THE IMPACT OF HIGH-STAKES SCHOOL-ADMISSION EXAMS ON STUDY EFFORT AND ACHIEVEMENTS: QUASI-EXPERIMENTAL EVIDENCE FROM SLOVAKIA

Miroslava Federičová

CERGE EI

Charles University
Center for Economic Research and Graduate Education
Academy of Sciences of the Czech Republic
Economics Institute

WORKING PAPER SERIES (ISSN 1211-3298)
Electronic Version

517

Working Paper Series 517
(ISSN 1211-3298)

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CERGE-EI
Prague, September 2014

ISBN 978-80-7343-321-5 (Univerzita Karlova. Centrum pro ekonomický výzkum a doktorské studium)
ISBN 978-80-7344-314-6 (Akademie věd České republiky. Národohospodářský ústav)

The Impact of High-Stakes School-Admission Exams on Study Effort and Achievements: Quasi-experimental Evidence from Slovakia[*1]

Miroslava Federičová[2]

Abstract

High-stakes admission exams to selective schools create incentives for more intensive study effort possibly increasing study achievements of students. Exploiting the exogenous change of a schooling system and using two waves of TIMSS survey data we find that high-stakes exams increase math test scores of ten-year-old students by 0.2 standard deviations. This effect additionally accrues by around 0.05 standard deviations for students in the top decile, i.e. students who apply for selective schools with the highest probability. Although the effects are similar for both genders, there are indications that girls exert higher study efforts than boys in a more competitive environment. The most perceptive to incentives are test items referring to the cognitive domain of reasoning requiring a deeper understanding of math problems.

Abstrakt

Přijímací zkoušky na výběrové školy, tedy zkoušky, ve kterých je hodně v sázce, podněcují žáky k intenzivnějšímu studijnímu úsilí, které může přispívat k jejich studijním výsledkům. Využitím exogenní změny školního systému na Slovensku v roce 2009 a dat ze dvou vln mezinárodního šetření desetiletých žáků TIMSS odhadujeme kauzální průměrný pozitivní dopad těchto zkoušek na matematická skóre žáků na konci čtvrtých ročníku v řádu 0,2 standardní odchylky. Tento efekt je vyšší o dalších 0,05 standardní odchylky u žáků v nejvyšším decilu, tedy u žáků, kteří se na výběrové školy hlásí s nejvyšší pravděpodobností. Ačkoliv jsou námi odhadnuté efekty podobné u obou pohlaví, nacházíme indicie, že v konkurenčnějším prostředí vyvíjejí dívky vyšší studijní úsilí než chlapci. Zkouškami motivované vyšší studijní úsilí má největší dopad na testové otázky vyžadující kognitivní charakter uvažování, tedy oblasti matematické gramotnosti vyžadující hlubší chápaní podstaty matematických problémů.

JEL classification: I21, I24

Keywords: high-stakes exams, students'motivation, achievement

[*] This research was supported by a grant P402/12/G130 of the Grant Agency of the Czech Republic.

[1] All errors remaining in this text are the responsibility of the author.

[2] CERGE-EI is a joint workplace of the Center for Economic Research and Graduate Education, Charles University in Prague, and the Economics Institute of the ASCR, v.v.i. CERGE-EI, P. O. Box 882, Politickych veznu 7, 111 21 Prague, Czech Republic; e-mail: miroslava.federicova@cerge-ei.cz

1. Introduction

Literature in psychology, pedagogy, and sociology provides rich evidence that students' motivations to learn are important co-determinants of educational outcomes (Vansteenkiste, Simons, Lens, Sheldon and Deci, 2004; Elliot, McGregor and Gable, 1999). The typical incentivising external factors that could motivate students to learn and improve their achievements are based on grading and evaluation schemes. Their impact on achievements depends on whether students perceive these factors as relevant for their future outcomes or as a mere task to be fulfilled (Ryan and Deci, 2000). An example of such external factors is high-stakes testing considered as an important instrument for enhancing students' motivations and educational accountability (Jacob, 2005). Most empirical studies have focused on exit exams at the end of key schooling stages—as one type of high-stakes testing—and most of them show an increase in study efforts and academic achievements[3].

However, empirical evidence on the effect of exit exams combines students' motivation to learn with the incentives of teachers and school administrators (Jürges, Schneider and Büchel, 2005)[4]. Results from exit exams at school levels are often publicly known, closely watched, and create strong incentives on the side of teachers and principals. There is abundant evidence that teachers tend to focus on teaching skills being tested at the expense of cultivating more complex skills, which are not tested or cannot be tested easily[5]. Moreover, while exit exams usually test students at the end of the lower and upper secondary stages of education, i.e. at the ages of 15 and 18,

[3] See Jürges, Schneider, Senkbeil, and Carstensen (2012); Jürges, Schneider and Büchel (2005); Woessmann (2002); Bishop (1997).

[4] See Bishop (1997) and Bishop (1999) for the detailed description of incentives of students, parents, teachers, and school administrators induced by high-stakes testing.

[5] Jürges et al. (2012) show a positive effect of central exit exams only on exam-specific knowledge together with no effect on knowledge not included in tested fields. A similar result is shown by Jacob (2005). When the test results are relevant also for teachers and school administrators, it seems that teachers teach predominately the curriculum that is tested.

relatively little is known about the formation of motivation to learn at the age of 10, i.e. at the time when pupils transfer from primary to lower secondary education. This age is characterised with high developmental changes and culminating gender differences in brain development (Lenroot et al., 2007).

In this study, we enrich the existing literature by separating the impact of teachers' incentives from students' motivations to learn. In particular, we explore whether and to what extent high-stakes admission exams to selective schools affect students' study efforts and consequently their achievements. Our identification strategy exploits the quasi-experimental design of the 2009 school reform in Slovakia that postponed the transition to selective schools by one year, from the end of the 4th to the end of the 5th grade. To identify the effect of high-stakes admission exams, we use students' achievements in the 4th grade from the international survey TIMSS before and after the Slovak reform. In 2007, i.e. before the Slovak reform, the 4th graders were tested by TIMSS during May and at the beginning of June the same students had to pass the admission exams to selective schools. In 2011, i.e. after the Slovak reform, TIMSS again examined the 4th graders during May, but these were expected to pass admission exams one year later. Our hypothesis is that this forward shift of a competitive school selection lowered the study incentives of 4th graders leading to lower study achievements in TIMSS 2011. Since between 2007–2011, the test scores could have followed some longer-term trend for reasons unrelated to the reform, we include to our study the data for students in the Czech Republic. Czechs were also tested by TIMSS 2007 and 2011; however, in both years they passed admission exams to selective schools at the end of the 5th grade, i.e. such as it happened to be in Slovakia after the reform. We employ the difference-in-differences methodology to identify the causal effect of admission exams and achievements.

Contrary to school exit exams, the results from high-stakes admission exams to selective schools are not publicly released, are not perceived as an indicator of school quality, and hence, do not create motivations on the side of teachers. Moreover, in our empirical case, there is anecdotal evidence that primary schools consider this early transition to selective schools as a threat to losing their best students.[6] For these reasons, teachers and schools usually do not provide additional tutoring and do not teach to these admission exams (Straková and Greger, 2013; Federičová and Münich, 2014). The effect of high-stakes admission exams we study can be thus attributed only to incentives of students and their parents.

High-stakes admission exams at early ages are a part of the admission process in the so-called Academic Schools that occur in most central European countries such as Germany, Austria, the Czech Republic, Slovakia, and Hungary. This selection takes place at the end of primary education. There is anecdotal evidence that some parents and students take these exams very seriously. Using data from a unique longitudinal study[7] in the Czech Republic, Federičová and Münich (2014) examine the scale and scope of the exam preparation. They document that among 20% of those who apply, nearly 85% devote some time to their preparation every week during the last semester before the admission exam, and among those, even more than half of them prepare for admissions almost every day. At the same time, only a small group of students (15%)

[6] Currently, schooling ministries in both countries consider the reduction of enrolment in Academic Schools, since the driving reason is perceived as an adverse impact of brain-drain on mainstream schools.
[7] The Czech Longitudinal Study in Education (CLoSE) follows the cohort of students in the Czech Republic that were tested in the 4th grade by TIMSS and PIRLS 2011. Data include detailed questions about the intention to apply for Academic School, the preparation for admission exams and their results in 2012. For a further description of CLoSE survey see Straková and Greger (2013).

has an opportunity to attend a preparatory course at their school. This again confirms the low interest of schools in supporting the school transition of their students. Moreover, Federičová and Münich (2014) also show that the vast majority (90%) apply on the basis of their own and their parents' interests and only half of the teachers agree with their school transition.

Our estimates imply that high-stakes exams increase math test scores of ten-year-old students by 0.2 standard deviations. Using the quantile regression, this effect additionally accrues by 0.05 standard deviations for students in the top decile of the math test score distribution, i.e. students who apply for selective schools with the highest probability. Besides the impact on the overall math score, we also investigate the impact on test scores covering different cognitive domains: knowing, applying, and reasoning. We find that equally to the basic skills—measured by the knowing part—students also improve their skills in more complex contents measured by the reasoning parts. Furthermore, we find some differences in behaviour between girls and boys. Although the main effect of admission exams is about the same, girls seem to put higher study efforts into succeeding in the admission exam in districts that have a more intense selection process.

Our paper is structured as follows. Section 2 reviews the literature on the role of motivations and the existing empirical findings on the effect of high-stakes testing on students' achievements. Section 3 describes the process of academic selection in the Czech Republic and Slovakia. Section 4 and 5 discuss the data and the identification strategy. Section 6 presents the results, and Section 7 concludes.

2. Literature Review

In the field of educational psychology, motivation plays an important role in exerting efforts, enhancing educational outcomes (Crumpton and Gregory, 2011; Hidi and Harackiewicz, 2000), and in the long-run, it can also affect labor market outcomes of individuals (Dunifon and Duncan, 1998). This is reflected in the commonly accepted definition of motivation that defines it as a force that moves one to act (Ryan and Deci, 2000). Classical motivational theory distinguishes two types of motivation, intrinsic and extrinsic. Intrinsic motivation is linked to individual interests and has a positive impact on students' achievements. Extrinsic motivation accrues from external factors such as rewards, deadlines, competition, or performance evaluations and can foster or undermine the impact of intrinsic motivations (Crumpton and Gregory, 2011).

Keeping the dichotomy of intrinsic and extrinsic motivation in mind, Ryan and Deci (2000) formulated a new self-determination theory (SDT). SDT defines several types of extrinsic motivation differing by the level of self-determination. In other words, the distinguishing feature is the extent one perceives external factors as important for their own sake. Some external factors motivate individuals only to obtain rewards or to avoid punishments. These incentives disappear with the disappearance of the source of motivation and hence do not motivate individuals to acquire new skills or personal goal formation. On the other hand, there are external factors that are personalized and finally identified as individual to that person. Although this extrinsic motivation is not driven by some inherent interest—as it is in the case of intrinsic motivation—it can enhance intrinsic motivation when students perceive the external factors as important for their present or future outcomes.

High-stakes exams, such as those related to school admissions or school grade, represent specific external factors of motivation. Although they are usually not intended to foster motivation *per se*, they do so because they are widely perceived as prestigious and important for future school outcomes.[8] Therefore, they can facilitate intrinsic motivation, and hence, lead to higher achievements. Several empirical studies found a positive effect of such high-stakes exams. Jacob (2005) shows that new policy that introduced high-stakes testing in several grades—as a requirement for transition to higher grades—in the Chicago schooling district increased the average math and reading test scores by 0.2 to 0.3 standard deviations. Central exit exams in cross country comparison studied by Woessmann (2002) yield even higher effects on math literacy with a magnitude around 0.4 standard deviations. By using the variation in the schooling systems across German states, Jürges et al. (2012) find that students in states with central exit exams outperform students in states without such exams by 0.26 standard deviations in tested subjects, though they find no effect on literacy not being tested by central exit exams. They interpret their finding as the accountability feature of high-stakes exams contributing to the monitoring of schools and teachers either by parents or school administrators. Contrary to this, high-stakes admission exams to selective schools motivate primarily students and their parents not schools and teachers. This is because schools have no interest in losing their best students.

Intergenerational transmission literature[9] provides evidence that parents play an important role in the interaction among extrinsic motivations. In our case, it is the

[8] In particular, more than 90% of students in the CLoSE survey perceive the success in admission to selective schools as a gateway to university education.

[9] For the impact of the family background on children academic outcomes, see Cunha and Heckman (2007); Feinstein (2003); and Anger and Heineck (2010). For the impact of parents attitudes on the development of children´s attitudes and on the creation of their goals and motives, see Grolnick and Ryan (1989); Friedel, Cortina, Turner and Midgley (2007).

parental push to apply for selective schools and to prepare for admissions. Moreover, there are good reasons to expect a different impact on genders. At the time of early school selection—usually at the age of ten or eleven—boys are less mature and are less responsive to parental authority than girls (Wilder and Powell, 1989). Although the effect of parental background seems to be stronger in the case of boys at this stage, girls are more aware of the importance of these admission exams and put greater efforts in preparation for admissions. Hence, one can expect that the presence of a selection at younger ages is increasing more girls' achievements. However, we do not observe corresponding differences in gender composition in selective schools. This can be explained by the stressful nature of high-stakes exams and a distinct perception of stress by genders. As documented by Gneezy and Rustichini (2004) and Jurajda and Münich (2011), high-stakes admissions may give rise to psychological stress that probably works against girls´ success in admissions. As a consequence, the greater sense of purpose of girls does not necessarily translate into greater success in admissions.

3. School Selection in the Czech Republic and Slovakia

Our identification strategy relies on a policy intervention in Slovakia. In addition to Slovak data, we use data from the Czech Republic to control for common trends. Slovakia and the Czech Republic are successors of the former Czechoslovak Federation dissolved in 1993. Although both countries have developed separately since then, they have remained extraordinary similar in terms of demographic structures and institutions, including their school system (Table 1).

Table 1: Characteristics of the school system in the Czech Republic and Slovakia

Characteristics of school system	Czech Republic		Slovakia	
	2007	2011	2007	2011
School entry age[1]	6	6	6	6
-number of years of compulsory education	9	9	10	10
-number of grades in primary and lower secondary education[2]	9	9	9	9
The grade of the first academic selection	6	6	5[3]	6
The average number of pupils in class				
-in primary education	19	19	19	17
-in lower secondary education	20	19	22	19
The teacher-pupil ratio				
-in primary education	1:17	1:17	1:16	1:14
-in lower secondary education	1:12	1:11	1:12	1:11
Owner structure of primary and lower secondary education				
-% of students in private schools	0,6%	0,8%	0,6%	0,9%
-% of students in church schools	0,6%	0,7%	4,8%	5,1%
Government expenditure on edu. (% of GDP)[4]	4,5%	4,7%	4,4%	4,6%
Teacher salaries in primary and lower secondary schools (in EUR)	877	1 091	545	802

Source: National statistical offices.

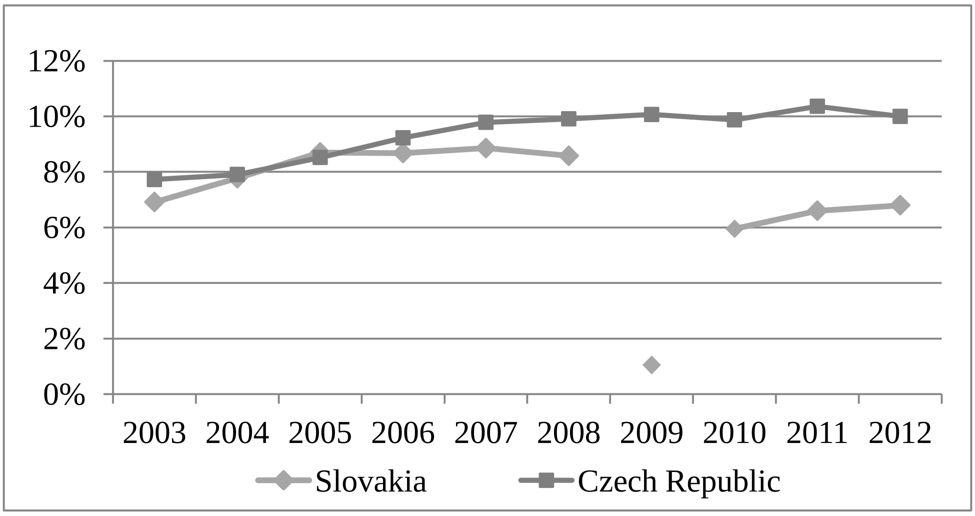
[1] Pupils can enrol into Basic School if they reach six years of age by September 1 of a given school year. Children can enrol at the age of 7 if recommended by pedagogy advisor or upon parental request.
[2] It was 8 years for both countries before 1998.
[3] The 2009 school reform in Slovakia that shifts forward the transition to selective schools by one year.
[4] Government expenditure data from OECD (2013). Years of reference for data are 2005 and 2010.

Both systems allow for the early tracking of students into selective schools. In particular, at the end of the 5th grade, a small proportion of students have an option to move from so-called *Basic School* (lasting 8 - 9 grades) into the so-called *Academic School*. Studies at Academic School last eight years and cover both the lower- and upper-secondary levels. In both countries, school types similar to Academic Schools had tradition before the Second World War but were closed by the communist regime in the early 1950s. After the Velvet Revolution in 1989, Academic Schools were re-established in both countries. The only difference between these two countries was the grade of enrolment. In the Czech Republic, Academic Schools have enrolled students after their 5th grade whereas in Slovakia it has been after the 4th grade. The 2009 school reform in Slovakia brought a forward shift in the enrolment grade by one year. As a part of the reform, Slovaks have also successively reduced the proportion of students enrolled in Academic Schools from 9% in 2009 to 5%.

Although the curriculum taught at Academic Schools does not differ from the curriculum taught in the corresponding grades of mainstream Basic Schools, it is taught there in greater depth and intensity, and higher study requirements are imposed. Compared to Basic Schools, Academic Schools have been perceived as more prestigious, of better quality, securing better peers, and as a result, they considerably increase students' chances in admission to high quality universities (Dearden, Ferri and Meghir, 2002). Since the number of slots is kept fixed, Academic Schools have been facing substantial excess demand since their re-establishment in the 1990s. The excess demand generates extrinsic study motivation to pass demanding admission exams.

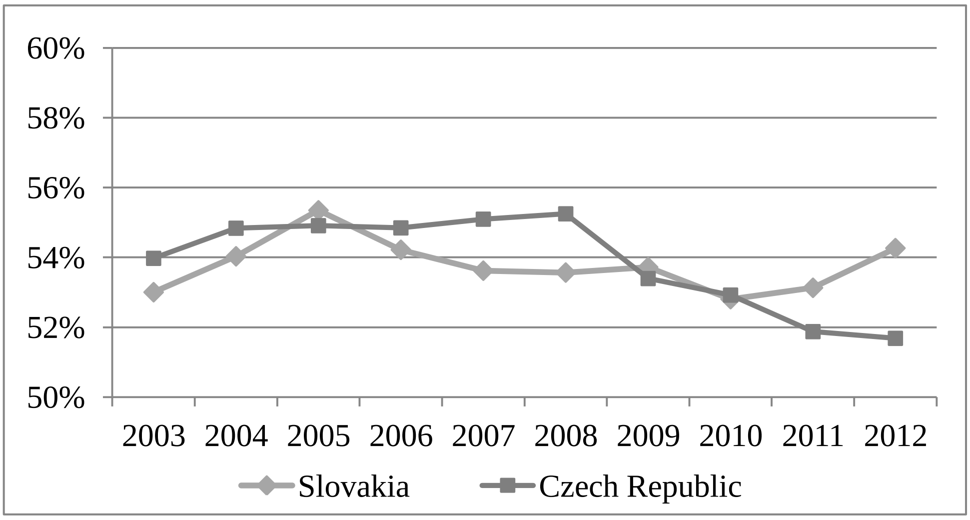
Since 1989, in both countries, the share of students in Academic Schools has grown gradually (Figure 1). The positive trend during the last decade was autonomous due to a demographical decline vis-à-vis a fixed number of slots in Academic Schools. The only intentional change in the selectivity rate was brought by the 2009 school reform in Slovakia. Regarding the gender composition, girls only slightly outweigh boys in Academic Schools. In the last decade, there are around 55% of girls (Figure 2).

Figure 1: The enrolment in the first grade of Academic Schools (lower secondary) as a share of an age cohort



Source: National statistical offices.
Note: The sudden drop in the time series of Slovakia was caused by the 2009 school reform.

Figure 2: The proportion of girls in the first grade of Academic Schools (lower secondary)



Source: National statistical offices.

In the school year 2011/2012, there were 275 and 147 Academic Schools in the Czech Republic and Slovakia, respectively. Admission exams to Academic Schools are administered at the end of April and at the beginning of June in the Czech Republic and

Slovakia, respectively. Before the 2009 reform in Slovakia, the TIMSS testing coincided with admission exams to Academic Schools. After the reform, the TIMSS testing precedes admissions by about one year in both countries. In both countries, each Academic School uses its own admission criteria which are, in most cases, based on written tests. Tests in mathematics and national language are most common. These are usually based on curricular knowledge as it is in the case of TIMSS testing. Some schools also use general study aptitude tests or adopt additional criteria like student's grade performance at Basic School or achievements in mathematical and other Olympiads.

4. Data

TIMSS is an international[10] survey testing 4th graders in mathematics and science skills in four-year cycles[11]. We employ two successive rounds of TIMSS: the 2007 round, i.e. before the school reform in Slovakia, and the 2011 round, i.e. after the reform. We also use data from the Czech Republic serving us as a control group.

In our investigation, we deal not only with the overall math scores but also with test scores mapping to three cognitive domains (Mullis, Martin and Foy, 2008): knowing, applying, and reasoning. 40% of TIMSS math test items are aimed at the student´s knowledge base (knowing domain), 40% at the ability to apply math knowledge (applying domain), and 20% at deeper understanding of math problems (reasoning domain). Individual math test items were constructed in a way to enable the

[10] The TIMSS assessment data are comparable across all participating countries since all students who are in TIMSS are tested by the same set of test items. Moreover, various procedures during the preparation of test items ensure compatibility of the test results across all countries (Mullis, Martin and Foy, 2008).

[11] The assessment data from the first cycle of TIMSS in 1995 were scaled by setting the mean test scores from all participating countries equal to 500 and the standard deviation to 100 (Olson, Martin and Mullis, 2008). In each successive TIMSS cycle, the assessment data were placed on a scale from the previous cycle to provide accurate measures for trends across all cycles of TIMSS.

comparison between these cognitive achievement scales (Mullis, Martin and Foy, 2008).

Figure 4 depicts kernel densities of TIMSS math test scores[12] in both countries in both years, and Table 2 reviews the corresponding basic distributional characteristics. In 2007, in terms of average scores, the Czech Republic lagged behind Slovakia, but until 2011, its average test scores grew five times faster than in Slovakia. In 2011, as a result, average scores in both countries were very similar. More importantly, whereas this shift in the Czech Republic is similar across all percentiles of the TIMSS math test score distribution, the shift in Slovakia does not appear in the top quartile. This pattern is in line with our key hypothesis that additional study effort due to preparation for admissions (present in Slovakia in 2007 but not in 2011) increases the study achievements of those who consider admission. Table 3 describes effectively the same phenomena within individual cognitive domains. Math achievements in all three cognitive domains have increased in both countries but noticeably more in the Czech Republic. The highest growth appeared in the cognitive domains of knowing and reasoning in the Czech Republic. This could be due to the adverse impact of the Slovak reform on the test scores of 4th graders we explore in the next section.

To account for possible dependence of the strength of extrinsic motivations on student's demographic and socio-economic family background, we control for individual characteristics. In particular, following common practice, we use the number of books at home as a proxy for socio-economic family background[13]. TIMSS reports the number of books on a discrete scale. The distributions of book possession are

[12] TIMSS provide five plausible values that represent student math test scores (Foy, Galia and Li, 2008). To compute descriptive statistics of math test scores and regression coefficients and their standard errors, we apply Rubin's (1987) methodology for multiple imputations.

[13] See e.g. Brunello and Checchi (2006) that show the number of books at home and the highest completed education of parents give similar effects on study achievements.

similar in both countries and exhibit similar, relatively small changes between the two years. Table 4 reviews the descriptive statistics of TIMSS individual background characteristics in the two testing years for both countries.

4.1 Excess Demand

We explore whether the presence of high-stakes admission exams gives rise to extrinsic motivations fostering study efforts of students and increasing their study achievements measured here by TIMSS math test scores. If selective admission to Academic Schools creates additional study incentives, greater incentives and impact might be observed in districts experiencing higher relative excess demand (measured as a ratio of applications to admitted students minus 1) and negligible incentives in districts with zero excess demand. Therefore, we collected district level data from school registers and merge them to TIMSS data. Figure 5 and Figure 6 depict the levels and changes in demand, supply and relative excess demand for Academic Schools between the years 2007 and 2011 at the district level. The systematic drop in supply in almost all Slovak districts in 2011 was due to the 2009 school reform. Some Academic Schools did not re-open classes or reduced class sizes[14] resulting in an overall drop in supply by 28%. However, the demand for Academic Schools in Slovakia dropped too (by 24%), so that the relative excess demand remained about the same. On the contrary, while supply between the two TIMSS rounds was relatively stable in the Czech Republic, demand increased by 20%. This led to higher relative excess demand (around 30%) driven primarily by demand in districts which had faced high demand and high relative excess demand already in 2007.

[14] In Nitra district, about half of the classes in Academic Schools were closed. As the demand for Academic Schools only decreased by 20%, the excess demand increased sharply in 2011 in Nitra. Because of this unusually big jump in excess demand, we exclude Nitra district from our analysis.

5. Methodology

Our identification strategy employs the quasi-experimental feature of the 2009 school reform in Slovakia, i.e. an exogenous forward shift of the grade when selection to selective Academic Schools takes place. Before the reform, the selection occurred at the end of the 4th grade based on admission exams organised in early June. In 2007, the selection coincided with the TIMSS testing organised in May, again for the 4th graders. In 2011, after the reform, the TIMSS testing preceded admission exams by about one year. Before the reform, the TIMSS tested students who had already finished preparation for admission exams while after the reform, the TIMSS tested students before they start preparing for admission exams. Our key hypothesis is that this forward shift of the selection grade lowered study incentives of students in the 4th grade leading to lower study achievements in TIMSS 2011 in Slovakia. To control for possible trends in test scores between 2007 and 2011 unrelated to the 2009 reform, we use Czech Republic pupils as a control group. Note that there was no reform in the Czech Republic, and the selection into Academic Schools has always taken place at the end of the 5th grade. Such data allow us to apply difference-in-differences methodology (DID) controlling for time- and district-specific effects (Wooldridge, 2002).

To examine the impact of admission exams on achievements via higher study effort, we estimate the following model:

$$S_{it}^{d} = \alpha + \beta_1 DD^{SVK} * DY^{2007} + \gamma_1 DY^{2007} + \gamma_2 DD^{d} + \gamma_3 X_{it}^{d} + \epsilon_{it}^{d}, \qquad (1)$$

where S is the math score[15] of student i in year t and in district d; DD^{SVK} is a dummy equal to 1 for Slovak districts and 0 for districts in the Czech Republic; and DY^{2007} is a time dummy equal to 1 for the year 2007, i.e. before the 2009 reform, and 0 for the year

[15] The mean of the math test score distribution is normalized to 0 and the standard deviation to 1.

2011. Thus, year 2011 and the Czech Republic represent the base captured by the intercept α. Furthermore, we control for time (DY^{2007}) and district (DD^{d}) specific effects. We also control for observed individual and school characteristics in vector X, such as student's age, number of books at home, and municipality size of school location. The key coefficient of our interest is β_1 capturing the effect of high-stakes admission exams (treatment) on achievements of Slovak students in 2007, i.e. before the reform. To allow for different impact on boys and girls, we estimate Eq. (1) separately by genders.

The presence of high-stakes admission exams is not the only factor at the level of school system that can affect students' study efforts and their achievements. The degree of excess demand can foster incentives and increase performance in order to secure admission. This establishes variation in competitiveness across districts and in time. Given that the excess demand is correlated with the interaction term, the estimate of interaction coefficient in the previous specification of Eq. (1) may be biased due to the omitted variable. To get unbiased estimates, we consider augmented specification of Eq. (1) controlling for relative excess demand:

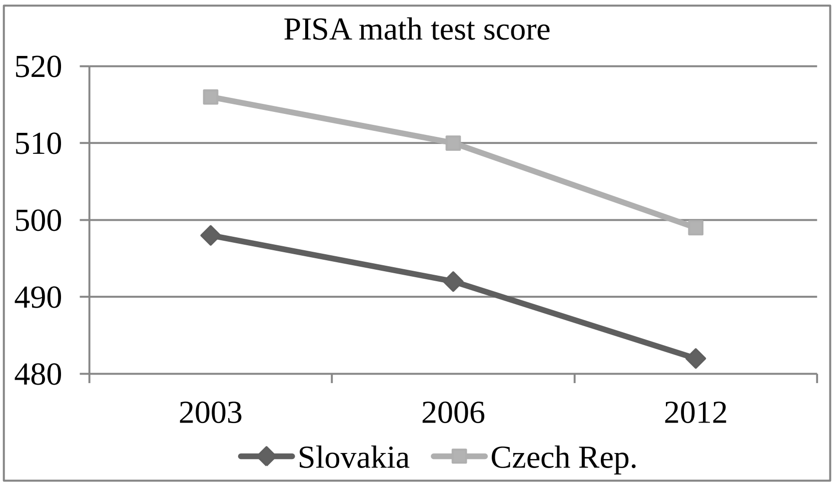
$$S_{it}^{d} = \alpha + DD^{SVK} * DY^{2007}(\beta_1 + \beta_2 ED) + \gamma_1 DY^{2007} + \gamma_2 DD^{d} + \gamma_3 X_{it}^{d} + \gamma_4 ED + \epsilon_{it}^{d}\,, \quad (2)$$

where ED is relative excess demand[16] for Academic Schools in district d and time t. Note that the degree of selectiveness should matter only in Slovakia before the reform, and hence, the coefficient γ_4 should be close to zero. The coefficient on the interaction term between treatment and the excess demand (β_2) captures the change in achievement due to more intensive study efforts initiated by the more competitive environment.

[16] Excess demand is measured as a ratio of applications to admitted students minus 1, i.e. zero excess demand represents districts with the same number of applications as admissions.

Our key identifying assumption is that in the absence of treatment, the coefficient β_1 would be equal to zero. Specifically, it means that on average and conditional on our covariates, the TIMSS test scores in the Czech Republic and Slovakia would have followed the same trends if the Slovak reform did not occur. As we point out in Section 3, after the division of Czechoslovakia the school system of the two countries remained very similar. We document this by trends in test scores from the international survey PISA[17] that tests 15-year-old students (Figure 3). Unfortunately, there are no other surveys available that would allow us to document similar trends more properly. Here, one has to rely on the assumption that the PISA test scores are not affected by the different grade of the first selection in the two countries before the reform.[18].

Figure 3: Time trends in math test scores (PISA) in the Czech Republic and Slovakia



Source: PISA 2003, 2006, and 2012.

[17] We should show that TIMSS test scores in the two countries evolve with parallel trends after the 2009 reform in Slovakia. However, the TIMSS test scores after 2011 are not available yet.

[18] The majority of students affected by the 2009 school reform in Slovakia have reached 15 years of age in the year 2014. Using the PISA survey before and after the reform, i.e. PISA 2012 and PISA 2015, respectively, we can additionally examine the effect of later selection, i.e. estimate whether one more year with the top students enhance or worsen achievements of students who remain in normal schools.

It should be noted that only 20% and 10% of students in the Czech and Slovak Republic, respectively, apply for Academic Schools. Therefore, one can argue that high-stakes admission exams have a greater impact on the study effort and achievements of applicants while the impact on other students via, for example, peer-effects, is much lower. Unfortunately, TIMSS data do not contain information on whether individual students apply for Academic Schools or not. We use two alternative approaches taking into account that probability of applying is higher at the upper tail of the initial skills distributions.

First, we estimate model (2) by a quantile regression[19]. The quantile regression model estimates the treatment effect at different parts of the conditional distribution of TIMSS test scores. Thus, in contrast to the linear regression model estimating the conditional mean function, the quantile regression model estimates the conditional quantile function (Hao and Naiman, 2007).

Second, we estimate the percentile distance of each student from the admission threshold and enter it as an additional covariate to models (1) and (2). We assess the distance in the following way. We estimate the probability of a student admission to Academic School using data from an *ad hoc* follow-up survey of the Czech TIMSS 2011 cohort at the end of the 5th grade (one year after TIMSS testing) containing information on whether a student was admitted to an Academic School[20]. We use estimated parameters of a probit model admitted / not admitted to predict corresponding admission probabilities for Slovak students. By ranking students by predicted probabilities within each district and taking into account the district-specific number of

[19] For detailed description of quantile regression see Koenker (2005).

[20] Czech longitudinal project CLoSE ran a follow-up survey of the TIMSS 2011 students' cohort one year later and asked detailed questions concerning the preparation for Academic School admissions and results of admissions. CLoSE data allow us to estimate a Probit model of the probability of being admitted to Academic School for the Czech sample of TIMSS 2011 students.

slots at Academic School, we compute the absolute percentile distance of each student from the admission threshold in both directions[21]. We further use the distance variable to estimate the specification from model (2) on the subset of students who are close to the admission margin from both sides, i.e. whose distance variable is less than 5 percentage points.

Finally, we also estimate model (2) replacing overall math scores on the left-hand side by tests scores capturing individual cognitive domains of knowing, analysing, and reasoning.

6. Results

Table 5 presents estimated coefficients and their standard errors for different specifications of the difference-in-differences models (1) and (2) for girls and boys separately. The *treatment* variable is the dummy for Slovakia in 2007. For easier interpretation of the estimated coefficient, we standardized test scores so that in 2007 they have zero mean and a standard deviation equal to one[22]. In the base-line model presented in Column (1), the average treatment effect is significant and equal to 0.16 and 0.18 standard deviations for girls and boys, respectively. Controlling for individual and school characteristics in Column (2), the treatment increases to about 0.22 standard deviations with negligible gender difference. Hence, the presence of admission exams to Academic Schools enhances the average math test scores by around 0.2 standard deviations.

[21] This threshold is specified for each district by the proportion of students in Academic Schools in its first year to the number of students in the respective cohort.
[22] Standardized score S is computed from original TIMSS scores T as $S = (T - T_{2007})/\sigma_{2007}$, where T_{2007} is mean score and σ_{2007} is standard error in 2007 (both countries).

We additionally control for the intensity of competition in admission by relative excess demand *ED* in Column (3). Significant positive coefficient on the interaction term of the excess demand and treatment in case of girls indicates a stronger impact on attainment in districts with higher competition. However, higher competition shows no impact on study efforts of boys. Regardless of the excess demand, the average treatment effect of boys is equal to 0.20 standard deviations. For girls, the average treatment effect rises from 0.14 standard deviations in districts with zero excess demand to 0.30 standard deviations in districts with relative excess demand equal to 1, i.e. with two applications per one slot. Hence, in districts with more competitive admissions, girls seem to devote higher efforts resulting in higher achievements. This is translated to the gender difference in average treatment effect being about 0.1 standard deviations in districts with relative excess demand equal to 1. The positive significant coefficient of excess demand refers to the effect of the change in excess demand between 2007 and 2011 on the math test scores. Hence, districts in which excess demand increases by 1 report the growth in mean math test scores by 0.09 and 0.04 standard deviations for girls and boys, respectively.

In the last Column (5) in Table 5, we exclude 4 districts with very high excess demand including both capital cities. Whereas the average treatment effect does not change, the effect of excess demand in treatment rises, in the case of girls, to 0.21 standard deviations.

Quantile regression estimates for 10^{th}, 25^{th}, 50^{th}, 75^{th}, and 90^{th} quantiles are reported in Table 6. The estimated impact of the treatment at the 90^{th} quantile (i.e. the upper end of the test score distribution) is higher than the treatment in lower quantiles and the base-line model estimates in Table 5. Moreover, in the case of boys, the treatment effect increases steadily from zero in the lowest decile to significant and positive effects in higher quartiles. The treatment boosts the median test scores of boys by 0.26 standard deviations and rises to 0.29 standard deviations for students on the 75th quartile. A slightly lower treatment effect is observed in the top decile and is equal to 0.25 standard deviations. This suggests that the best performing boys in mathematics devote less effort to prepare for the math part of admissions. It could be explained by their higher self-confidence in passing admission exams. On the other hand, the estimated treatment effect for girls is significantly positive only for the upper half of test score distribution and gradually increases from 0.16 standard deviations in median to 0.18 standard deviations in the top decile.

Further, the treatment effect notably increases across the math test score distribution with the intensity of the selection process, but again only in the case of girls. Thus, girls in the lowest decile additionally increase their achievements by 0.1 standard deviations in districts with unit excess demand. On the other side, for girls in the highest decile, this effect is more than double. Among girls at the top decile, a unit change[23] in relative excess demand raises the achievement by 0.24 standard deviations compared to the 0.16 standard deviations in conditional means. Hence, in the districts with zero excess demand, the presence of admission exams affects more the study efforts of boys than girls (by 0.06 standard deviations) whereas in the highly competitive districts, i.e. with excess demand equal to 1, the treatment effect on achievements is higher for girls by around 0.2 standard deviations.

Table 8 presents estimates of models (1) and (2) using the estimated absolute distances of students from district-specific admission thresholds. The estimated

[23] Note that a unit change in relative excess demand corresponds to a substantial growth from a balanced demand-supply to demand being twice of supplied slots.

treatment effect is equal to 0.19 and 0.15 standard deviations at the admission threshold for girls and boys, respectively, and is significantly declining with the increasing distance from the threshold.

The augmented specification is presented in the 2nd column. Controlling for the excess demand, the average treatment effect becomes insignificant for both girls and boys. It means that there is zero treatment effect at the admission threshold in districts with no selectivity, i.e. with zero excess demand. Also, the effect of distance from the admission margin does not differ for students with or without the treatment. However, we observe very high positive estimates for excess demand in interaction with treatment for both genders. Here, a unit change in relative excess demand significantly raises the treatment effect by 0.52 and 0.33 standard deviations for girls and boys respectively. This effect is further declining with the distance from the admission threshold. A percentile change in distance decreases the treatment effect of girls by 0.005 standard deviations. Hence, relatively low, and for boys even zero, effects of more selective admissions on average students' achievements are higher by around 0.3 standard deviations for students at the admission margins, i.e. for students who are most affected by admissions.

Focusing on the subset of students 5 percentage points above and below the admission margin and estimating the model (2), we obtain similar results as in previous specifications. Results are presented in Column (3) of Table 8. These students exhibit zero average treatment effects that further increase with excess demand and achieve 0.6 and 0.4 standard deviations in districts with unit excess demand for girls and boys, respectively.

Table 9 presents estimates of model (2) and its versions for individual cognitive domains, i.e. knowing, applying, and reasoning domains. For girls, we find the highest treatment effect for reasoning test items equal to 0.24 standard deviations, whereas for knowing test items, it is only 0.16 standard deviations. Boys improve in knowing and reasoning test items almost equally by around 0.19 and 0.16 standard deviations, respectively. The treatment effect is insignificant for analysing test items for both girls and boys. The effect of excess demand is significant only for girls and for knowing test items. A unit increase in relative excess demand raises achievements in knowing test items by 0.17 standard deviations.

We also pay attention to possible setbacks due to the ordinal nature of TIMSS test scores. There is a possible problem that one point change of the test score in the lower tail of skills distribution does not necessarily corresponds to the same increase in skills in the upper tail. This problem was highlighted by a recent study of Bond and Lang (2013) showing sensitiveness of estimated test score gaps on the choice of a scale. They demonstrate that various monotone transformations of test scores can lead to very different test scores gaps.

To investigate the possible presence of this problem in our estimation, we apply several order-preserving scale transformations of TIMSS test scores similar to those used by Bond and Lang (2013). By minimizing and maximizing the difference in the test score changes between Slovakia and the Czech Republic over time (i.e. DID effect), we can set an interval for a treatment effect that is robust to the choice of scale. In Table 10 we compare base-line model estimates presented in Column (4) in Table 5 with those of the difference-maximizing and difference-minimizing model. The estimated parameters are not effectively different from those of the baseline model, and the choice of scale does not significantly affect our estimates.

7. Summary and Conclusion

We address important policy questions concerning the impact of students' motivations on achievements. Educational psychology studies consider the role of external factors such as rewards, deadlines, competition or evaluation. A plethora of studies in this area shows that such incentives can increase students' study performance but can also undermine it. Our analysis focuses on particular, but very common and rarely investigated study incentives born by high-stakes admission exams and their consecutive impacts on students' achievements. High-stakes admission exams at early ages differ from other high-stakes testing like exit exams in that they affect an out-of-school learning effort while not affecting in-school teaching intensity. If some students and their parents perceive admission exams to selective schools as contributing positively to their future study and labor market outcomes, such exams create additional study incentives based on personal interest.

Our empirical findings indicate that the presence of high-stakes admission exams to Academic Schools at the end of primary education motivate some students to intensify study efforts leading to higher achievements. Our identification strategy utilising exogenous quasi experimental policy intervention estimates treatment in the range of 20% of the standard deviation. The size of the treatment effect is very similar to the findings in existing empirical studies although they report students' efforts and teachers' incentives together. The effect is of the same nature for both genders, but girls seem to be more sensitive to the degree of competition and peer pressures. Although girls on average lag behind boys in mathematics, they are not deterred from admission exams and put higher efforts into securing their admission, especially, when they face pressure from a more intense selection process. We find that in districts with the most competitive admissions, i.e. with two applicants per one slot, girls increase their achievements by 0.3 standard deviations when they face admission exams in the near future. This effect is even higher on the top decile equal to roughly 0.42 and 0.25 standard deviations for girls and boys, respectively. Possible gender differences in motivation and its effect on academic performance can contribute to the gender inequality in educational outcomes, such as participation in academic education or test achievements. However, further research is needed to better understand the origin and consequences of gender differences in the creation of motivations to learn.

Our estimates identify notably a greater impact in the domains of reasoning and knowing. Hence, approximately equally, students improve both their basic and more complex math skills requiring a study strategy of deep processing (Elliot, McGregor and Gable, 1999). This supports the results of a positive effect of high-stake admission exams as the deep processing is usually connected with intrinsic motivations enhancing study achievements.

Our findings should be used cautiously when arguing for early school selection. This is because early selection involves many other effects which, from a normative point of view, are much less desirable. These include the important role of family wealth, time devoted and personal pressure on the side of parents and perseverance, ambition, and rigour on the side of students. This means that selective schooling systems open space to factors whose role should be diminished by the primary schooling system. It relates to the current debate in the UK about Grammar Schools enrolling students well prepared to pass the admission exam but not having sufficient study skills to make progress in follow-up study.

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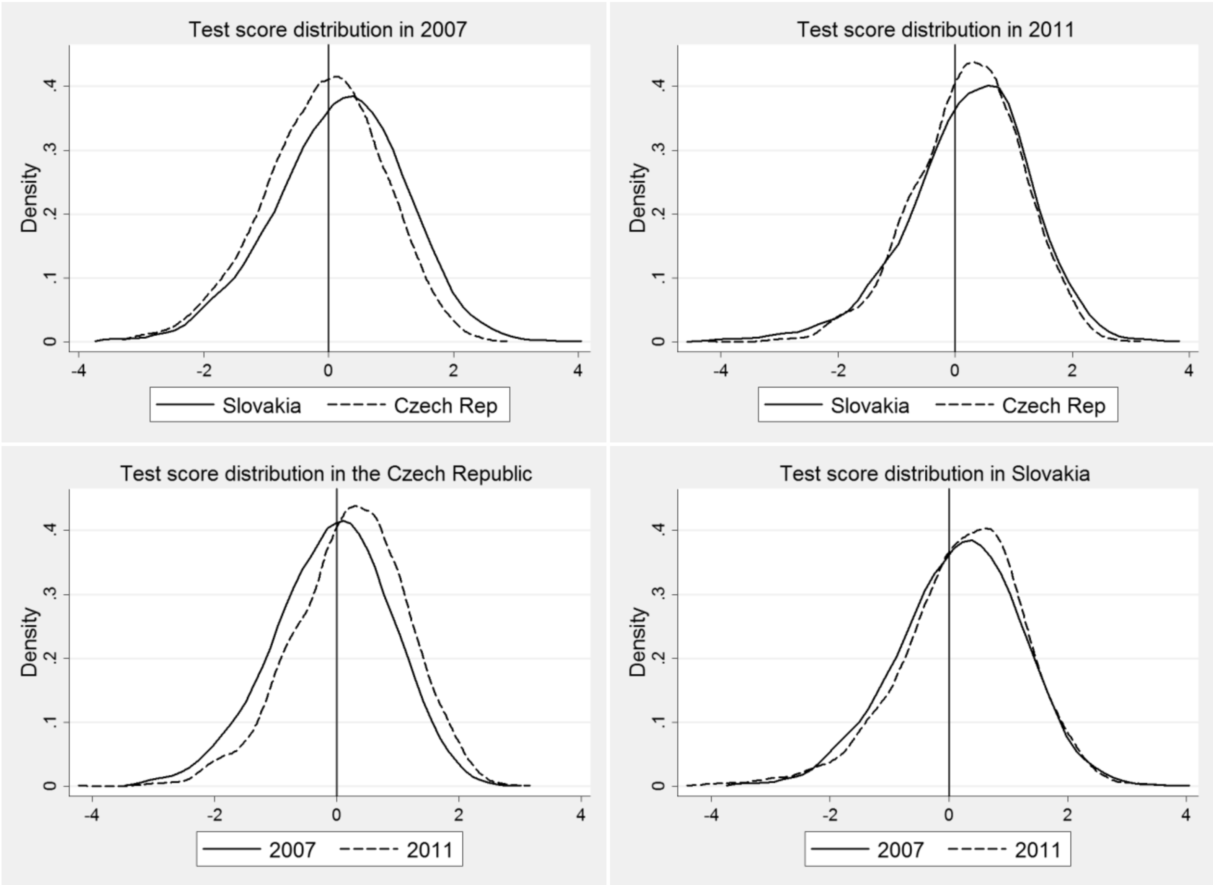
Figure 4: Math test score distributions in years 2007 and 2011



Source: TIMSS 2007 and 2011.

Table 2: Math test scores in Slovakia and the Czech Republic in 2007 and 2011

Percentiles	Slovakia			Czech Republic		
	2007	2011	Δ 2011-07	2007	2011	Δ 2011-07
5th	350 (10.2)	363 (8.5)	13 (14.3)	361 (7.1)	387 (5.8)	25 (9.5)*
10th	389 (9.8)	401 (7.2)	12 (13.4)	392 (7.0)	419 (4.9)	27 (8.7)*
25th	446 (4.2)	460 (3.7)	15 (6.0)*	440 (4.5)	467 (2.8)	27 (5.3)*
50th	502 (3.0)	513 (3.7)	11 (5.1)*	490 (4.0)	514 (2.4)	24 (4.3)*
75th	553 (3.5)	560 (2.9)	7 (5.0)	536 (3.0)	560 (2.3)	24 (3.6)*
90th	597 (4.6)	600 (4.3)	3 (6.6)	576 (2.9)	598 (2.3)	22 (2.9)*
95th	623 (5.2)	626 (6.1)	2 (8.9)	597 (3.0)	621 (3.7)	24 (4.6)*
overall	496 (4.5)	506 (3.8)	10 (6.4)	486 (2.8)	511 (2.4)	25 (3.3)*
N	4,919	5,150		4,199	4,580	

Source: Own calculations based on TIMSS 2011 and TIMSS 2007.

Note: Standard errors are in parentheses. *p<0.1

Table 3: Math test scores in Slovakia and the Czech Republic in 2007 and 2011, by cognitive domains

Cognitive	Slovakia			Czech Republic		
domains	2007	2011	Δ 2011-07	2007	2011	Δ 2011-07
Knowing	493 (3.9)	506 (3.9)	13 (6.0)*	473 (2.4)	502 (2.4)	29 (3.3)*
Applying	498 (4.0)	505 (4.1)	6 (6.2)	496 (2.7)	512 (2.8)	16 (3.7)*
Reasoning	500 (4.0)	510 (4.0)	11 (6.2)*	493 (3.4)	523 (2.7)	30 (4.2)*

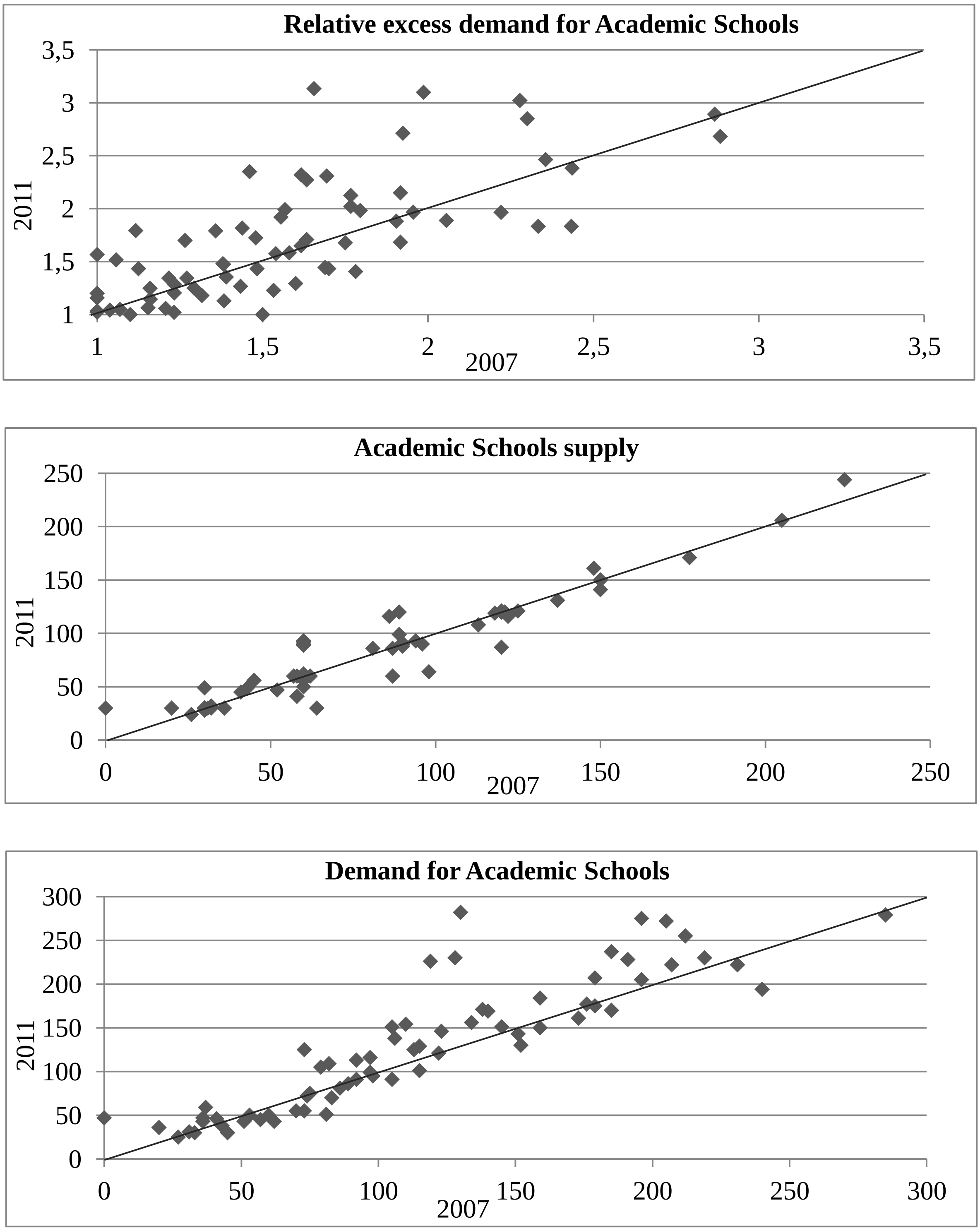
Source: Own calculations based on TIMSS 2011 and TIMSS 2007.

Note: Standard errors are in parentheses. *p<0.1

Table 4: Students' background characteristics

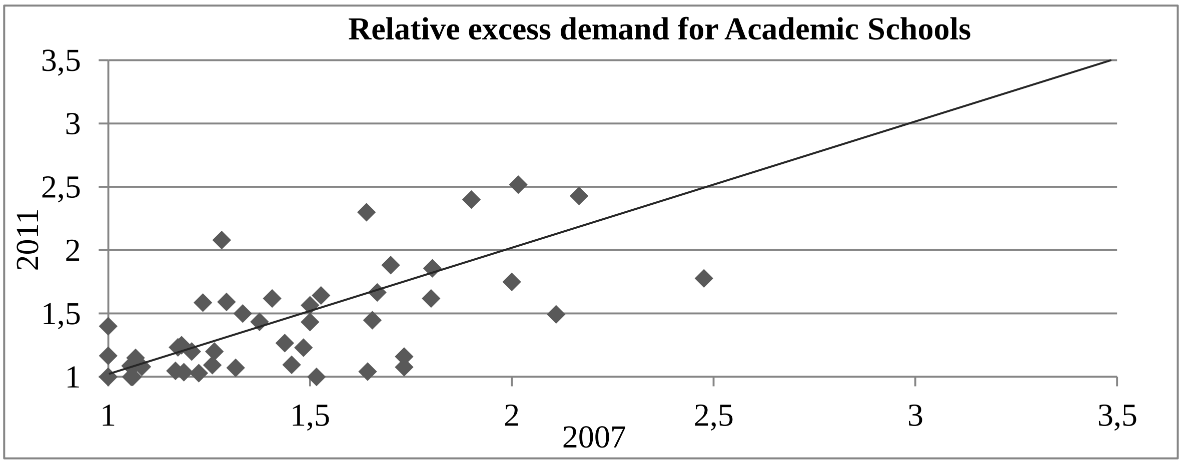
Cognitive domains	Slovakia		Czech Republic	
	2007	2011	2007	2011
Gender (% of boys)	51.2	50.1	52.7	51.6
Age	10.40	10.45	10.26	10.38
Books at home				
0-10	11.4	11.4	6.5	6.2
11-25	32.5	23.9	26.4	19.6
26-100	36.2	38.1	40.1	40.6
101-200	11.8	15.9	15.6	18.4
200+	8.1	10.6	11.5	15.2
Municipality size of school location				
more than 500 000 people	7.4	5.9	8.8	10.3
100 001 to 500 000 people	4.0	6.4	9.7	8.2
50 001 to 100 000 people	11.7	13.7	12.2	12.0
15 001 to 15 000 people	23.2	22.4	20.3	19.7
3 001 to 15 000 people	18.5	22.3	24.2	23.2
3 000 people or fewer	35.2	29.4	24.7	26.6

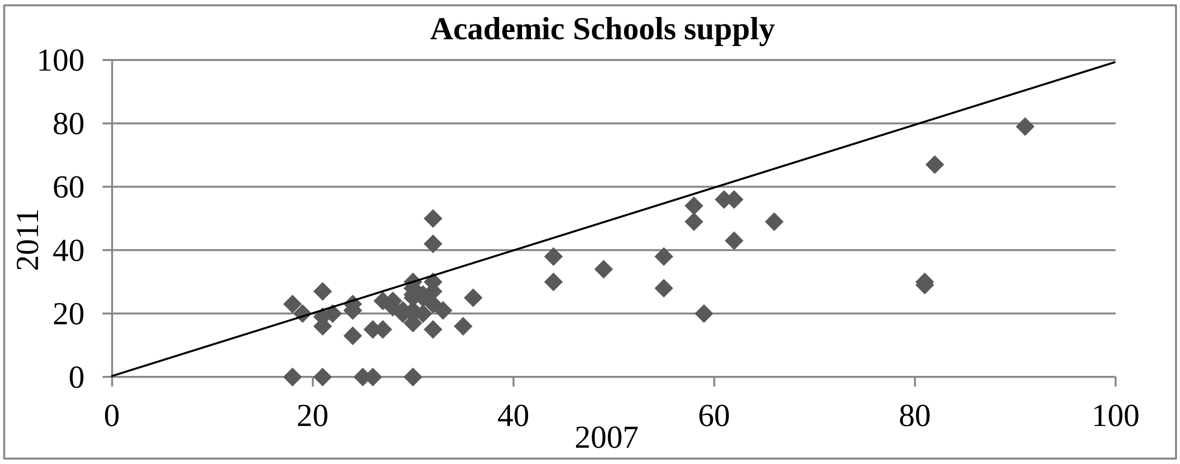
Figure 5: Academic School´s demand, supply and relative excess demand in years 2007 and 2011, by Czech districts

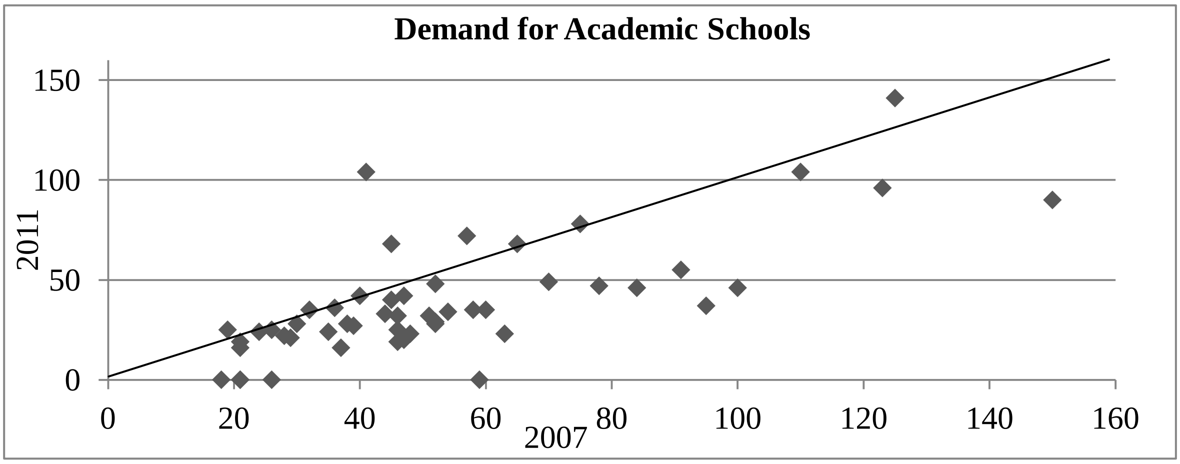


Source: MŠMT

Figure 6: Academic School´s demand, supply and relative excess demand in years 2007 and 2011, by Slovak districts







Source: ÚIPŠ

Table 5: Impact of admission exams on students achievements (treatment effect under various specifications)

Dependent variable: standardized math test scores	(1)		(2)		(3)		(4) without 4 districts[1]	
	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys
Treatment	0.156***	0.177***	0.220***	0.226***	0.136**	0.202***	0.127**	0.197***
	(0.053)	(0.051)	(0.053)	(0.045)	(0.062)	(0.075)	(0.063)	(0.077)
Treatment*Excess demand					0.158*	0.021	0.208*	0.022
					(0.084)	(0.085)	(0.116)	(0.120)
Excess demand					0.093***	0.041*	0.028	0.100
					(0.028)	(0.024)	(0.068)	(0.073)
Controls			Yes	Yes	Yes	Yes	Yes	Yes
Time dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	9,105	9,510	9,100	9,505	8,518	8,879	7,869	8,197
Adj. R^2	0.107	0.111	0.228	0.226	0.223	0.222	0.215	0.216

Note: Standard errors robust to clustering at the year and district level in parentheses.

[1] We exclude 4 outliers in excess demand: Praha, Brno, Bratislava, and Usti nad Labem.

*p<0.1 **p<0.05 ***p<0.01

Table 6: Impact of admission exams on students achievements (Quantile regression)

Dependent variable: standardized math test scores	Girls					Boys				
	q10	q25	q50	q75	q90	q10	q25	q50	q75	q90
Treatment	0.084	0.118	0.157***	0.142**	0.184**	-0.049	0.141***	0.263***	0.293***	0.245***
	(0.054)	(0.084)	(0.042)	(0.069)	(0.087)	(0.126)	(0.044)	(0.018)	(0.056)	(0.063)
Treatment*Excess demand	0.106*	0.120	0.137**	0.179***	0.241*	0.285*	0.075	-0.072*	-0.034	0.012
	(0.041)	(0.073)	(0.062)	(0.057)	(0.141)	(0.157)	(0.083)	(0.042)	(0.112)	(0.031)
Excess demand	0.078*	0.095***	0.093**	0.090***	0.092**	0.042	0.030	0.041	0.030	0.083**
	(0.047)	(0.022)	(0.037)	(0.029)	(0.031)	(0.065)	(0.022)	(0.039)	(0.034)	(0.037)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	8,518	8,518	8,518	8,518	8,518	8,879	8,879	8,879	8,879	8,879

Note: Standard errors robust to clustering at the year and country level in parentheses. Standard errors are bootstrapped using 50 replications.
*p<0.1 **p<0.05 ***p<0.01

Table 7: Probability of student's admission to Academic School (marginal effects after Probit model)

Dependent variable: Probability of being admitted	(1)
Math score from TIMSS	0.067***
	(0.005)
Boy	-0.015**
	(0.007)
Age	-0.007
	(0.009)
Books at home:	
10-25 books	0.035
	(0.036)
26-100 books	0.054*
	(0.030)
101-200 books	0.100**
	(0.051)
more than 200 books	0.157**
	(0.065)
District controls	Yes
N	3,655
Pseudo R^2	0.180

Note: *p<0.1 **p<0.05 ***p<0.01

Table 8: Impact of admission exams on student achievements, controlling for the distance from the admission threshold

Dependent variable: standardized math test scores	(1)		(2)		(3) Obs. around admission margin[1]	
	Girls	Boys	Girls	Boys	Girls	Boys
Treatment	0.212***	0.187***	-0.065	-0.025	-0.122	-0.062
	(0.082)	(0.068)	(0.114)	(0.099)	(0.077)	(0.074)
Treatment*Distance	-0.002**	-0.002**	0.001	-0.001		
	(0.001)	(0.001)	(0.002)	(0.002)		
Treatment*Distance* Excess d.			-0.005***	-0.002		
			(0.002)	(0.002)		
Treatment*Excess d.			0.517***	0.334**	0.577***	0.271*
			(0.171)	(0.149)	(0.165)	(0.146)
Distance	-0.029***	-0.031***	-0.030***	-0.032***		
	(0.003)	(0.002)	(0.003)	(0.003)		
Distance *Excess d.			0.001	0.001		
			(0.001)	(0.001)		
Excess demand			0.041	0.097	0.158*	0.148
			(0.077)	(0.068)	(0.076)	(0.081)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Time dummy	Yes	Yes	Yes	Yes	Yes	Yes
District dummies	Yes	Yes	Yes	Yes	Yes	Yes
N	7,698	7,927	7,205	7,413	1,025	963
Adj. R^2	0.710	0.728	0.711	0.729	0.345	0.362

Note: Standard errors robust to clustering at the year and district level in parentheses.
[1] Included only students 5 percentage points above and below admission margin. Standard errors clustered at the year and country level.
*p<0.1 **p<0.05 ***p<0.01

Table 9: Treatment effect by cognitive subgroups and gender

Dependent variable:	Baseline		Knowing		Applying		Reasoning	
standardized math test scores	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys
Treatment	0.136**	0.202***	0.163**	0.187**	0.076	0.087	0.240*	0.159*
	(0.062)	(0.075)	(0.080)	(0.097)	(0.087)	(0.093)	(0.112)	(0.089)
Treatment*Excess demand	0.158*	0.021	0.166*	0.117	0.125	0.053	0.108	0.061
	(0.084)	(0.085)	(0.094)	(0.101)	(0.082)	(0.089)	(0.087)	(0.089)
Excess demand	0.093***	0.041*	0.097***	0.060	0.093***	0.072*	0.086***	0.033
	(0.028)	(0.024)	(0.028)	(0.036)	(0.029)	(0.036)	(0.029)	(0.029)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	8,518	8,879	8,518	8,879	8,518	8,879	8,518	8,879
Adj. R^2	0.223	0.222	0.244	0.246	0.209	0.213	0.201	0.204

Note: Standard errors robust to clustering at the year and district level in parentheses.
*p<0.1 **p<0.05 ***p<0.01

Table 10: Treatment effect under various transformations of the test scores

Dependent variable: standardized math test scores	Baseline		Maximizing transformation		Minimizing transformation	
	Girls	Boys	Girls	Boys	Girls	Boys
Treatment	0.136**	0.202***	0.136**	0.205***	0.137**	0.203***
	(0.062)	(0.075)	(0.063)	(0.076)	(0.063)	(0.075)
Treatment*Excess demand	0.158*	0.021	0.162*	0.020	0.157*	0.021
	(0.084)	(0.085)	(0.085)	(0.086)	(0.084)	(0.086)
Excess demand	0.093***	0.041*	0.095***	0.044*	0.092***	0.040*
	(0.028)	(0.024)	(0.029)	(0.024)	(0.029)	(0.024)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Time dummy	Yes	Yes	Yes	Yes	Yes	Yes
District dummies	Yes	Yes	Yes	Yes	Yes	Yes
N	8,518	8,879	8,518	8,879	8,518	8,879
Adj. R^2	0.223	0.222	0.222	0.221	0.224	0.223

Note: Standard errors robust to clustering at the year and district level in parentheses.
*p<0.1 **p<0.05 ***p<0.01

Working Paper Series
ISSN 1211-3298
Registration No. (Ministry of Culture): E 19443

Individual researchers, as well as the on-line and printed versions of the CERGE-EI Working Papers (including their dissemination) were supported from institutional support RVO 67985998 from Economics Institute of the ASCR, v. v. i.

Specific research support and/or other grants the researchers/publications benefited from are acknowledged at the beginning of the Paper.

Published by
Charles University in Prague, Center for Economic Research and Graduate Education (CERGE)
and
Economics Institute of the ASCR, v. v. i. (EI)
CERGE-EI, Politických vězňů 7, 111 21 Prague 1, tel.: +420 224 005 153, Czech Republic.
Printed by CERGE-EI, Prague
Subscription: CERGE-EI homepage: http://www.cerge-ei.cz

Phone: + 420 224 005 153
Email: office@cerge-ei.cz
Web: http://www.cerge-ei.cz

Editor: Marek Kapička

The paper is available online at http://www.cerge-ei.cz/publications/working_papers/.

ISBN 978-80-7343-321-5 (Univerzita Karlova. Centrum pro ekonomický výzkum a doktorské studium)
ISBN 978-80-7344-314-6 (Akademie věd České republiky. Národohospodářský ústav)