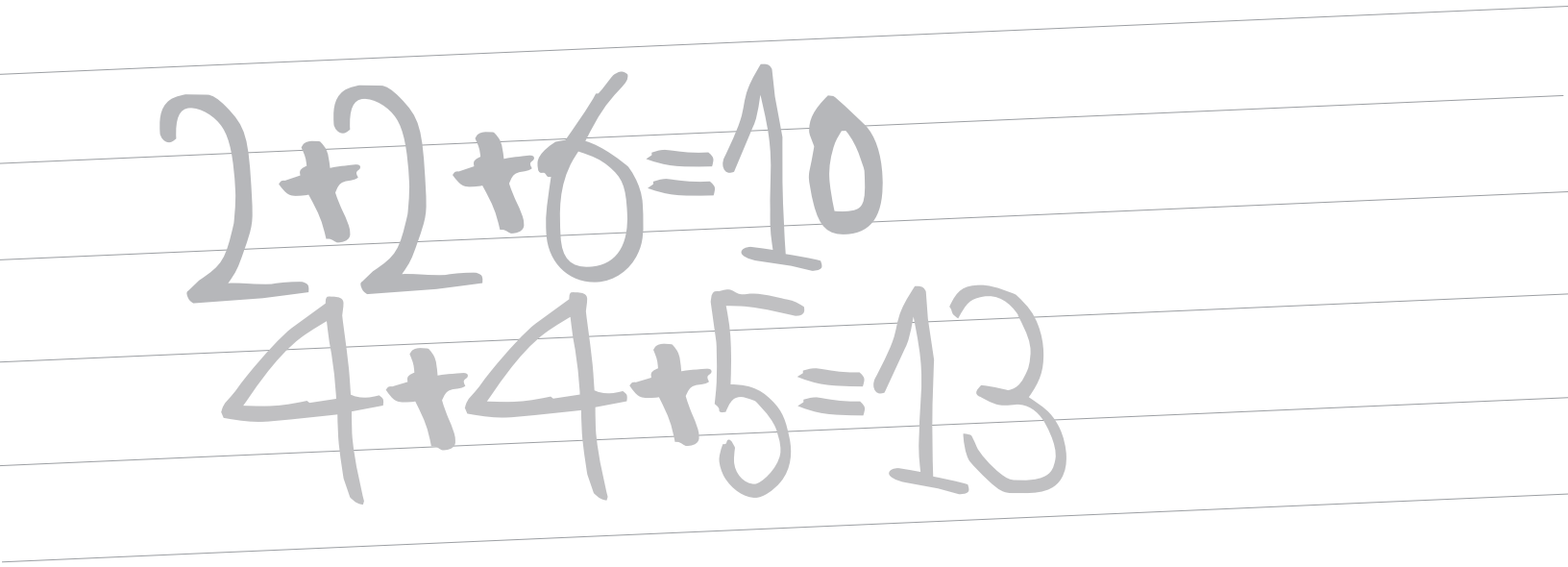


TABLE 1 PISA PERFORMANCE BY SCALE FOR BULGARIA IN 2000-2012

	2000	2006	2009	2012
Reading	430	402	429	436
Math	430	413	428	439
Science	448	434	439	446

Source: PISA 2000, 2006, 2009, and 2012[7]

points. Finally, Bulgaria's scores are about 40 points below those of EU12 new-member states, and need to increase by about 60 points to reach the OECD average in all disciplines (equivalent to one and a half years of schooling).

Bulgaria has reduced the share of students below basic proficiency levels since 2006, although it remains high. PISA categorizes scores in six levels of proficiency; students who score below level 2 in the reading and math tests are considered functionally illiterate and innumerate, respectively. According to the 2012 data, around 44 percent of 15-year-old students in Bulgaria score below level 2 in math (Figure 3a), meaning that they are not able to understand and solve simple math problems, severely limiting their development and skill acquisition process. The picture is similar for reading: about 39 percent of Bulgarian students are considered functionally illiterate. That said, an important part of the progress made by Bulgaria since 2006 was due to the improvements of students performing below level 2. Countries like Poland have a much lower share of students below level 2 (Figure 3b) and their progress in the last decade was also mainly driven by the improvements of low achievers.

Figure 4 Student performance in math on PISA 2006-2012 by socioeconomic group

The World Bank's mission has recently been articulated into two main goals: boosting the end of extreme poverty and promoting shared prosperity. The definition of the latter focuses on the income of the bottom 40 percent. This number has been arbitrarily chosen given that: (i) in many low-income countries, the bottom income quintile coincides with the percentage of people in extreme poverty so that this group needed to be expanded; and (ii) this indicator expands this notion to also capture the people considered moderately poor in middle-income countries.

Source: Data from PISA 2006, 2009, and 2012.

BOX 2 PISA'S INDEX OF ECONOMIC, SOCIAL, AND CULTURAL STATUS

Created by OECD, PISA's Index of Economic, Social, and Cultural Status (ESCS) is a multidimensional measurement that takes into account information reported by students on their family's wealth and occupational, educational, and cultural background. It is derived from a combination of three other indexes: (i) an index of the highest occupational status of parents, indicating not only labor market status, but also the type of job held by parents; (ii) an index based on the highest level of parental education in years of schooling; and (iii) an index of family home possessions, which itself consists of a combination of the family's possessions (such as cars, bathrooms, or technological devices) and educational resources (such as desks, computers, textbooks, the number of other books), as well as the type of cultural possessions (such as the type and genre of books or works of art). The ESCS Index is the most important determinant of student achievement and is therefore crucial for analysis of the quality of education.

Source: PISA 2012 results (OECD 2014).

Without sustained improvements for all, disadvantaged students are unlikely to experience an increase in their future living standards

Improvements since 2006 promoted shared prosperity for the bottom 40 percent, but the gap between students of privileged socioeconomic background and the disadvantaged remains high.[8] Without sustained improvements for all, disadvantaged students are unlikely to increase their future living standards. While average score growth is important, it is also crucial to foster improvements among the bottom 40 percent of a country's student population. From the PISA data, the OECD's Index of Economic, Social, and Cultural Status (ESCS) is used herein as a measure of student wealth and level of household development (see Box 2). Results (in Figure 4) show that since 2006, the bottom 40 percent of students in terms of socioeconomic status have made advancements in math comparable to those of average students (and similar trends are seen in reading and science). However, the differences in math and reading scores between students in the highest and lowest quintiles of socioeconomic status are 115 and 150 points, respectively (representing between three and four years of education), while the OECD average differences between these income quintiles are 100 points in math and 90 points in reading.

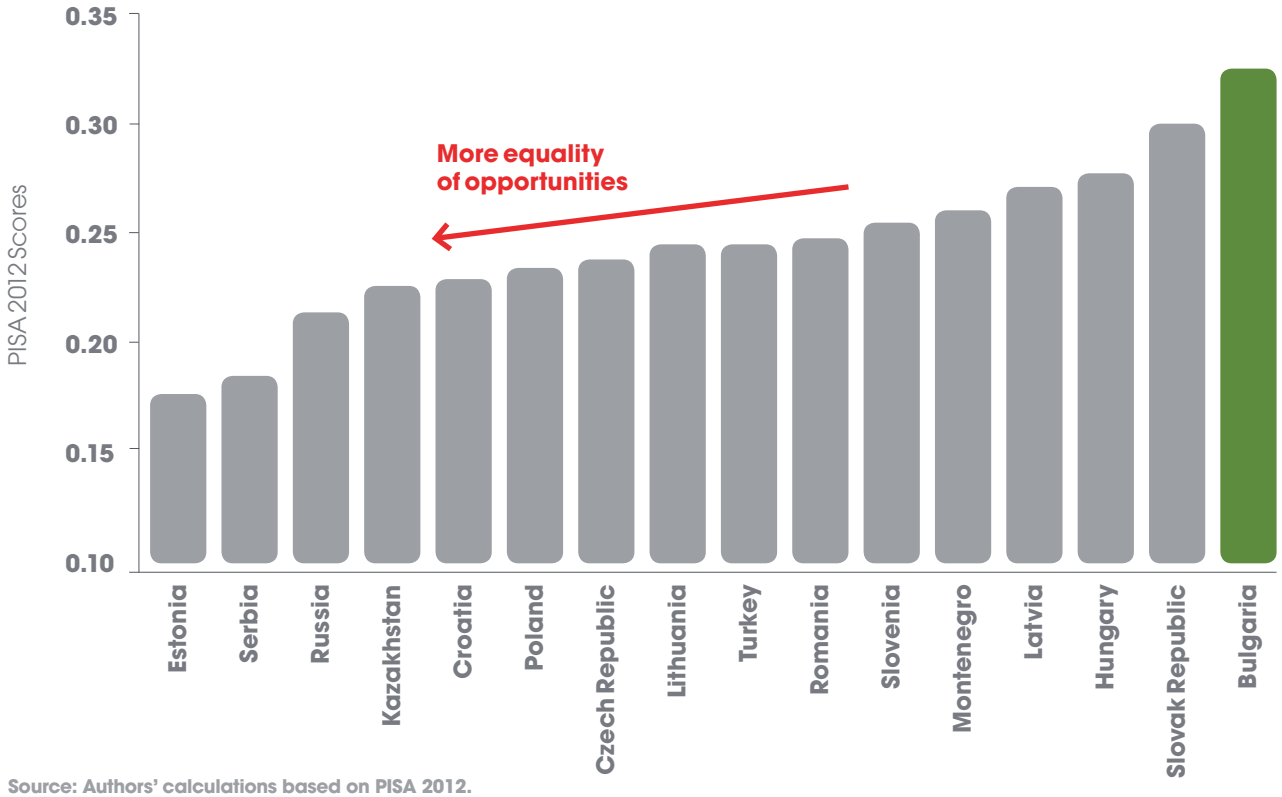
2. What determines the quality of education in Bulgaria and can it be improved?

In this section, we analyze the determinants and drivers of education quality in Bulgaria. We use PISA student achievement as a measure of education quality and relate it to the variables in the PISA student and school questionnaires that can determine quality in an education system. We use different analytical techniques for this purpose, and broadly divide variables into individual and school characteristics, with subgroups of variables within school characteristics: peer characteristics, school resources, and system variables like school autonomy (Table 2).[9]

The importance of pupils' origin: the lifelong impact of unequal opportunities

PISA results suggest that the opportunities for obtaining a good education are highly unequal in Bulgaria, and mostly depend on students' background characteristics. As seen in the previous section, the difference in math scores between students in the highest and lowest quintiles of socioeconomic status is very large. Analysis indicates that the importance of certain individual characteristics (gender, age, and socioeconomic status) to students' performance in Bulgaria is among the highest in the region (Figure 5), explaining 33 percent of the difference in reading achievement,[10] and reflecting the low equality of educational opportunities. Disaggregating test scores reveals important differences in the effects of a number of variables, such as gender, school location (rural or urban), and language spoken at home.

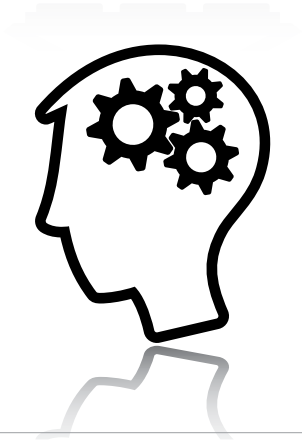
Figure 5 Index of equality of opportunities: Bulgaria and other ECA countries, 2012



Source: Authors' calculations based on PISA 2012.
Note: The index is the percent of the variance in reading scores explained by the main predeter mined charactristics (age, gender, and socioeconomic status) in a linear regression (Ferreira and Gignoux 2011).

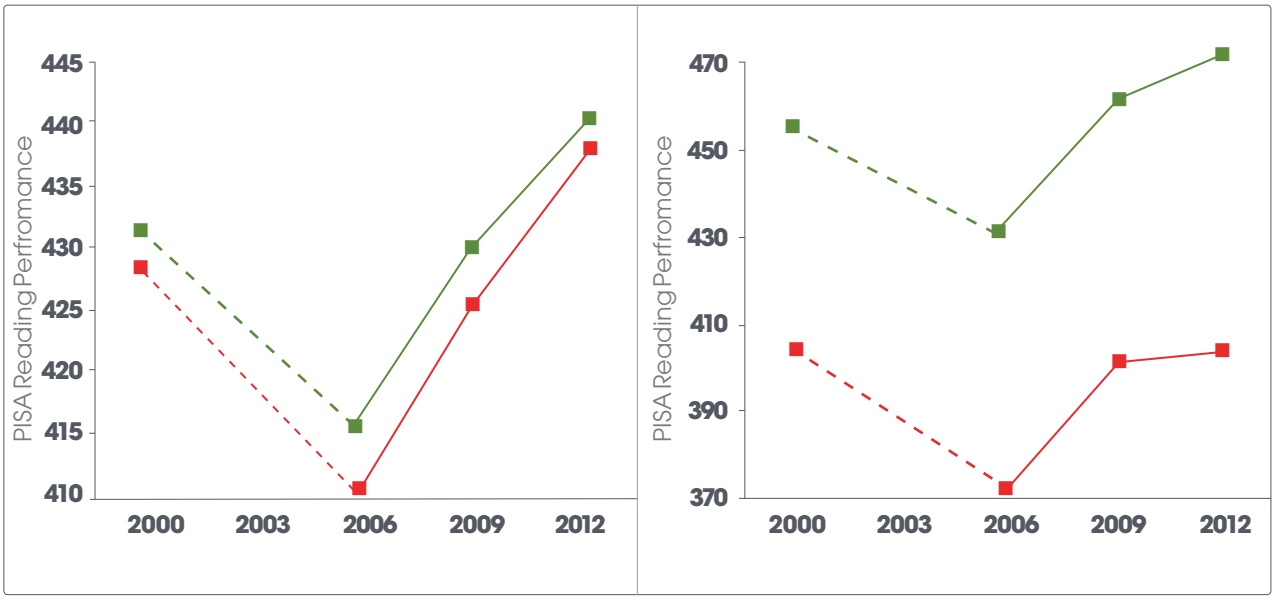
TABLE 2 DETERMINANTS OF ACHIEVEMENT IN PISA, BY CATEGORIES

Individual Characteristics		Age Gender Socio-Economic Status (ESCS Index) Ethnicity Grade Participation in Pre-Primary Education
School Characteristics	**Peer Characteristics**	School average socioeconomic status Index (ESCS Index) School dropout rate Share of minorities
	School Resources	Quality of Educational Resources (Index) Student-Teacher Ratio Location (Urban or Rural) Parental Engagement Type of school (Public or Private)
	School Autonomy	Responsibility over Curriculum and Assessment (Index) Responsibility over Human and Financial Resources (Index)



Source: Greenwald, Hedges and Laine 1996; Hanushek 2009

Figure 6 Math and reading performance of Bulgarian students by gender



Source: PISA 2012.
Note: Results in 2003 were estimated by linear interpolation.

Gender disparities

Bulgarian girls outperform boys by almost 70 PISA points in reading, while performance in math does not vary significantly by gender. Differences in performance between girls and boys in both math and reading have not changed significantly since 2000 (Figure 6). In OECD countries, girls and boys also perform at similar levels in math. And in other neighboring countries, girls tend to score higher than boys on the reading scale, as in Bulgaria. For example, girls score 45 points more on reading in Serbia, 46 points more in Turkey, and 40 points more in Romania. Relative to these countries, the difference in Bulgaria is very high. In particular, Bulgarian girls' enrollment in general profiled schools is higher than boys': 56 percent of girls study in these programs versus 40 percent of boys, a streaming process that may be exacerbating the gender gap.

Urban-rural disparities

The disparity between the PISA scores of urban and rural students is high for all three disciplines. In Bulgaria, around 25 percent of PISA-takers live in rural areas, in municipalities with a population smaller than 15,000. The difference between rural and urban students' scores is 89 points in reading and 65 points in math. The difference in math scores between urban and rural locations is very high compared to the ECA average of 27 points. As this only provides an absolute number without taking into account several other differences in the characteristics of these two subpopulations, the Annex further explores the key factors behind the urban-rural disparity. Results show that individual and peer characteristics as well as school resources are the main drivers explaining the differences between urban and rural students.

TABLE 3 CHARACTERISTICS OF STUDENTS IN BULGARIA BY LANGUAGE GROUP IN 2012

	Bulgarian speaking students	Linguistic minority students
Enrolled in general profiled schools (percent)	51.9	16.0
Live in rural areas (percent)	19.8	44.9
Mother working (percent)	82.0	57.2
Father working (percent)	87.8	76.3
Mother's education (years)	11.8	9.1
Father's education (years)	11.5	9.2

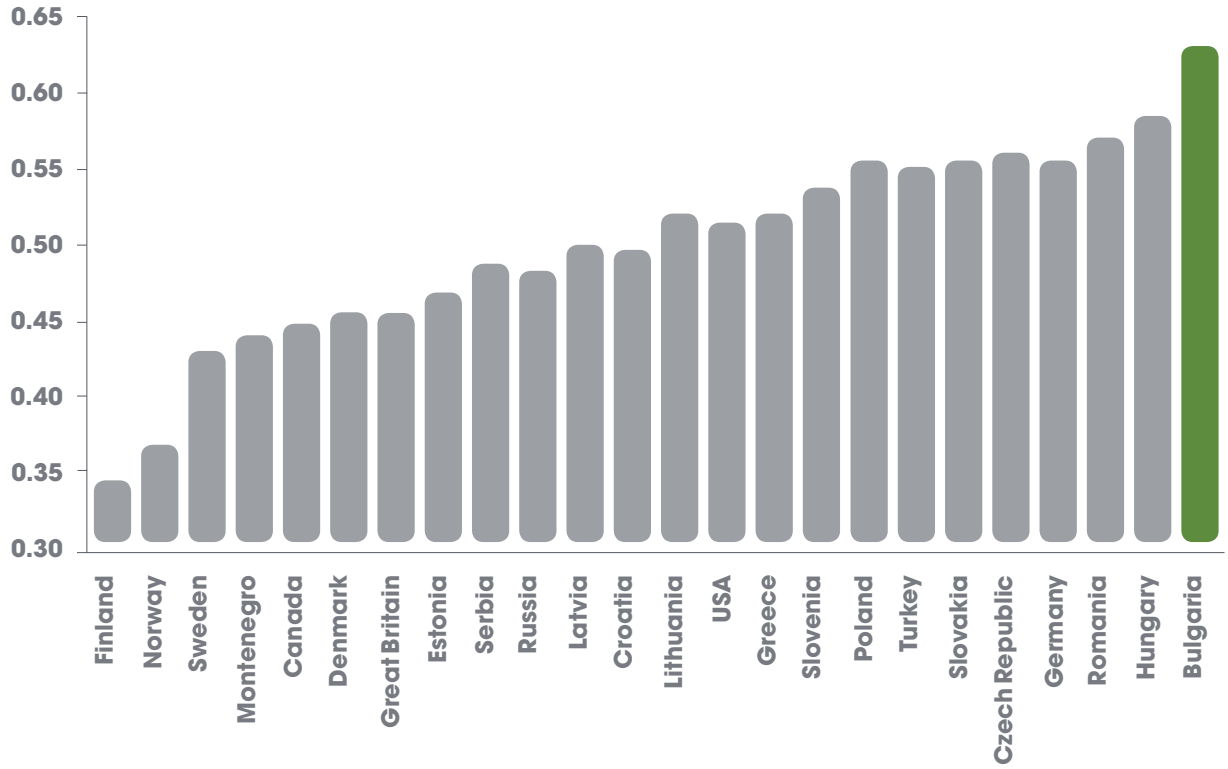
Source: PISA 2012.

Linguistic minorities

In Bulgaria, linguistic minority students lag significantly behind Bulgarian-speaking students. In 2012, almost 11 percent of students reported speaking a language other than Bulgarian at home. PISA data did not identify which language was spoken by these language minority students, but given the population structure, it is likely that they were mostly Turkish and Roma ethnic minorities. Students from linguistic minorities lag behind Bulgarian-speaking students the equivalent of three years of schooling in reading (121 points) and two years of schooling in math (75 points) and science (82 points). A more detailed picture shows that the language groups in Bulgaria do not share the same socioeconomic and geographical characteristics (see Table 3). In particular, linguistic minority students are much less likely to be enrolled in general profiled schools, tend to be concentrated more in rural areas, and have parents who are less educated and less likely to participate in the labor market. Overall, the large gap in educational opportunities between language groups can be summarized by large differences in their socioeconomic backgrounds.

Linguistic minority students are much less likely to be enrolled in general profiled schools, tend to be concentrated more in rural areas, and have parents who are less educated

Figure 7 Index of School Social Stratification in PISA 2012-participating countries



Source: Authors' calculations based on PISA 2012.
Note: The index goes from 0 to 1. A higher index indicates a higher correlation between students' and schools' socioeconomic status. The figure includes a selected number of PISA countries.

What can policy makers do to improve education in Bulgaria?

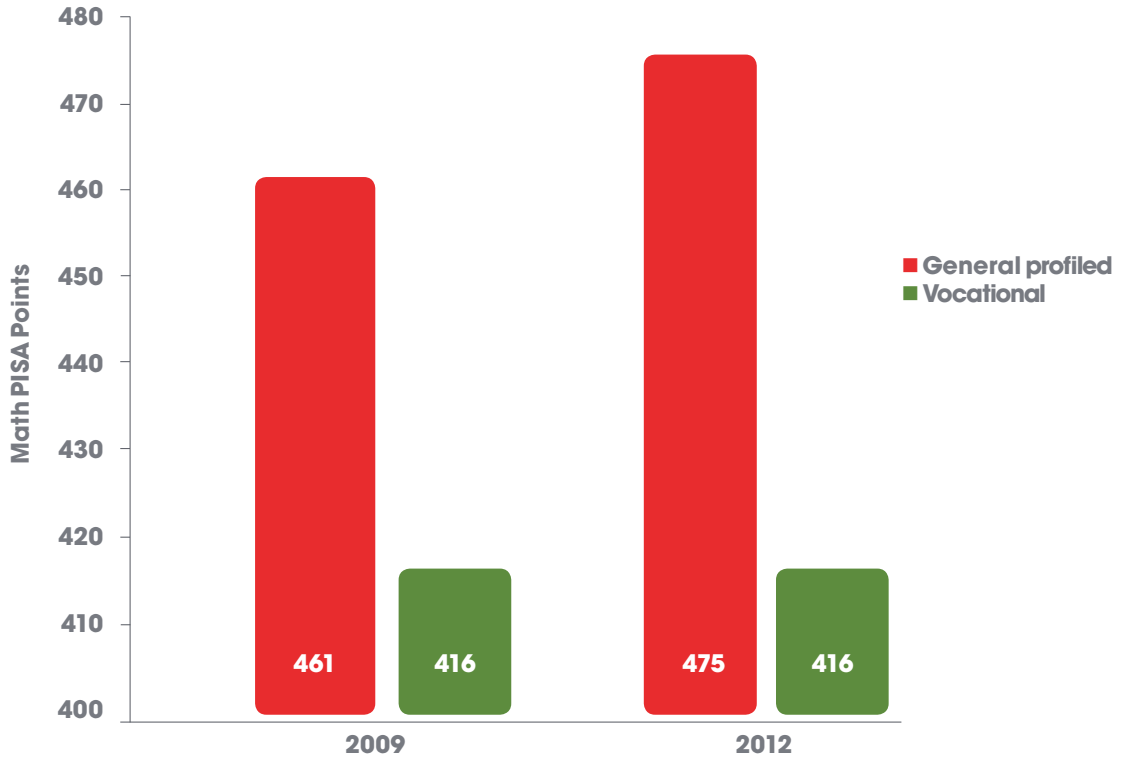
A stratified school system: the importance of peers and tracking mechanisms

Peer effects are a fundamental driver of student achievement in Bulgaria. The previous section studied the importance of individual predetermined characteristics, which explained 33 percent of students' differences in reading. However, individual characteristics averaged at the school level (i.e., peer characteristics) explain more of the differences in scores (48 percent) than do individual characteristics. This critical finding suggests that a student's performance depends more on where he or she attends school than on his or her individual characteristics.[11]

Moreover, there is a strong relationship between each student's individual characterstics and those of other students in the same school.

Social stratification in Bulgarian schools is the highest among EU countries (Figure 7). We define the Index of School Social Stratification as the correlation between the PISA student's socioeconomic status and the average school's socioeconomic status.[12] In a world without social stratification (thus an index equal to zero), families from different socioeconomic backgrounds would randomly settle across the country and students from different backgrounds would study together, making schools more diverse. However, households tend to co-locate in neighborhoods with other households similar to them, and students tend to attend school with peers who have a similar socioeconomic status as a result of spatial inequalities.

Figure 8 Evolution of PISA math scores by school type



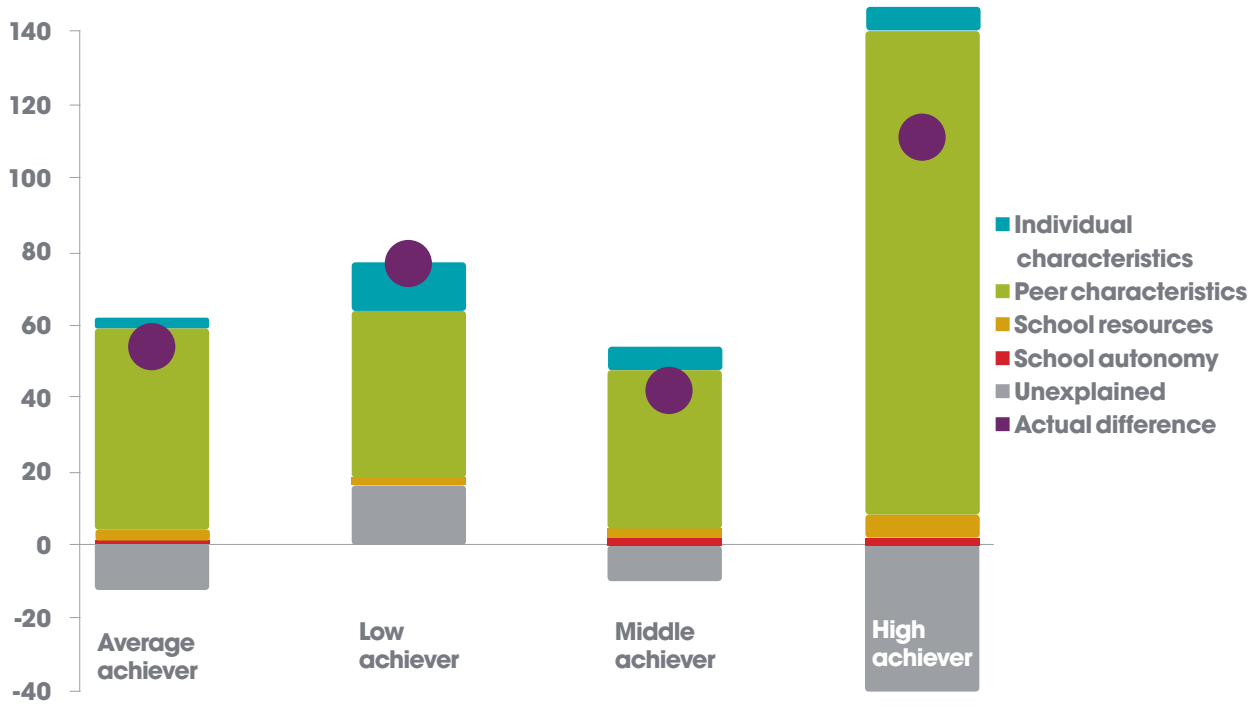
Source: PISA 2009 and 2012.

Disparities in performance by school type are large and have recently increased. Figure 8 shows the average math scores by type of school for the two largest streams of 15-year-old students: the difference in math scores between general profiled school students (comprising 48 percent of the sample in 2012) and vocational school students (41 percent) increased from 45 to 60 points in math (equivalent to one and a half years of schooling). The situation is similar for reading, with an increase in the difference from 68 to 86 points in reading (two years of schooling). This indicates that slightly less than half of Bulgarian children have good opportunities in general profiled schools, while most of the other half struggle in typically lower-quality vocational or general non-profiled schools. General profiled schools have a very low share of disadvantaged low-achieving students13 relative to vocational schools. This means that not only are general profiled students better off in terms of their family background, but they also have the privilege of interacting with similarly better off peers.

Delaying student tracking reduces school stratification and allows for better opportunities for low achievers. Several factors may lead to segregated schools. Some have to do with the geographic assignment of students to schools (e.g., when wealthier people are concentrated in a particular neighborhood). Another factor is the use of exams to select and stream students at early stages. Moreover, parents in high and low socioeconomic groups may have different access to information or different priorities when they make schooling decisions. Bulgaria streams its students at age 13 into general profiled, general non-profiled, and vocational education schools based on a high-stakes exam. Examination of the existing admission policies of a number of primary schools suggests that this mechanism leads to sorting as early as grade 1. A recent World Bank report (2013a) found that the prospective of high-stakes exams creates incentives for parents to invest in private tutoring, leading to sorting of students and raising important equity risks. Most countries with better education

Most countries with better education systems stream students at later stages of schooling, usually at age 16.

Figure 9 Decomposition of general profiled-vocational school PISA 2012 math score gaps into different factors by student achievement group

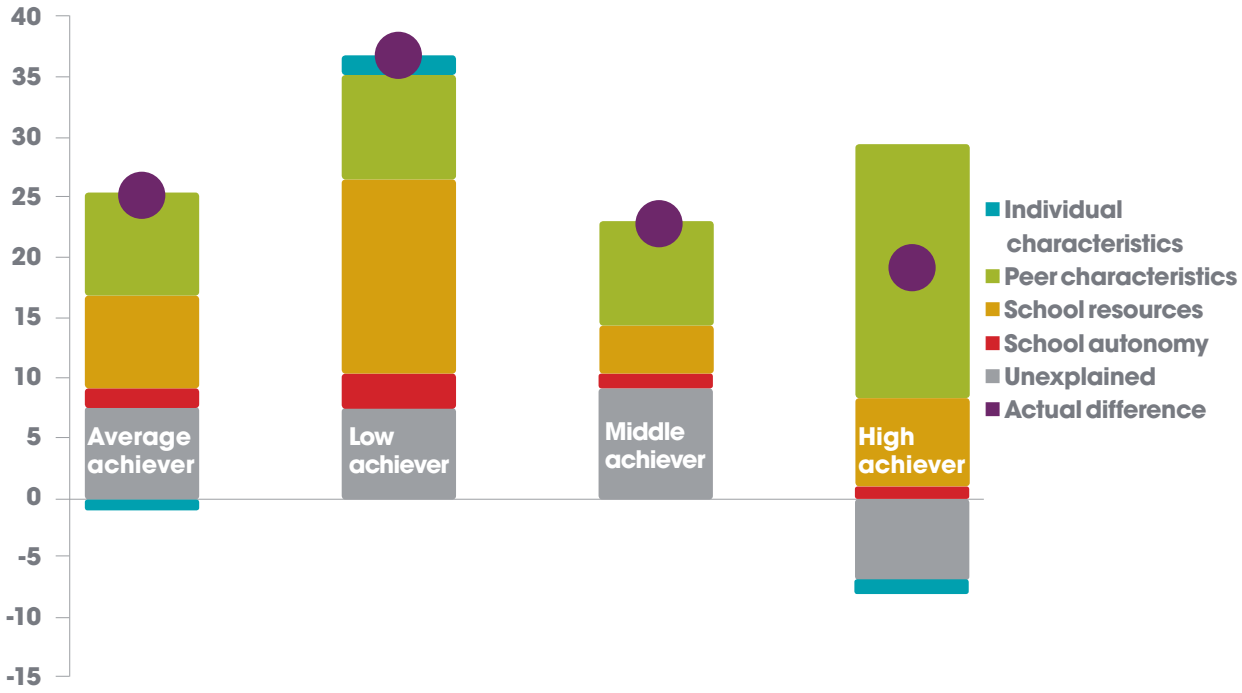


Source: Authors' calculations based on PISA 2012.
Note: Results decomposition was done using an Oaxaca-Blinder method on RIF-regressions for each quantile of the distribution of performance (Firpo, Fortin and Lemieux 2009). Low achievers are students in the 20th percentile.[15]

systems stream students at later stages of schooling, usually at age 16. Hanushek and Woessman (2006) used previous PISA data to show how early tracking systems lead to a systematic increase in inequality of student performance without affecting average performance levels. This suggests that there are no efficiency gains from introducing early streaming of students.

Individual and peer socioeconomic characteristics are the major determinants of the difference in student achievement between general profiled and vocational schools in Bulgaria. Econometric analysis shows that socioeconomic status and peer characteristics explain most, if not all, of the differences in student outcomes, no matter how students performed in each school (Figure 9). In fact, peer effects appear to be more important than individual characteristics. Although it is difficult to disentangle peer from individual effects due to their high relation (already explained in this section), it is clear that the ability based selection of students through national tests after grade 7, which in practice is implicitly sorting students according to their socioeconomic status, determines differences between general profiled and vocational schools.[14] This finding has important policy implications. While little can be done about individual characteristics, policy levers can be used to reduce school segregation and promote more interaction between children of different backgrounds, which may lead to major improvements in student achievement.

Figure 10 Decomposition of changes in PISA math scores gaps between 2006 and 2012 into factors and by student achievement group



Source: Authors' calculations based on PISA 2006 and 2012.
Note: Results decomposition was done using an Oaxaca-Blinder method on RIF-regressions for each quantile of the distribution of performance (Firpo, Fortin and Lemieux 2009). Low, middle, and high achievers are students in the 20th, 50th, and 80th percentile, respectively.[14]

Overall, the results derived from the governance reform were not the game-changer that policy makers expected.

Has the 2007 school autonomy reform worked?

By linking student outcomes to school information, PISA data offer a great opportunity to assess Bulgaria's 2007 school autonomy reform for the first time. In 2007, the Government of Bulgaria engaged in an ambitious reform to decentralize education management from the central to the school level (Box 3). Evidence suggests that it takes time for such autonomy reforms to yield tangible results, such as an increase in student test scores. Borman et al. (2003) showed that school-based management reforms need about five years to bring fundamental changes at the school level and about eight years to show up in indicators such as test scores. As the PISA 2012 test was taken five years after the beginning of the 2007 reform, it provides a great opportunity to make an initial assessment of the reform's impact on Bulgarian student outcomes

BOX 3 BULGARIA'S 2007 AUTONOMY REFORM

In 2007, the Government of Bulgaria introduced a decentralization reform to promote greater autonomy in schools with respect to financial and personnel management. The education system became highly decentralized in resource allocation matters after the reform. Schools now have the autonomy to manage their own budgets, a role transferred from the central government to municipalities and from municipalities to schools based on per-capita financing principles. Schools may have their own revenues in addition to those received from the government, although the share of schools' own revenues in their budgets is modest. School principals have the authority to hire and fire teachers and to decide individuals' workloads, remuneration, and bonuses within broadly defined central regulations. School principals are hired by the Ministry of Education and its regional structures.

However, there is still room for improving the reform's implementation. Relationships of accountability between principals and parents need further development. School Boards are composed of parents and representatives of the local community, but do not have the legal authority to participate in school decisions, budget preparation, or supervision. Further, student assessments and school-specific assessment data are known to education authorities (central and regional) and schools, but are not disclosed to the public. Assessment results are used to track performance and inform decisions for administrative and pedagogical adjustments, but are not part of a long-term national plan for school improvement, as they are outside the accountability framework.

Source: World Bank 2011b

TABLE 4 RATE OF AFFIRMATIVE RESPONSES ON THE RESPONSIBILITY OF EACH BODY OVER RESOURCES AND PEDAGOGY, AS REPORTED BY SCHOOL PRINCIPALS.

	Principal (%)		School Governing Board (%)		Regional Authority (%)		Central Authority (%)	
	2006	2012	2006	2012	2006	2012	2006	2012
Responsibility for teacher hiring	100	99	2	4	6	4	2	2
Responsibility for teacher firing	99	95	3	3	7	2	1	2
Responsibility for teachers' starting salaries	15	79	0	6	8	2	89	41
Responsibility for teachers' salary increases	19	90	4	10	10	1	87	25
Responsibility for formulating budget	56	65	4	9	48	26	33	53
Responsibility for budget allocations	83	91	18	31	26	5	20	6
Responsibility for student discipline	37	48	93	93	9	5	55	21
Responsibility for student assessment	24	59	27	39	13	17	91	63
Responsibility for student admission	52	77	47	19	33	20	34	9
Responsibility for textbook use	66	83	61	41	6	2	23	21
Responsibility for course content	20	36	15	7	7	4	90	88
Responsibility for courses offered	18	19	47	55	11	8	88	82

Source: PISA 2006 and 2012 School Questionnaire. The percentage indicates the percentage of principals that reported some responsibility of each administrative body over different resources.

and of the reform's strengths and weaknesses. The model employed to do this decomposes the change in scores between PISA 2006 (baseline) and PISA 2012 to make a preliminary assessment of the impact of the shift in responsibility from the government to school principals.

Moderate to significant changes in school autonomy between 2006 and 2012 allow for assessment of the reform's impact. As part of the PISA, school principals are given a questionnaire in which they respond to questions related to the organization of the school, the school's student and teacher bodies, the school instruction and curriculum, the school climate, school policies and practices, and the school financing. The section on school policies and practices includes the following question: "Regarding your school, who has considerable responsibility for the following tasks?" For each task, the principal can indicate which of four educational institutions have responsibility (with more than one response possible): Principals, School Governing Board, Regional Authority, or Central Authority. Table 4 displays the percentage of responses given by principals for each of the educational institutions by specific autonomy responsibility in 2006 and 2012. Although this does not reflect the exact responsibility of each educational stakeholder, it displays a major shift in responsibility towards principals, mainly in the decision of teacher salaries and in student assessment and admission, and also moderate shifts in principals' responsibilities for budgets, textbook use, and development of course content. The increase in principals' decision making allows us to identify if the reform helped explained the changes in PISA results between 2006 and 2012.

Exploratory analysis of changes between 2006 and 2012 shows little changes in results associated with the school autonomy reform, but highlights the importance of school resources as a driver of improvements for low achievers. Using an approach similar to that followed to identify the factors associated with the gap between general profiled and vocational schools, the increase in math performance between 2006 and 2012 is mainly explained by improved socioeconomic conditions and the quality of educational resources (Figure 10).[16] The improvement in socioeconomic conditions (through individual households and peer effects) explained most of the performance increase for high-achieving students. Similarly, improvements in school resources – through increased availability of quality library materials, lab equipment, and computer materials – played a crucial role for low achievers (explaining almost half the increase). One hypothesis for this is that improvements in the school learning environment are particularly important for children who lack materials at home. This finding draws important policy lessons for future decisions. The overall effects of the school autonomy reform are not statistically significant (see Annex) and suggest that had the reform not been implemented, PISA performance would have been essentially the same in 2012. Overall, the results derived from the governance reform were not the game-changer that policy makers expected.

Although the overall results are limited, the effects of different types of autonomy vary by urban and rural settings. The overall impact of the reform can be disaggregated by type of autonomy.[18] This decomposition includes the interaction of autonomy indexes with a rural variable indicator to

Global evidence shows that providing quality preschool education is important for promoting children's social, emotional, physical, and cognitive development

allow the impact of the reform on rural and urban schools to be disentangled (see Annex). On one hand, the results show that the shift in autonomy for allocation of resources (such as teacher salaries and budget allocation) had a positive and very significant impact on all students' scores (6 points on average), and especially on those of low achievers (11 points). This impact was stronger in urban than in rural areas; a possible reason may be better and more accountable school administration in urban areas. On the other hand, the impact of principals' greater curriculum and assessment responsibilities on students' performance was slightly negative (although not very significant), outweighing the gains made from greater autonomy in resource allocation. The fact that the impact of the reform was higher for low-achieving students (especially in urban areas) suggests that greater autonomy allowed principals and teachers to focus on those students who lagged behind or who needed more support.

Early childhood policies, teacher practices, and the school environment

There is room for policy interventions that have the power to improve the quality of education.

The previous section emphasized how individual and peer characteristics are an important determinant of student achievement. In this part of the study, a multilevel analysis of determinants first includes individual characteristics, peer characteristics, and school resources variables (such as quality of educational resources and shortage of teachers). In the next step, the two autonomy measures discussed in the previous section are also included in the model of determinants of learning (see the Annex for a summary of results).

The analysis finds that early childhood education (ECE) has a positive and significant effect on student achievement (see Annex).

About 77 percent of 15-year-old students taking the PISA in Bulgaria have more than a year of pre-primary education. This is due to the increased

efforts of the Government of Bulgaria to expand the coverage of preschool education during the last decade. Results show that having attended at least a 2-year pre-primary education program increases PISA math scores by an average of 7 points relative to having attended one year or none at all. The effect of ECE is greatest for low achievers (10 points on average) and students who speak a different language at home (19 points on average), while its effect on high achievers is not significant.[19] Global evidence shows that providing quality preschool education is important for promoting children's social, emotional, physical, and cognitive development; it also increases school readiness, which helps learning (Heckman and LaFontaine 2010; Heckman 2008; Engle et al. 2011). Cognitive skills gaps start opening during early life and inequalities in access to early childhood perpetuate learning gaps. Given that attendance in early childhood programs is correlated with higher educational attainment, policies improving access to and quality of ECE in Bulgaria for the most disadvantaged students (who still face challenges in starting education early) have the highest potential to increase student achievement. This would help improve the cognitive and social skills of the entire population, translating into higher human capital and productivity and likely contributing to an overall reduction in learning inequality.

The school and classroom environment affects student achievement. Disciplinary climate measures the frequency and severity of disruptions by students in a school[20] and is an important variable in explaining students' academic performance (about 6 points on average). Disciplinary climate depends not only on the student body but also on the social and managerial abilities of teachers and principals.

An orderly school (i.e., one where teachers can teach effectively, and students listen to their teachers and work well) offers fewer disruptions to students and is more conducive to learning.

Teaching practices are another important determinant of learning. For instance, effective teacher management of a classroom (such as keeping the class orderly, getting students to listen, starting lessons on time, or ensuring that there are no disruptions) has a positive and significant effect on the PISA math score (about 5 points).[21] Nonetheless, changing teaching practices to improve service delivery in education is not straightforward. Therefore, developing relevant policies to tackle this issue – such as effectively reforming teacher pre- and in-service training or attracting more qualified teachers to the teaching force – is a challenge for the medium and long run. Finally, other school-related variables, like class size, were not found to be significant in determining student achievement as measured by students' PISA math scores.

3. Drilling down further into math & reading skills

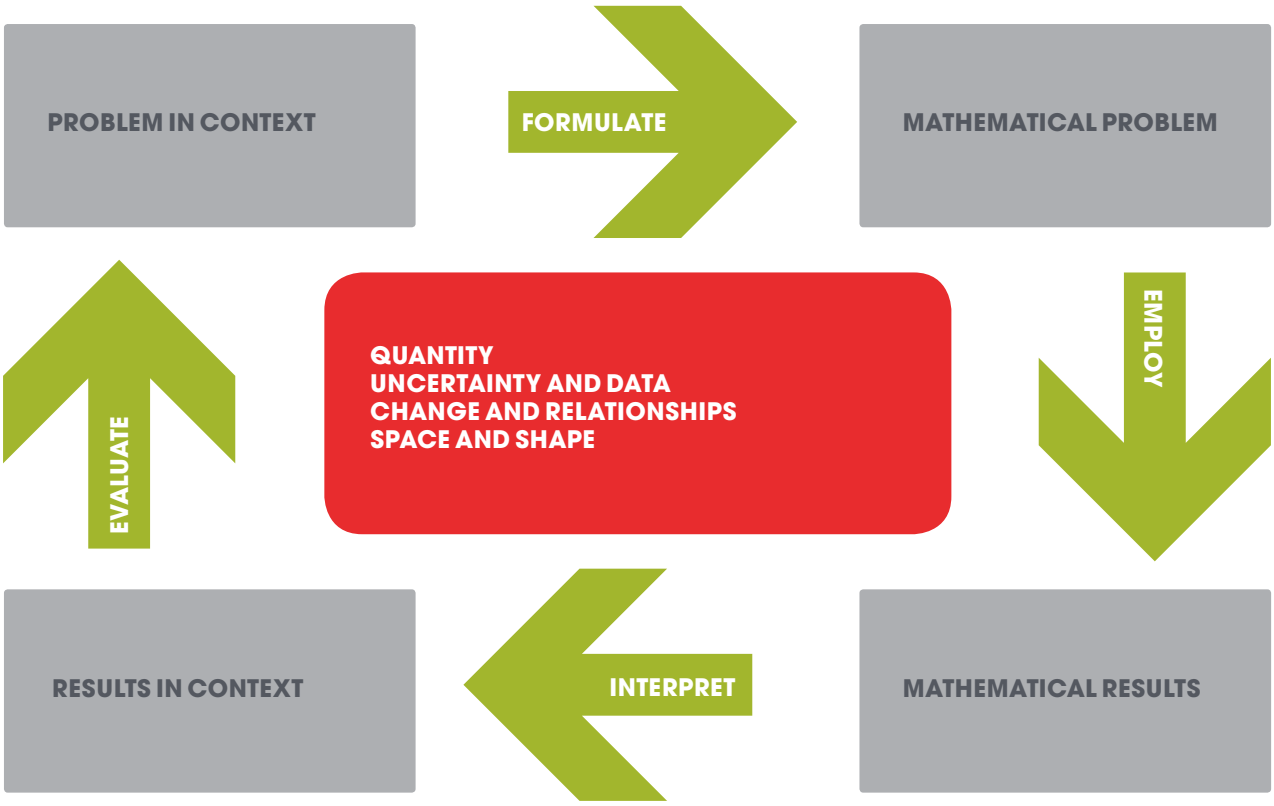
PISA offers the opportunity to fully explore one subject area every three years, even though all three subjects are assessed every time PISA is administered. PISA seeks to assess not merely whether students can reproduce knowledge, but also to examine how well they can extrapolate from what they have learned and apply it in unfamiliar settings, both in and outside of school. The detailed test of "subscale" skills of a given subject area is an in-depth assessment with a larger set of questions. The detailed assessment was on reading in 2000 and 2009, on math in 2003 and 2012, and on science in 2006. The 2015 round will focus again on science.

Math skills in PISA 2012

The PISA math 2012 subscale assessment measured individuals' abilities to formulate, employ, and interpret mathematics in a variety of contexts and content areas. In PISA, the concept of mathematical literacy includes: (i) mathematical reasoning; (ii) usage of mathematical concepts, procedures, and facts; (iii) tools to describe, explain, and predict phenomena; and (iv) the role that mathematics plays in the world and the need to make well-founded judgments and decisions needed by constructive, engaged, and reflective citizens. Furthermore, mathematic literacy as defined by PISA is not an attribute that an individual has or does not have; rather, it can be acquired to a greater or lesser extent, and it is required in varying degrees in society. PISA seeks to measure not just the extent to which students can reproduce mathematical content knowledge, but also how well they can extrapolate from what they know and apply their knowledge of mathematics in new situations.

PISA's math framework is a sophisticated tool for connecting students' mastery of mathematical processes and contents. The math subscale assessment evaluates capacity in four content categories (Figure 11): quantity (incorporates the quantification of attributes of objects, relationships, situations, and entities); uncertainty and data (understanding messages embedded in data, and appreciating variability that is inherent in many real processes); change and relationships (temporary and permanent relations among objects and circumstances); and space and shape (phenomena encountered in patterns, object properties, positions, representations, visual information, navigation, and dynamic interactions). Figure 11 also shows a schematic of the stages faced by a student when solving a real life problem through the mathematical modelling cycle. The action begins with identifying the problem in context and finishes when the results of the problem are found in a context and again are reflected in the problem context. This process involves four skills that PISA defines as "processes," and were assessed in 2012 as: formulate a mathematical situation according to the concepts and relationships identified; employ mathematical facts, procedures, and reasoning to obtain a result (usually involving calculation, manipulation, and computation); interpret the results in terms of the original problem to obtain the "results in context"; and finally, evaluate the outcomes and their reasonableness in the context of the problem.[22]

Figure 11. Math contents and process categories in PISA 2012



Source: OECD 2014.

Reading skills in PISA 2009

Students in Bulgaria performed better in problems related to space and shape and quantity, but not as well in problems related to data and statistics (Figure 12). Compared with the average score of all math subscales, Bulgaria's results show slightly higher variation across subscale assessments than is found in OECD countries. Students successfully solved problems related to space and shape and quantity, usually related to geometry, algebra, and physics. However, students underperformed when they needed to use their ability to solve data problems or to appreciate variability and uncertainty in real life problems.

The PISA 2009 subscale assessment of readings skills measured students' ability to actively, purposefully, and functionally apply reading in a range of situations. PISA defines reading literacy as understanding, using, reflecting on, and engaging with written texts to achieve one's goals, to develop one's knowledge and potential, and to participate in society. Understanding refers to the reader's ability to construct meaning from text; using refers to the kind of reading that is directed toward applying information in a text to an immediate task; reflecting means that readers relate what they are reading with their thoughts and experiences. Although texts are differentiated in different characteristics (medium, environment, type and format), performance on text format is the only one reported in PISA through two

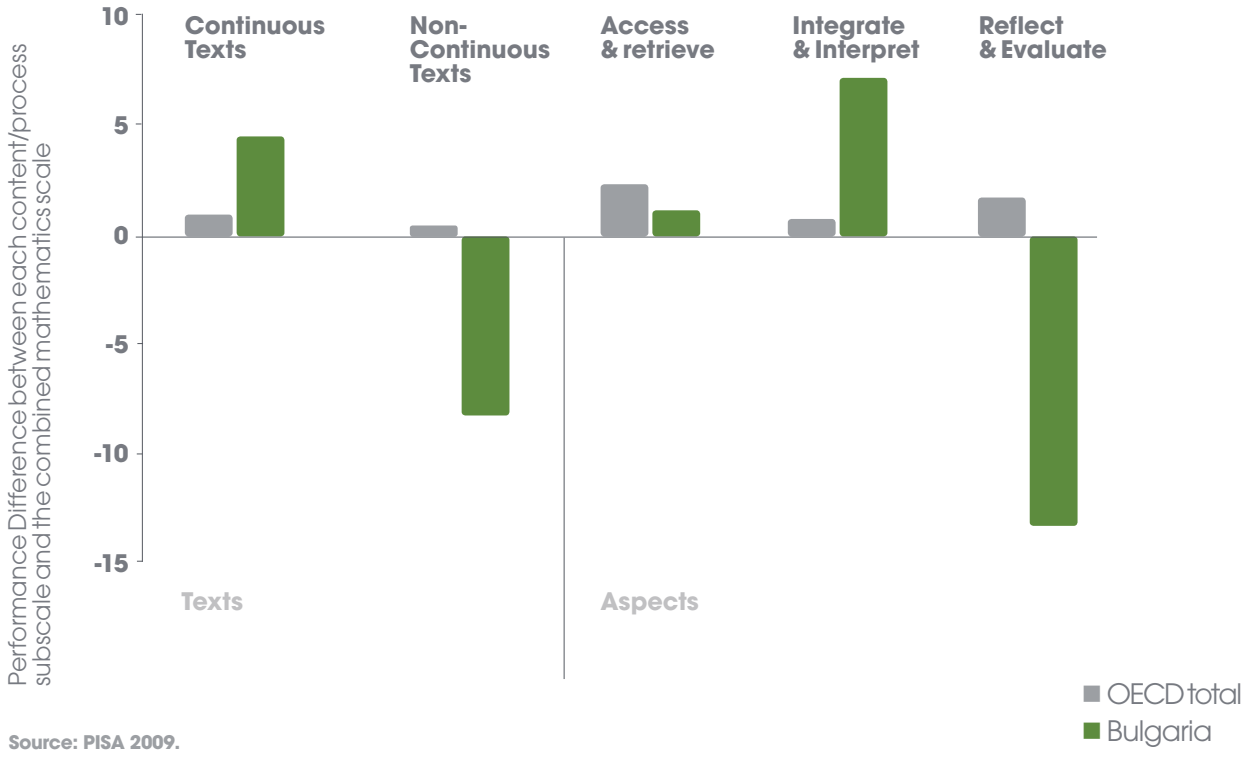
Figure 12. PISA 2012 performance on different math subscales compared to the average math performance

Source: PISA 2012.

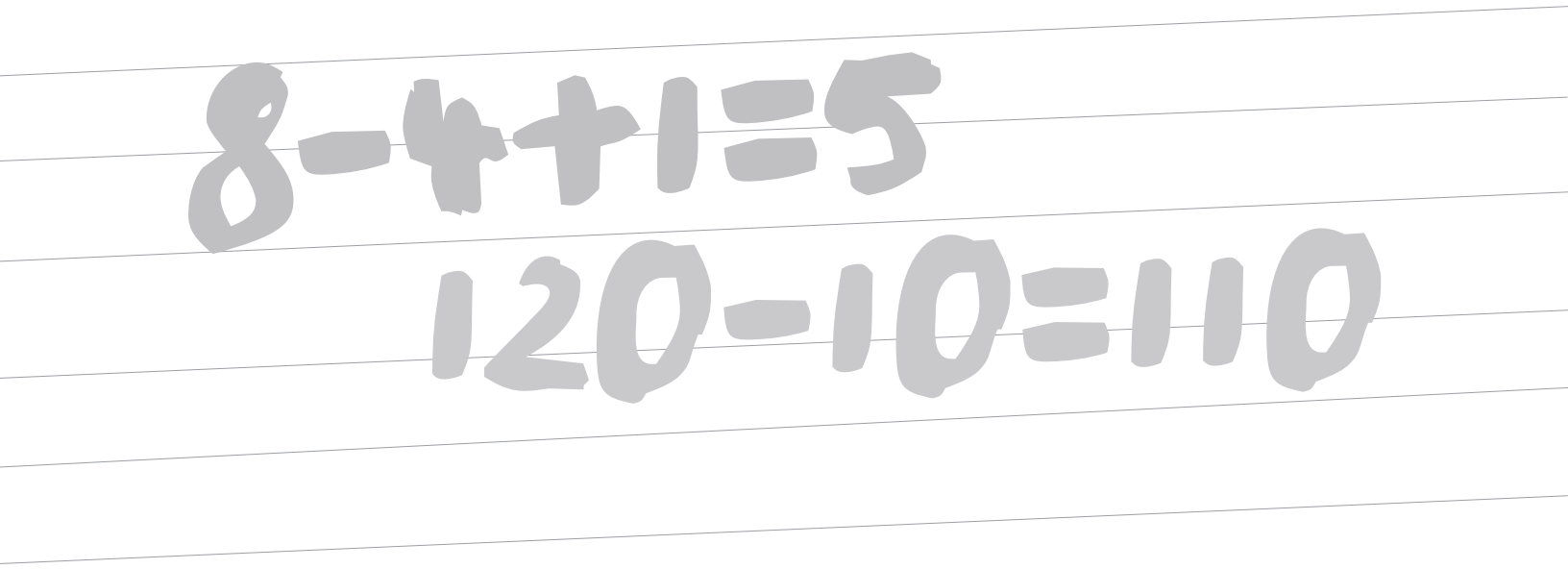
There is a need to improve the reflection and evaluation skills in reading

types: continuous texts (sentences organized into paragraphs, which may fit into even larger structures) and non-continuous texts (smaller sentences, usually in sample lists, graphs, diagrams, or catalogues), although there are also mixed and multiple texts. Aspects are measured as PISA reading subscales with three categories: access and retrieve (skills associated with finding, selecting, and collecting information); integrate and interpret (which involves understanding the relations between different parts of a text, or making meaning from something that is not stated in the text); and reflect and evaluate (which involves drawing on knowledge, ideas, or values external to the text). Finally, situations intend to maximize the diversity of content included in the PISA reading survey; for example, personal, public, educational, and occupational situations are represented.

Figure 13. PISA 2009 performance on different reading subscales compared to the combined reading perfor mance



Source: PISA 2009.



The 2009 subscale assessment for reading revealed that Bulgarian students have a better understanding of continuous text compared with non-continuous text, while there is a need to improve their reflection and evaluation skills in reading. Comparing the reading subscale results with the average score across all reading subscales, Bulgaria shows much more variation across subscales compared with OECD countries, which means there is large room for improvement in some subscales. In particular, students perform better with more traditional texts rather than texts contained in sample lists, graphs, or diagrams. Moreover, students' ability to relate their own experiences to the text is weak, reflecting a disconnect between what students learn and their ability to apply this knowledge in real life situations.

4. Findings & recommendations

After a drop between 2000 and 2006, Bulgaria's PISA scores improved in all three disciplines. To sustain the recent success, new policies are required. A large share of the improvement since 2006 is explained by the improvement in students' socioeconomic status, which translated into better test scores, as well as the better quality of educational resources. It is now necessary to devise a new set of effective policies to continue narrowing the gap in scores with OECD and other countries in the region. Investment in educational resources is important to ensure minimum standards, but is not sufficient to sustain continuous improvement.

Although it is difficult to affect students' predetermined characteristics in the short term, there is still an important role for policy. In Bulgaria, the difference in performance between students in the bottom and top socioeconomic quintiles is much larger than in OECD countries. The significance of predetermined factors in affecting students' educational performance can be discouraging, as these factors generally take time, often generations, to improve.

Inequality of educational opportunities in Bulgaria is the highest in the region and the EU. Disadvantaged groups, such as rural populations and linguistic minorities, perform much worse on the PISA than urban populations and Bulgarian-speaking students. Moreover, the performance gap between girls and boys on the PISA reading score is the highest in the region.

An assessment of Bulgaria's 2007 school autonomy reform shows little impact. This report is the first analysis of the impact of Bulgaria's school-based management reform, which shifted more responsibility to school principals. The results show that overall the results have been more limited than expected, especially given the amount of effort expended on the 2007 reform. A detailed analysis shows that principals' greater autonomy over curriculum and assessment policies had a slight negative impact on Bulgaria's 2012 PISA math scores, while their greater autonomy over management of resources (teachers and budget allocation) had a positive impact. The impact of the reform was higher in urban schools, suggesting better and more accountable school administration in urban areas. Overall, the results indicate the need to further improve the management capacity of principals in rural areas while also strengthening accountability mechanisms.

Students performed better on problems related to space and shape and quantity, and not as well on problems related to data and statistics. Compared with the average math performance of all subscales, Bulgaria's results show slightly higher variation across subscale assessments than is found in OECD countries. Students successfully solved problems related to space and shape and quantity, usually related to geometry, algebra, and physics. However, students underperformed when they needed to use their ability to solve data problems or to appreciate variability and uncertainty in real life problems.

Bulgarian students have a better understanding of continuous text than of non-continuous text, and there is a need to improve their reflection and evaluation skills in reading. Comparing the reading subscale results with the average reading performance of all subscales, Bulgaria shows much more variation across subscales compared with OECD countries, which means there is large room for improvement in some subscales. In particular, students perform better with more traditional texts than with texts contained in sample lists, graphs, or diagrams. Moreover, PISA reveals students' weaknesses in relating their own experiences to the text, reflecting a disconnect between what they learn and their ability to apply that knowledge in real life situations.

If adequate policies are pursued, Bulgaria is likely to succeed in increasing the equality of opportunities to achieve its "Learning For All" goals. With this in mind, six main policy recommendations arise as a result of this study:

1 **Delay the tracking of students into different types of schools as it leads to school stratification with no benefits.** School stratification – the concentration of students with similar socioeconomic status in the same schools – is a result of the inequalities in the Bulgarian education system combined with use of a high-stakes exam that channels students into different schools according to their socioeconomic status. As a consequence, disadvantaged students suffer not only from their own situation but are also penalized by having to interact with similarly disadvantaged peers. Thus, it is plausible that the implementation of adequate selection mechanisms for students in secondary schools, like streaming students at the end of compulsory education (age 16), could raise the overall education quality of the less favored without lowering average performance.

2 **Continue to improve the quality of educational resources to ensure that all students learn in an appropriate environment of books, libraries, lab equipment, and technological resources.** The analysis of the improvement in performance in math and reading between 2006 and 2012 shows that the two key drivers were the evolution of students' socioeconomic status and the improved quality of educational resources. The impact of educational resources was especially important for low-achieving students, indicating a low-hanging fruit for improving the quality and equity of the education system. Continuation of this would include better provision of lab equipment, computer and software materials, library materials, and instructional materials and/or the renovation of buildings and grounds.

3 **Expand preschool education for the most disadvantaged students, as analysis shows it is especially beneficial for the less favored.** The study found that the expansion of preschool education to at least two years raises low achievers' and minorities' scores by up to 10 and 19 points, respectively (even after taking into account other relevant individual and school factors). Universal preschool education would provide a great opportunity to effectively narrow the skills gap from the early stages of children's lives.

4 **Learn from successful schools to improve accountability mechanisms for schools country-wide, particularly in rural areas.** There is a need to further understand: (i) why the autonomy reform did not function as expected; (ii) why the reform was more successful in urban areas; and (iii) why PISA scores were positively affected by greater autonomy in the management of school resources, but not by greater autonomy in curriculum development and assessment. Learning from successful schools could help the Government of Bulgaria augment the impact of the reform in rural areas over the coming years.

5 **Reevaluate the curriculum and assessment framework to better align student learning to the envisaged country goals.** The PISA full assessment analysis derives important lessons for policy makers in Bulgaria. Results shed light on the large discrepancies (as compared to other countries) within reading and math skills. PISA results present a good opportunity to engage in an in-depth debate about a curriculum and assessment framework reform, as well as how to better align the education system with national social and economic development goals.

6 **Promote effective classroom management and strengthen teaching practices.** The analysis shows that a class that is orderly, with fewer disruptions to students, is more conducive to learning and therefore improves PISA scores. The government could use classroom observation methods and international best practices on classroom management to help teachers identify opportunities to improve their performance in the classroom. Teacher development programs could be implemented to improve management techniques in the classroom for the current and future teaching workforce, yielding rapid improvements in the quality of learning.

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Annex

The analytical approach used in Section 2 of this report is based on the Firpo, Fortin, and Lemieux (2009) methodology. Typically, the literature on decomposition of student scores in PISA through groups (Amermueller 2004) and years (Barrera et al. 2011) has focused on the mean differences, with little attention to what happens at the tails of the distribution. The Firpo, Fortin, and Lemieux (FFL) method allows one to decompose gaps in student performance not only for the mean but also for other statistics of the distribution. Traditionally, the problem with quantile regressions has been that the law of iterated expectations does not apply, thus making it impossible to interpret the unconditional marginal effect of each independent variable on a student's performance. However, recent econometric techniques, such as the one proposed by FFL, have solved this methodological difficulty. The FFL technique is based on the construction of re-centered influence functions (RIF) of a quantile of interest, , as a dependent variable in a regression:

$$RIF(I;q_\tau) = q_\tau + \frac{\tau - D(I \leq q_\tau))}{f_I(q_\tau)}$$

where is an indicator function and is the density of the marginal distribution of scores. A crucial characteristic of this technique is that it provides a simple way of interpreting the marginal impact of an additional unit of a certain factor on students' PISA scores. Once the unconditional quantile regression has been computed for different quantiles of the distribution, the results can be decomposed following the Oaxaca-Blinder approach.

Table A. **1. Decomposition of urban-rural PISA math score gaps by student achievement groups.**

Variables	Average	Percentile 20	Percentile 50	Percentile 80
Rural	400.2***	307.0***	401.2***	449.2***
	(6.980)	(17.49)	(6.230)	(9.039)
Urban	459.1***	397.8***	451.3***	542.5***
	(5.518)	(7.648)	(4.715)	(12.50)
Difference	-58.87***	-90.72***	-50.10***	-93.33***
	(8.897)	(19.09)	(7.813)	(15.43)
Unexplained	-38.70***	-52.55**	-30.34***	-53.32***
	(9.693)	(21.38)	(9.874)	(19.15)
Explained	-20.17*	-38.17	-19.76**	-40.01***
	(10.39)	(25.32)	(10.07)	(15.08)
Individual Characteristics	-16.05***	-40.66***	-12.14***	-14.03***
	(3.084)	(9.369)	(2.924)	(5.130)
Peer Characteristics	1.814	19.35	-3.437	-22.04
	(9.272)	(24.80)	(9.199)	(13.65)
School Resources	-4.670	-14.78	-3.335	-2.714
	(5.128)	(14.11)	(5.236)	(6.678)
Autonomy	-1.263	-2.083	-0.851	-1.225
	(1.875)	(4.290)	(1.768)	(2.383)
Constant	17.62	77.70	-136.9	156.9
	(161.0)	(489.4)	(174.7)	(268.2)
Observations	4,501	4,501	4,501	4,501

Note: Robust standard error in parentheses and clustered at the school level. *** p<0.01, **p<0.05,*p<0.1. Variable effects are grouped and include individual characteristics (age, gender, grade, language at home, participation in ECE, and socioeconomic status), peer characteristics (socioeconomic status, school dropouts, and minorities at school), school resources (school owner ship, location, quality of educational resources, teacher shortage, and parental pressure), and school autonomy (autonomy in resources, and autonomy in curriculum and assessment).

Table A.**2. Decomposition of general-vocational PISA math score gaps by student achievement group**

Variables	Average	Percentile 20	Percentile 50	Percentile 80
Year 2012	444.9***	373.7***	439.3***	522.1***
	(4.532)	(6.902)	(3.789)	(9.214)
Year 2006	420.0***	337.2***	417.4***	501.3***
	(6.251)	(3.469)	(6.773)	(9.796)
Difference	24.88***	36.50***	21.86***	20.81
	(7.721)	(7.724)	(7.760)	(13.45)
Explained	17.20***	29.84***	13.15**	26.91**
	(6.601)	(10.42)	(5.725)	(13.39)
Unexplained	7.680	6.658	8.710	-6.102
	(5.654)	(9.553)	(6.281)	(10.79)
Individual Characteristics	-0.464	1.295	0.117	-2.025
	(1.125)	(2.597)	(1.022)	(1.995)
Peer Characteristics	9.348**	8.612*	7.611**	21.61**
	(4.647)	(4.542)	(3.790)	(10.71)
School Resources	6.980***	16.68***	4.277	6.838
	(2.709)	(6.176)	(2.614)	(6.170)
Autonomy	1.333	3.252	1.141	0.487
	(2.467)	(5.117)	(2.384)	(5.442)
Constant	-89.58	-443.1***	55.61	-418.0*
	(114.6)	(170.3)	(139.0)	(228.5)
Observations	8,749	8,749	8,749	8,749

Note: Robust standard error in parentheses and clustered at the school level. *** p<0.01, **p<0.05,*p<0.1. Variables effects are grouped and include individual characteristics (age, gender, grade, language at home, participation in ECE, and socioeconomic status), peer characteristics (socioeconomic status, school dropouts, and minorities at school), school resources (school owner ship, location, quality of educational resources, teacher shortage, and parental pressure), and school autonomy (autonomy in resources, and autonomy in curriculum and assessment).

Table A.**3. Decomposition of 2006-2012 PISA math score gaps by student achievement group**

Variables	Average	Percentile 20	Percentile 50	Percentile 80
Year 2012	444.9***	373.7***	439.3***	522.1***
	(4.532)	(6.902)	(3.789)	(9.214)
Year 2006	420.0***	337.2***	417.4***	501.3***
	(6.251)	(3.469)	(6.773)	(9.796)
Difference	24.88***	36.50***	21.86***	20.81
	(7.721)	(7.724)	(7.760)	(13.45)
Explained	17.20***	29.84***	13.15**	26.91**
	(6.601)	(10.42)	(5.725)	(13.39)
Unexplained	7.680	6.658	8.710	-6.102
	(5.654)	(9.553)	(6.281)	(10.79)
Individual Characteristics	-0.464	1.295	0.117	-2.025
	(1.125)	(2.597)	(1.022)	(1.995)
Peer Characteristics	9.348**	8.612*	7.611**	21.61**
	(4.647)	(4.542)	(3.790)	(10.71)
School Resources	6.980***	16.68***	4.277	6.838
	(2.709)	(6.176)	(2.614)	(6.170)
Autonomy	1.333	3.252	1.141	0.487
	(2.467)	(5.117)	(2.384)	(5.442)
Constant	-89.58	-443.1***	55.61	-418.0*
	(114.6)	(170.3)	(139.0)	(228.5)
Observations	8,749	8,749	8,749	8,749

Note: Robust standard error in parentheses and clustered at the school level. *** p<0.01, **p<0.05,*p<0.1. Variables effects are grouped and include individual characteristics (age, gender, grade, language at home, participation in ECE, and socioeconomic status), peer characteristics (socioeconomic status, school dropouts, and minorities at school), school resources (school owner ship, rural, quality of educational resources, and parental pressure), and school autonomy.

Table A.**4. Decomposition of 2006-2012 PISA math score gaps by student achievement group, detailed autonomy variables**

Variables	Average	Percentile 20	Percentile 50	Percentile 80
Year 2012	444.9***	373.7***	439.3***	522.1***
	(4.532)	(6.902)	(3.789)	(9.214)
Year 2006	420.0***	337.2***	417.4***	501.3***
	(6.251)	(3.469)	(6.773)	(9.796)
Difference	24.88***	36.50***	21.86***	20.81
	(7.721)	(7.724)	(7.760)	(13.45)
Unexplained	7.680	6.658	8.710	-6.102
	(5.654)	(9.553)	(6.281)	(10.79)
Explained	17.20***	29.84***	13.15**	26.91**
	(6.601)	(10.42)	(5.725)	(13.39)
Individual Characteristics	-0.464	1.295	0.117	-2.025
	(1.125)	(2.597)	(1.022)	(1.995)
Peer Characteristics	9.348**	8.612*	7.611**	21.61**
	(4.647)	(4.542)	(3.790)	(10.71)
School Resources	6.980***	16.68***	4.277	6.838
	(2.709)	(6.176)	(2.614)	(6.170)
Autonomy Curriculum	-1.891	-2.598	-2.242	-2.278
	(1.495)	(3.105)	(1.428)	(3.574)
Autonomy Curriculum (Interaction with Rural)	-0.996	-2.118	-0.555	-2.055
	(0.698)	(1.743)	(0.629)	(1.470)
Autonomy Resources	7.008***	13.95***	7.304***	10.02*
	(2.360)	(4.572)	(2.172)	(5.851)

Variables	Average	Percentile 20	Percentile 50	Percentile 80
Autonomy Resources (Interaction with Rural)	-2.788** (1.271)	-5.981* (3.053)	-3.367*** (1.244)	-5.203** (2.342)
Constant	-89.58 (114.6)	-443.1*** (170.3)	55.61 (139.0)	-418.0* (228.5)
Observations	8,749	8,749	8,749	8,749

Note: Robust standard error in parentheses and clustered at the school level. *** p<0.01, **p<0.05,*p<0.1. Variables effects are grouped and include individual characteristics (age, gender, grade, language at home, participation in ECE, socioeconomic status), peer characteristics (socioeconomic status, school dropouts, minorities at school), school resources (school ownership, rural, quality of educational resources, parental pressure), and school autonomy.

Table A.**5. Share of variation in mathematics scores: multilevel models**

	Model 1	Model 2
Individual characteristics (gender, ESCS, Grade	YES	YES
School characteristics (Disciplinary climate, peer characteristics, and teacher shortage)	YES	YES
System characteristics (autonomy variables—autonomy in resources and in curriculum and assessment)		YES
Explained variation (%)	0.52	0.53

Source: PISA 2012.

Table A **6. Determinants of math performance: a multilevel approach**

	Model 1	Model 2	Model 3
ESCS		7.57***	7.58***
		(1.23)	(1.23)
Kindergarten		6.89***	6.91***
		(2.41)	(2.41)
Female		-15.42***	-15.45***
		(2.07)	(2.07)
Foreign language at home		-17.22***	-17.53***
		(3.95)	(3.95)
Age		6.34*	6.38*
		(3.47)	(3.47)
Mathematics anxiety		-20.04***	-20.03***
		(1.04)	(1.04)
Sense of belonging		2.06*	1.99*
		(1.15)	(1.15)
ESCS-school		44.16***	43.20***
		(5.12)	(5.06)
Teacher shortage		6.18	4.71
		(5.71)	(5.62)
Student-teacher ratio		-0.15	-0.12
		(0.13)	(0.13)
Student-teacher relations		-4.98***	-4.96***
		(1.09)	(1.08)

	Model 1	Model 2	Model 3
Teacher support		-1.87 (1.21)	-1.84 (1.21)
Disciplinary climate		6.05*** (1.25)	6.04*** (1.25)
Grade		19.71*** (4.14)	19.71*** (4.14)
Classroom management		5.38*** (0.97)	5.41*** (0.97)
Rural		-6.72 (7.49)	-6.05 (7.33)
Educational Resources		3.84*** (1.33)	3.59*** (1.31)
Program 2		-9.12 - (11.31)	9.23 (11.28)
Program 3		7.68 (10.37)	7.52 (10.34)
Program 4		-2.24 (10.74)	-2.42 (10.68)
Autonomy curriculum			-7.09** (3.10)
Autonomy resources			5.80** (2.85)

	Model 1	Model 2	Model 3
_cons	429.75***	177.29***	174.84***
	(5.19)	(59.50)	(59.48)
ICC (Intraclass correlation, % of variance attributable to schools)	0.58	0.30	0.28

Source: PISA 2012 Bulgaria.

Note: Multilevel models are able to analyze data in nested structure (students within classrooms, within schools) and allow correlation of observations within clusters. For this exercise, we use a random coefficient model at the school level (disciplinary climate). ECE is measured as two years of pre-primary education, and the baseline is one year or less of pre-primary education. Standard errors in parenthesis, *** p<0.01, **p<0.05,*p<0.1

Endnotes

1 Socioeconomic status is measured in PISA with the OECD's Economic, Social, and Cultural Status Index (ESCS).

2 Tracking of students refers to separating students into different academic paths.

3 See Sala-i–Martin, Doppelhofer, and Miller (2004).

4 See Hanushek and Woessman (2007) and Hanushek (2010). Using these tests as measures of cognitive skills of the population, they show that countries that had better quality of education in the 1960s experienced faster economic growth during the years 1960-2000, controlling for other factors.

5 PISA 2009 Technical Report (OECD 2012).

6 Note: Countries that participated only once in PISA between 2000 and 2012 were not considered for the ECA average trend. Linear interpolations were made for Albania, Bulgaria, and Romania in missing years.

7 Ferreira and Gignoux (2011) propose a measure of educational opportunity using the share of variance in test scores that is explained by individual predetermined circumstances. If a significant share of the results is explained by these characteristics, then the equality of opportunities is low.

8 In fact it depends on with whom he or she attends school.

9 See World Bank (2013b).

10 According to PISA data, a student is classified as a disadvantaged low achiever if he or she is in the bottom quarter of the PISA ESCS Index in a country and performs in the bottom quarter of students from all countries/countries, after accounting for socioeconomic status. Only 2.8 percent of students in general profiled schools are disadvantaged low achievers, while the figure increases to 12.5 percent in vocational schools.

11 Although results show the weight of peer effects to be more important than that of individual socioeconomic characteristics, this should be interpreted with caution, as the high correlation between them indicates that both matter.

12 Decomposition included individual characteristics, peer characteristics, school resources, and autonomy. Student and peer characteristics were the most important characteristics in the regression (full results can be found in Table A.2 in the Annex). By decomposing differences, one often finds that one of the explanatory factors is negative or higher than the actual difference, meaning that other factors outweighed their impact.

13 In this analysis, parental and teacher engagement in the school community were used as proxies to control for school accountability.

14 By decomposing differences, one often finds that one of the explanatory factors is negative or higher than the actual difference, meaning that other factors outweighed their impact.

15 OECD aggregates all the autonomy measurements shown in Table 4 into two indexes: an index that relates to autonomy in resource allocation (RESPRES), such as teachers and budget preparation, and an index that relates to curriculum and assessment policies (RESPCURR), such as course content, textbooks, or assessment policies.

16 Low achievers were classified as those students at the bottom 20% of the learning distribution.

17 The Disciplinary Climate Index is derived from students' reports on how often the followings happened in their lessons: (i) students don't listen to what the teacher says; (ii) there is noise and disorder; (iii) the teacher has to wait a long time for the students to quiet down; (iv) students cannot work well; and (v) students don't start working for a long time after the lesson begins.

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