Direct and Reverse Causality between Teacher Effect and Student Performance

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Abstract

Students and teachers tend to choose schools according to their community determined ranking. These preferences lead in time to the development of highly ranked schools and the disappearance of others that have a lower ranking. However, there are certain conditions that impede students and teachers from accessing highly ranked schools. Students from poor families cannot compete for entry into the highly rated schools, since they cannot afford the private tutoring that would complement the instructional quality they receive in schools, which makes these students more competitive in the education system. In addition, newly qualified teachers might not be able to gain positions in the highly ranked schools when there are no vacancies or might not want to enter such schools when there are only part time vacancies available. For new teachers, the preference for a full time job in any school is greater than the preference for a part time job in a highly ranked school. Under these circumstances, we found a positive teacher effect of comparable teachers on students' value added relative to that of their peers located at the same place in the admission test score distribution.

1. Introduction

Some empirical evidence for the Romanian secondary education system suggests there is a significant relationship between student performance, student's ratio per teacher and professional qualification. As Gandhi (1996) points out, there are obvious institutional factors affecting individual student achievement, inducing variables that are significant in boosting the secondary school student's performance. Evaluating school output also implies in the Romanian case various means such as quantifying grades, the advance in school and better scoring at various tests. However, to quote Hanushek (2004), 'this work generally ignores issues of variation in school quality'.

Therefore the illumination of the subtle causalities that govern this relationship is a task of utmost importance and in the same time a challenge. This is especially the case in countries facing radical reforms of educational systems following decades of distortions induced by exogenous factors, particularly those factors associated with ideological motivations. The analysis of the effects generated by schooling reform on secondary education with regard to students' incentive to learn and teachers' incentive to teach is our aim. Furthermore, we claim that under certain conditions, the schools' value added, quantified by the difference between students' performance at the point of entry into and their exit score from high schools, might be a sufficient statistical basis for assessing the efficacy of the teachers' contribution to human capital creation.

Schools that are informally rated highly as a consequence of their students' results are often also populated with the best educated students, these students usually having an upper middle class background. However, these schools are not necessarily those where the 'value added' is particularly high. One might be tempted to say that this is going to happen anyway when the best prepared teachers – who consistently score higher in professional assessments – are going to teach the best students. This being the case, the so called 'teacher effect' on student performance should be regarded as mostly endogenous.

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Student performance is definitely influenced by the teacher's 'quality' and vice versa, implying that the positive effects of teachers on student performance could actually also reflect reverse causality. This requires us to find ways to isolate the effect of the teachers' performance from the effect of the students' ability on the students' school achievements. Actually, as Fives (2003) demonstrates on the basis of substantial research in this area, 'little focus has been placed on teacher efficacy'. This is definitely the case in present day Romania, where beyond the often suggested and occasionally implemented school policies for improving incentives towards high performance, such as supplementary pay for teachers, other schemes for providing academic or administrative rewards have not been adopted in practice.

This contribution is organised as follows: Section 2 describes the matching process of students with high schools; section 3 describes the matching process of new teacher hires with schools; section 4 presents the research framework; and section 5 concludes.

2. Students' admission in upper secondary education (students' matching with high schools)

Upper secondary education is the last compulsory education stage, which must be successfully graduated before students can continue to the higher education level. This stage lasts four years, out of which graduation from the first level is compulsory. Registration for this stage requires for most students a school change, since the coexistence of lower and upper secondary education in the same school unit is an exception rather than a rule. Since high schools are mostly located in urban areas, for most students from rural areas the continuation of the upper secondary education means either commuting or living in a boarding house. Entry of students to schools for the upper secondary education level is competitive, based on two assessments of students' academic knowledge: the average score obtained during the whole lower secondary education stage and the average score obtained through the National Standardised Test (NST) passed after the graduation of the lower secondary education stage.

According to the norms in place since 1999, graduates of lower secondary education successfully passing the NST have freedom of choice in selecting the school for their next educational stage (the upper level of secondary education), according to their performance. If many students have chosen the same high school and the number of places is inevitably limited, the accepted students are those with the highest admission score[1]. Each candidate states his/her list of preferences after the individual scores are published. Thus the candidate knows his/her position in the score hierarchy before stating his/her list of school preferences. In theory, the number of options is unlimited. In practice, due to the limited mobility of students, their choice is limited to the range of schools in their town for those from urban areas or to the nearest towns for those from rural areas.[2] This means that the system of multi-school choice in fact increased competition among schools in the same locations, but did not affect competition between schools in different locations. In fact there is little competition between schools across counties or regions. In order to estimate the chances of admission to the preferred school, the widely used criterion at hand would be the previous year's minimum admission score.

Before 1999, lower secondary education graduates had a one-school option when choosing the school for the upper secondary stage. The distribution among the options was made according to the admission score. If students failed to enter the school of their choice, a secondary distribution was made across schools with available places. The rationale of the switch from a one option to multi option system for selecting the desired school to attend was to allow schools that did well in terms of performance to attract more students and those that did poorly to lose students and thus improve the incentives for teachers to improve student achievement in order to secure their jobs.

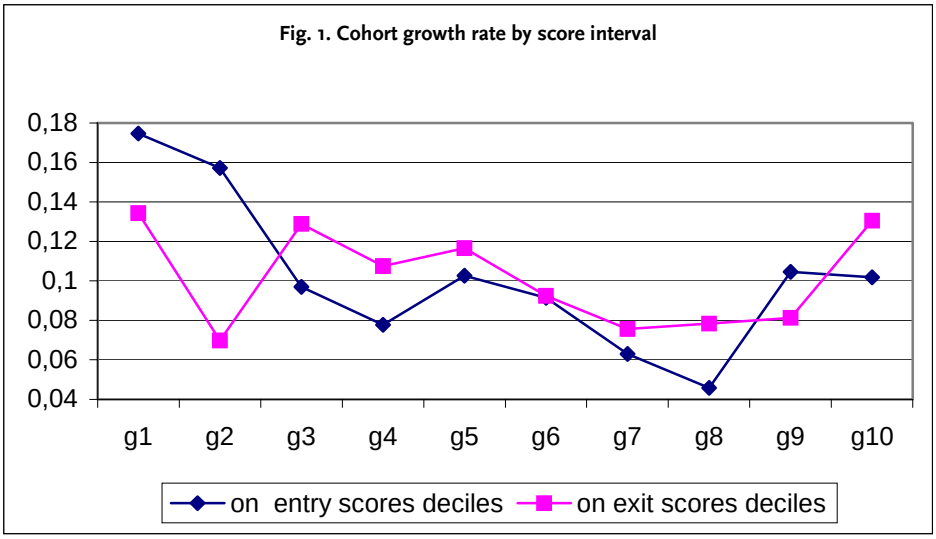
An analysis of the effects of the policy change after seven years shows that the expectations were partly achieved. The fastest expanding high schools, in terms of the number of new entrants in 2005 compared to the number of new entrants in 2001 (the average logarithmic change), were those from both tails of the 2001 admission score distribution, the fastest expansion being evident in the schools from the lower tail (Fig. 1). This reflects the deepening of the income divide among families, since entrance to the best schools is dependent on costly private tutoring, an option that is becoming too expensive for an increasing number of families. In 1999, parents and students were empowered with the freedom of

[1] The admission score is computed as a simple average of the average NST score – obtained by averaging the test scores obtained at disciplines (only written tests) – and the average score of the completed four year period of lower level secondary education.

[2] In 2001 only 5.6% of total students registered for NST moved from one county to another.

school choice, but were not given the information to help them choose. The information at hand was the entry scores in the previous year and not the exit score, which would have better guided the expectation of learning associated with the schools. This assumption is supported by the more equal distribution of expansion rate of schools when distributed according to the exit score rather than the entry score.

Fig. 1. Cohort growth rate by score interval



3. Teachers' admission in upper secondary education (teachers' matching with high schools)

The Romanian upper secondary education sub-system is served by approximately 62,000 teachers (out of 300,000 for the whole system). The student-teacher ratio has increased from 11 in 2001 to 12.4 in 2004.[3] The increase was due to shrinkage in the teaching staff by 4% coupled with increase of student enrolment by 8%.[4] In 2004 the Ministry of Education posted 16,061 vacancies for the whole education system, out of which 4,765 were for the upper secondary level, representing 7.7% of the teaching staff in the upper secondary education and covering a range of 40 disciplines[5]. The vacant posted jobs were of three kinds: permanent (34% of the total posted), meaning that they involve at least a 4 year full teaching load[6]; temporary[7] (56% of the total posted), usually lasting one year; and jobs for teachers already in the system wanting to move from one position to another (10% of the total posted). After the jobs are posted and the qualifying exam is taken, the candidates state their job options and the assignment of jobs takes place. Filling the vacant jobs occurs primarily according to the score obtained within the annual National Program for Teacher's Nomination (NTN) competition. In the case of equal scores between two candidates in the NTN competition, social criteria (permanent residence, family issues) apply.

The job matching process involves three stages. Firstly, the permanent jobs are filled through a two round distribution: one round at county level, where vacancies in each county are matched with residents from that county and the next round at country level, where the unfilled permanent jobs during the first round are matched with the remaining applicants regardless of their residence. Secondly, teachers occupying a permanent job for at least two years who want to move are matched. Thirdly, the permanent jobs which could not be matched become temporary and together with the other temporary

3 Compared to the OECD countries, where the average student-teacher ratio is 14.8 and ranges between 25.5 in South Korea and 9.2% in Austria or 9.5% in Hungary, Romania's student teacher ratio corresponds to international standards (OECD, 2000).

4 The evolution in the teacher employment market in the upper secondary education during the last years (2001-2004) seems to be affected by supply driven shocks: the number of teachers has declined and the average monthly salary has increased faster than the average salary in the economy, rising from 95% of the average wage in 2001 to 108% of the average wage in 2004.

5 The most requested disciplines are Romanian literature (803 vacancies), English (502 vacancies), mathematics (340 vacancies), French (312 vacancies), history (270 vacancies) and informatics (258 vacancies). The highest average scores at the NTN exams were obtained by the candidates for literature, philosophy and history (7.6 out of 10) and the lowest scores were obtained by candidates for religion, economics, physics and chemistry (6.7-6.8 out of 10).

6 The full teaching load consists of a full norm, representing on average 18 hours per week.

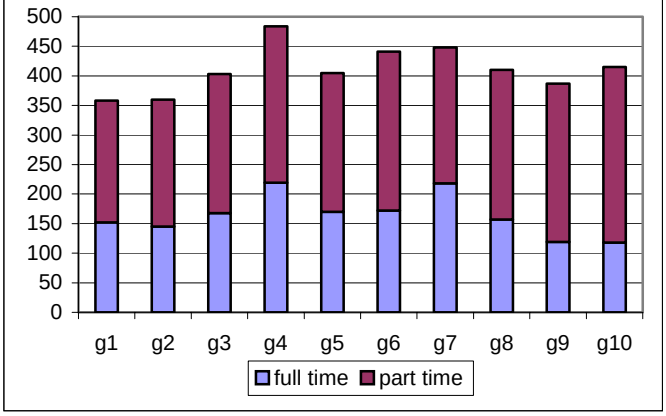
7 A temporary position is viable for less than 4 years and is usually filled for one year. A recent (2005) Ministry of Education and Research order indicates that temporary jobs available until 2007 already temporarily occupied in 2004 and 2005 should be filled until then.

jobs are matched during this final stage. The matching with permanent jobs requires at least a score of 7 (out of 10) in the NTN exam, while the matching with other types of jobs requires at least a score of 5 in the NTN exam.

After being matched with a permanent job, both well and less well qualified teachers could expect to follow roughly the same career track, including similar compensation and pension schemes. However, teachers from schools ranked high in the community preference might have an advantage compared to teachers from schools ranked low. Teachers performing in the highly ranked schools, with students coming from wealthier families, could participate in a lucrative private tutoring sector, which is often applicable to their own students. Moreover, the 'quality' of school to which a teacher belongs influences the price for that particular market niche of private tutoring that is acknowledged in various manners, most of them informal. This kind of logic could be expanded also, as Hanushek et al. (2005) point out, within the sub-frames (teaching areas) of each particular school. If the teacher belongs to a school highly ranked by the community, the price that particular teacher could charge for private classes obviously rises. The empirical, not to say anecdotal, evidence says that this is the case for a very lucrative parallel market.

Theoretically, the above incentives, if accurate, generate two main consequences: firstly, competition is stronger for the vacant positions within highly ranked schools that are filled by applicants with the highest scores from the NTN exam. Secondly, the highly ranked schools do not score necessarily higher than the average gains in student performance, unless their teachers are privately tutoring their own students, for their own benefit first, but also with social (both positive and negative) consequences for the PR of that particular school.

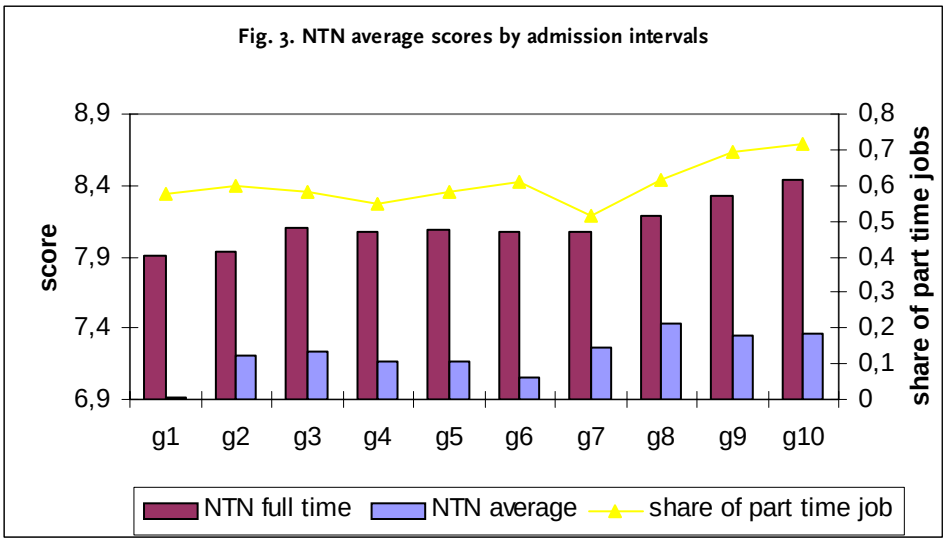
Fig. 2. Distribution of new hired teachers by admission score groups



The distribution of teachers' jobs in 2004 in schools deciles according to students' admission score intervals (Fig. 2) in 2001 shows that the number of vacancies are higher in the middle deciles and lower in the upper and the lower deciles. Moreover, the number of part time jobs relative to the full time jobs is highest in the two upper deciles of schools registering the highest entry score in 2001. Despite the skewed distribution of part time jobs (which are matched with the lowest NTN scores candidates) on school deciles, the difference for both the average NTN scores and the average NTN score of the candidates matched only with full time jobs between upper and lower deciles is around a half point (Fig. 3).

In summary, the actual teachers' admission to upper secondary education reveals the preferences of candidates for schools highly rated by the community (the schools with the highest students' entry scores in the upper secondary education). The system tends to match the teachers and students with the highest scores. It seems that through the mix of available jobs (part time – full time) in schools, the Ministry of Education moderates the polarisation of schools quality, relying on the fact that among the newly hired teachers the preference for a full time job dominates the preference for a part time job in highly rated schools.

Fig. 3. NTN average scores by admission intervals



4. Research Frame

Our objective is to assess the authenticity of the empirically observed strong relationship between students' performance and teachers' 'professional quality' (Kallai and Maniu, 2004). Obviously, the extent to which teachers contribute to students' achievement and whether the money spent to finance the educational process is efficient in terms of students' achievement is a matter of policy interest. It is also in line with the concerns for institutional development that are necessarily oriented toward quality.

We propose to assess the teacher quality in the upper secondary education through the value added gain achieved by graduate students from the upper secondary education system. The value added is measured as the difference between the graduation score from upper secondary education and the admission score in upper secondary education. Both scores reflect the results obtained at the national standardised exam. The admission score in upper secondary education is in fact the assessment of students' achievement during their period in lower secondary education. The graduation score is the assessment of students' achievement during upper secondary education and represents one of the main admission criteria in universities. For the accuracy of teacher's quality assessment through the value added, one should take into account that teachers' quality might be correlated with students' ability. Part of the graduation score is influenced by the students' ability as reflected in their admission scores. As a consequence, the effects of the admission score might be correlated with teacher effect, if teachers chose the schools according to the admission grade. Consequently, there is a need to address a variety of selection issues related to the matching of teachers and schools on the one hand, and the matching of students with schools on the other.

4.1 Data

To estimate variations in teacher quality based on value added to student achievement, we use matched data on newly hired teachers and students' admission and graduation scores by schools. The data base is built on three administrative data sets, partially procured from online and partially on the basis of an agreement with the Ministry of Education and Research. The first data set covers individual data on the NST score in the upper level of secondary education for 2001. The admission score consists of the NST score and the average score obtained during the lower level of secondary school. The score at the NST is the average of the scores obtained in three written exams: Literature, Mathematics and an optional discipline. The second data set refers to the graduation score obtained by students participating in the high school graduation exam in 2005, these being the cohort admitted in 2001. The third data set refers to the scores obtained in the NTN exam in 2004 by the newly hired teachers. The individual data from each set were aggregated by schools and then merged using the school name. The description of the data sets is provided in Annex 2.

The sample of schools in our database was obtained by making a selection of 1,050 schools from the total number of schools in the upper secondary education (77% of the total number of schools), characterised by having data for admission in 2001, for graduation in 2005, and jobs posted in 2004. The

structure by types of schools in our sample compared to that of the whole school set shows that the theoretical and agricultural schools are over represented compared to the economics and theological schools.

4.2 Methodology

The question we are seeking to answer is how much of the quality of the schooling in the upper secondary education (high school) system is due to the students' ability and the teachers' effort. The basic model relates the achievement gain of a school (G_i-A_i)[8] to teachers' NTN score (Tit_i), school size ($Size_i$) and school type dummies (D_{ij}, D_{ij}=1, when $Type_i$=j, and 0 otherwise), reflecting the various types of schools (theoretical, industrial, agricultural, pedagogical, economics, sport, theological and forestry):

$$G_i - A_i = c_1 Tit_i + c_2 Size_i + \sum t_{ij} D_{ij} Type_i + \varepsilon_i \quad (1)$$

This formulation controls past family and school factors and permits concentration on the contemporaneous circumstances that are generally measured along with student achievement. However, focusing on achievement gains does not eliminate the difficulties in separating the various inputs from unmeasured confounding factors. A series of specification and measurement issues must be addressed before it is possible to obtain credible estimates of the influence of teachers on student achievement.

4.2.1 General specification issues

The fact that for some schools the competition at the entry point is higher than for others, reflected in the distribution of schools by admission score intervals, shows that the community ranks high schools on the basis of the expected rate of learning conditional on admission scores. Moreover, the ranking process has been continuously adjusted between 2001 and 2005 (the rank correlation for schools according to the admission scores in 2001 and the admission scores in 2005 was 0.56 below 0.9 the rank correlation between 2001 and 2002). In particular, students with family background and other factors conducive to higher achievement tend to seek out better schools with presumably higher quality teachers. Thus a rank of schools from the community perspective emerged.[9] Despite the fact that there is some evidence showing that preferences of the newly hired teachers for a school depend upon the community ranking when choosing among full time positions (presented in Section 3), there is no correlation between the rank of schools sorted upon the NTN scores and the rank of schools sorted either upon the graduation score of students or admission score of students for the whole sample. This does not mean that teacher quality does not influence students' achievement gain across schools. This means rather that the available mix of jobs (full time-part time) for newly hired teachers dampen teachers' preferences for higher achieving schools with, wealthier students. The average NTN score by schools reflects this moderation. The consequence is that using NTN scores in relation to the students' achievement makes it reasonable to assume on the one hand that the teachers' effect is orthogonal on the error in (1), but on the other hand the variation of teachers NTN scores by schools is limited and does not reflect the real variation of teachers' quality among schools. Therefore our empirical model employs a test metric (described below) that evaluates comparable teachers on the basis of their performance with comparable students.

4.2.2 Test measurement issues

The accumulation of knowledge is a process and the assessments of the accumulated knowledge at various points in the process are obviously correlated. Consequently, the variation in test score gains generated by differences in teachers' quality differs across the initial achievement distribution. For example, the additional gain in test score resulting from a substantial improvement in the quality of instruction may be quite sizeable for a student who begins at the lower end of the skill distribution and might not be so impressive for a student at the higher end of the skill distribution.

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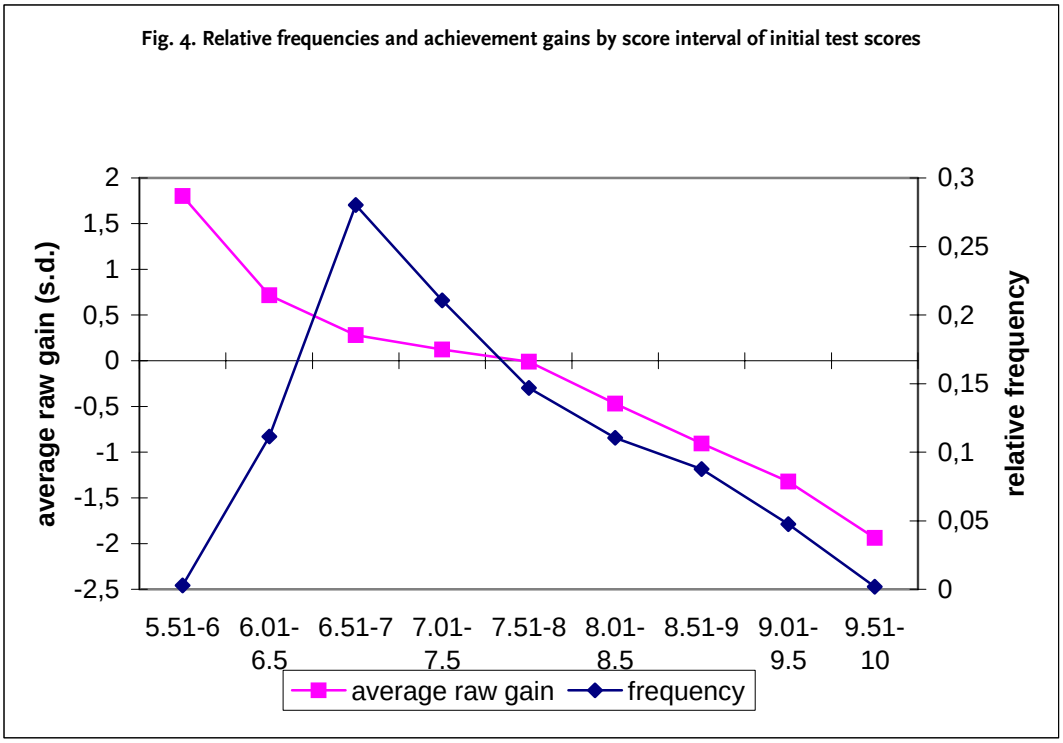
8 The achievement gain of a school represents the achievement of the cohort, which entered into that school in 2004. It is computed as the average graduation rate of students from that school in 2005 minus the average admission score of the students entering in that school in 2001. The two populations of students might not be identical, due to an attrition/mobility rate of around 5% of the cohort size at the point of entrance. However, since the size of the two populations is almost the same, it can be inferred that there was a replacement process. This process did not alter the quality of students in terms of score. Students are allowed to move from one school to another only if their admission score would have allowed the admission in the new school. Another way to compute the average achievement gain of a school is as the average of individual achievement gains. But this approach would have required the identification of each student in 2001 and 2005, which was impossible. Only students remaining in the same school could have been identified and not the mobile students; therefore we opted for the first approach.

9 The criterion at hand to judge the value of a school was the past entry admission rate. As long as the experience showed that the admission rate as a ranking criterion was not necessarily correlated with the instructional quality, the ranking criterion and the overall ranking only slowly changed. How and why this ranking changed in time is a research issue for itself, which is not pursued in this paper.

Figure 4 below hints at the extent of this problem. The relative frequency of schools and the average raw gain of schools were plotted against schools' average admission test score distribution. The schools' average admission test scores were divided into ten equal score intervals. Two thirds of schools have admission scores to the upper secondary education level below 8, and 60% of schools register positive average gains during upper secondary education. The typical gains at the low tail of the distribution are higher than at the upper tail. Part of this could reflect regression to the mean induced by measurement error, but the problem is not simply one of the bounds on the tests, since schools on the upper tail registering negative average gains could make gains (0.7-0.6 points) comparable to those at the lower tail without exceeding the maximum score. It seems that it is actually the case that the highly ranked schools according to the admission scores are performing poorly in terms of the value added obtained relative to the average value added of the whole school population.

Fig. 4. Relative frequencies and achievement gains by score interval of initial test scores



To mitigate the problem of correlation between the initial knowledge and the expected gain, we differentiate our analysis upon admission scores intervals. Moreover, we analyse in depth the nature of the relationship, search for the possibility of a nonlinear relationship and seek to quantify whether a structural break exists. Separating the analysis on the basis of admission score intervals and allowing for a nonlinear relationship between the initial score and the value added, on the one hand, and introducing a test metric, on the other hand, are our instruments for mitigating the problem that identical differences in teacher quality do not produce identical variation in average student improvement in each admission score interval.

4.2.3 Test metric

In order to improve the accuracy of the measurements of schools' value added and newly hired teachers' average scores in schools, we apply the normalisation approach proposed by Hanushek (2005). We apply normalisation separately for the admission score, the graduation score and the NTN scores. This involves the following steps. First, individual measures (admission scores, graduation score and NTN

scores) are pooled together and divided into 5 score intervals[10], and for each score interval k the mean ($\overline{m^k}$) and the standard deviation ($\overline{\sigma^k}$) are computed. Second, the individual measures (admission scores, graduation score and NTN scores) corresponding to each school, are divided into the same 5 score intervals, and each individual measure m_i is transformed into a normalised measure n_i as follows:

$n_i = \frac{m_i - \overline{m^k}}{\overline{\sigma^k}}$, where $\overline{m^k}$ and $\overline{\sigma^k}$ are the mean and standard deviation of interval k to which the individual measure m_i belongs.

Consequently each normalised measure is distributed with zero mean and standard deviation, one for each score interval in the whole population (the basic statistics are presented in Annex 2). Schools where the average of normalised admission scores has a mean above 0 attract students with admission scores higher relative to other students in the same place in the admission test score distribution. The average normalised admission and graduation scores of a school account only for differences in the own students' scores relative to other students' score in the same place of the test score distribution. The normalised scores ignore the structural differences of the distribution of the own students across score intervals relative to the distribution of the whole population across score intervals.

The normalised average NTN score of teachers hired in a school uniquely reflects the scores those teachers obtained compared to other teachers in the same place in the NTN score distribution, thus eliminating the structural effects of the job mix offered in a particular school which made inappropriate the use of the average NTN to measure teachers' quality variation.

4.2.4 Non-linear relationship between admission and exit scores

This section seeks to uncover nonlinear features in the function that relates schools' value added to schools' admission scores. We perform the test for absolute and normalised values. In order to find the shape of the function, we divide the 1,050 schools in our sample sorted in ascending order according to the admission test score (separately for absolute and normalised value) into 10 equal groups of 105 schools (the basic statistics test score groups are presented in Annex 3). Then an OLS regression is estimated for the value added in both absolute (2) and normalised forms (3) on the admission score dummies (g1 to g10) for the ten groups, the size of the school (measures as the number of students enrolled in 2001, $admnr_i$), teachers' NTN scores (absolute and normalised, tit_i and $titn_i$ respectively), school types dummies (teo, ind, for, agr, ped, eco and spo).

$$G_i - A_i = c_o + c_1 g1 + c2g2 + c3g3 + c4g4 + c6g6 + c7g7 + c8g8 + c9g9 + c10g10 + c11 admnr_i + \\ + c12 tit_i + c13 teo + c14 ind + c15 * agr + c16 * for + c17 * eco + c18 * ped + c19 * spo + \varepsilon_i \quad (2)$$

$$Gn_i - An_i = c_o + c_1 g1 + c2g2 + c3g3 + c4g4 + c6g6 + c7g7 + c8g8 + c9g9 + c10g10 + c11 admnr_i + \\ + c12 titn_i + c13 teo + c14 ind + c15 * agr + c16 * for + c17 * eco + c18 * ped + c19 * spo + \varepsilon_i \quad (3)$$

The results are presented in Table 1. The estimated coefficient of the different admission test score groups represents the effects on value added of each group relative to group 6, which is used as a reference. The reference school type is art school. Consequently, the estimated coefficient of the different types of schools represents the effects on value added of each type of school relative to art schools in the sample. Several important results emerge: the effects of admission scores on value added may contain a structural break according to both regressions. According to these outcomes, teachers positively and significantly contribute to the normalised value added of schools, larger schools seem to significantly

[10] The score intervals are 5-6, 6-7, 7-8, 8-9 and 9-10. The mean and the standard deviations are as follows:

	NTN		admission score		graduation score	
Score intervals	Mean ($\overline{m^k}$)	Standard deviation ($\overline{\sigma^k}$)	Mean ($\overline{m^k}$)	Standard deviation ($\overline{\sigma^k}$)	Mean ($\overline{m^k}$)	Standard deviation ($\overline{\sigma^k}$)
5-6	5.46	0.33	5.78	0.15	5.78	0.16
6-7	6.58	0.32	6.52	0.28	6.61	0.26
7-8	7.47	0.30	7.47	0.29	7.54	0.28
8-9	8.49	0.29	8.45	0.28	8.51	0.28
9-10	9.39	0.26	9.32	0.23	9.39	0.24

have larger normalised value added, and pedagogical school seem to have significantly larger value added (relative to art schools) according to both regressions.

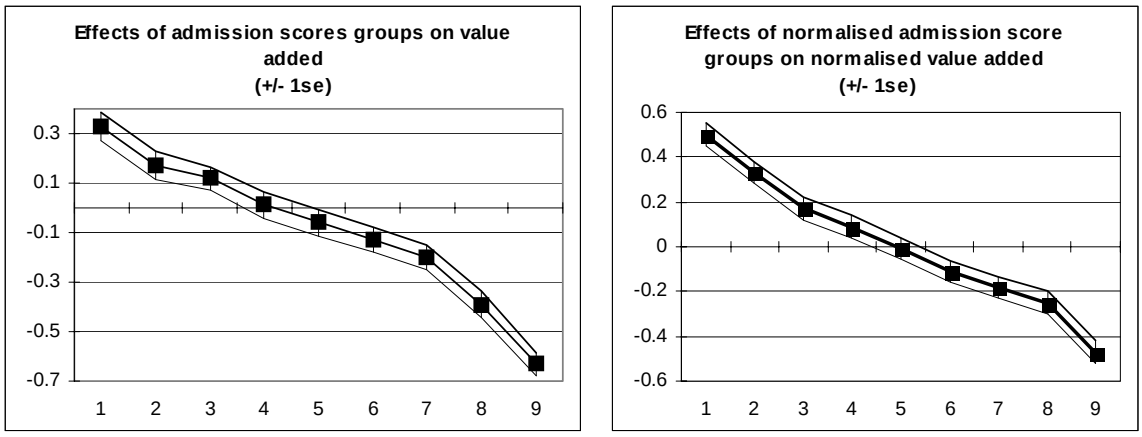
Table 1. Estimated coefficients of admission test score groups

	Absolute values (regression 2)		Normalised values (regression 3)	
	coefficient	t-stat	coefficient	t-stat
c	0.6	4.57	-0.1	-1.52
g1	0.33	5.7**	0.45	14.79**
g2	0.17	3.15**	0.25	9.2**
g3	0.12	2.55**	0.13	5.1**
g4	0.01	0.2	0.07	3.21**
g6	-0.05	-1.08	-0.01	-0.53
g7	-0.13	-2.61**	-0.09	-3.67**
g8	-0.2	-4.13	-0.14	-5.68**
g9	-0.39	-7.67*	-0.19	-6.58**
g10	-0.63	-13.42**	-0.36	-9.24**
admnr	-0.00005	-0.36	0.0002	3.2**
tit	-0.004	-0.32	0.02	2.21**
teo	0.16	1.82*	0.06	0.96
ind	0.04	0.52	-0.098	-1.47
agr	0.02	0.24	-0.11	-1.67*
for	0.1	0.91	-0.018	-0.25
eco	0.4	3.93**	0.05	0.71
ped	0.2	1.86*	0.13	1.74*
spo	-0.05	-0.47	0.03	0.42
R^2	0.30363		0.463	

Notes: OLS heteroscedastic consistent estimates; the significant coefficients at 5% significance level are indicated by an **, and the significant coefficients at 10% significance level are indicated by * in the column of t-statistics. The school type dummies stand for: teo, theoretical schools, ind, industrial schools, agr, agricultural schools, eco, economics schools, for, forestry schools, ped, pedagogical schools, spo, sport schools. Number of observation: 1,050.

Low admission scores have positive effects and high admission score have negative effects on value added both on absolute and normalised values (Fig. 5), but the effects are not symmetrical.

Fig. 5. Effects of different admission score groups on value added



The following questions arose: at what level of admission score does the structural break occur, is that structural break significant[11], and what is the estimated value of the admission score on value added on either side of the structural break. In order to answer these questions we use the estimation technique used by Sarel (1996)[12], defining first A^* the admission score at which the structural break occurs and a dummy DD=1 if $A>A^*$, 0 otherwise, and a variable extra=DD$(A-A^*)$ and then estimating an OLS regression for value added (absolute and normalised values) on A and extra and the other covariates from (2) and (3) that is

[11] In other words, is the effect of admission score on value added significantly different above the structural break from what it is below the structural break?

[12] Sarel (1996) used the above method in estimating the structural break in the effects of inflation on economic growth.

$$G_i - A_i = c_o + c1A_i + c2extra_i + c3admnr_i + c4tit_i + c5teo + c6ind + c7 * agr + c8 * for + c9 * eco + c10 * ped + c11 * spo + \varepsilon_i \quad (4)$$

$$Gn_i - An_i = c_o + c1An_i + c2extran_i + c3admnr_i + c4titn_i + c5teo + c6ind + c7 * agr + c8 * for + c9 * eco + c10 * ped + c11 * spo + \varepsilon_i \quad (5)$$

When the admission score is below A*, the effect of admission score on value added is the coefficient of A. But, when the admission rate if higher than A*, the effect of admission rate on value added is the sum of two coefficients: the coefficient of A and the coefficient of extra. The coefficient of extra estimates the difference in the admission score effect value added between the two sides of the structural break, and its t-statistics value tests whether or not the structural break is significant. The level of structural break A* is found through an iterative process, estimating regressions (4) and (5) for different values for A* and picking that value for A*, which maximises R^2 (or minimises the sum of squared residuals from the regression), using the assumption that the error variance is equal for the entire admission score range. Following this procedure, the structural break for absolute values is 6.43 and for normalised values if 0.19. Below the structural break for absolute values enter 10% of schools, while below the structural break for normalised values enter 74% of schools. With these values adopted for structural break, the results for regressions (4) and (5) are presented in Table 2. The results of the regression confirm that there is a structural break only in the case of normalised values. In this case the t-statistics for extra makes possible to reject the hypothesis of equal effects of normalised admission scores on normalised value added. When the normalised admission score is less than 0.19, its effect on the normalised valued added is negative and statistically significant, while in cases where it is higher than 0.19, its effects become positive, maintaining the overall effect negative, but on a lower level. Importantly, the regression results on normalised values confirm the previous findings from regression 3: the teachers' effect, measured by the normalised NTN score, is positive and significant; the larger schools have significantly larger normalised value added, while pedagogical schools have significantly larger normalised value added than the art schools.

Table 2. Regressions for the main test

	Absolute values (regression 4)		Normalised values (regression 5)	
	coefficient	t-stat	coefficient	t-stat
Estimated point of structural break	6.43		0.19	
c	7.06	5.59**	-0.2	-3.88**
A	-0.96	-4.86**	-1.06	-13.17**
extra	0.65	3.25*	0.4	3.95**
admnr	-0.0003	-0.21	0.0002	3.34*
tit	-0.002	-0.16	0.0199	2.06**
teo	0.13	1.79*	0.08	1.69*
ind	-0.002	-0.024	-0.079	-1.63
agr	-0.02	-0.26	-0.093	-1.73*
for	0.05	0.47	-0.005	-0.099
eco	0.38	4.38**	0.08	1.53
ped	0.2	1.97**	0.14	2.49**
spo	-0.08	-0.74	0.027	0.398
R^2	0.3141		0.51	
Estimated coefficient for high admission score	-0.31	0.6	-0.66	9.73

Notes: OLS heteroscedastic consistent estimates; the significant coefficients at 5% significance level are indicated by an **, and the significant coefficients at 10% significance level are indicated by * in the column of t-statistics.
The school type dummies stand for: teo theoretical schools, ind industrial schools, agr, agricultural schools, eco, economics schools, for, forestry schools, ped, pedagogical schools, spo, sport schools. Number of observations 1050.

5. Conclusion

Students and teachers tend to choose schools according to the community determined ranking, which is mainly guided by high learning expectations from schools with high entry scores. The expectations appear not to be backed by realities, since the value added achieved by schools in the upper tail of the admission score distribution is below the average value added achieved by the entire school population.

The expansion rate of schools between 2005 and 2001 along the admission score distribution shows a faster expansion of schools with the highest and lowest admission rate, the later rate being the leader. This evinces the increasing divide between wealthy and poor families. On the one side, there are the wealthy families who can afford private tutoring for their child in order to ensure their access into the highly ranked schools. On the other side, there are the offspring of poor families who enter the admission exam with just the knowledge they have received in schools, and as a consequence can only obtain places in the lower ranked schools. Who is better off? In terms of value added gains the students from the lower ranked schools seems to be the winners. In terms of normalised value added, the students from the highly ranked schools are the winners.

The comparable teachers' effect on the value added gains in schools relative to other schools with comparable students are positive and significant.

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Annex 1. Main indicators in the upper secondary education

Table 1. Main indicators of upper secondary education

	2000/2001	2001/2002	2002/2003	2003/2004	2004/2005
Schools	**1367**	**1379**	**1388**	**1397**	**1413**
High schools and colleges	530	529	529	548	555
Industrial schools	434	437	450	451	456
Agricultural schools	100	92	74	61	49
Forestry	14	21	20	19	17
Agro-mountain	4	5	6	5	4
Veterinary	6	11	17	18	17
Economics	78	85	94	102	117
Pedagogical	39	39	37	33	31
Art	44	44	44	43	45
Sport	31	30	31	30	32
Military	5	5	5	5	4
Theological	73	73	72	72	74
Special	9	8	9	10	12
Enrolled students	**687919**	**7100663**	**740404**	**758917**	**773848**
High schools and colleges	334642	345549	359795	364854	369497
Industrial schools	195566	202802	209818	221431	229240
Agricultural schools	24108	21898	17312	12474	11698
Forestry	7738	8885	10035	9665	8874
Agro-mountain	1706	1970	3162	3447	3802
Veterinary	6244	6479	7091	7130	5988
Economics	66524	70960	78387	85378	88436
Pedagogical	14098	12610	11931	9624	10550
Art	10252	11205	12682	13521	14296
Sport	11924	12617	14004	15068	15313
Military	2109	1903	1874	1788	1762
Theological	12323	12707	13460	13755	13616
Special	685	1078	853	782	771
Teaching staff	**64068**	**64729**	**60988**	**58925**	**62192**
High schools and colleges	21877	21316	20825	20801	21924
Industrial schools	26540	27426	25385	24312	25713
Agricultural schools	4362	4060	3078	2450	2034
Forestry	546	883	787	692	761
Agro-mountain	113	141	208	84	76
Veterinary	116	308	432	552	557
Economics	3618	3695	3582	3860	4596
Pedagogical	1833	1869	1788	1467	1445
Art	2571	2533	2537	2217	2484
Sport	1316	1269	1162	1163	1241
Military	145	138	143	138	133
Theological	848	844	837	912	948
Special	183	247	224	277	280
Graduates	**161106**	**147650**	**173584**	**153300**	**172371**
High schools and colleges	79371	74938	87250	76497	84740
Industrial schools	45620	39793	46044	66560	48956
Agricultural schools	7200	5491	3684	11287	2520
Forestry	1300	1178	2385	2523	2197
Agro-mountain	456	320	520	116	910
Veterinary	1579	1482	1690	1730	1792
Economics	14070	13733	18228	10547	20119
Pedagogical	3689	3353	4849	3223	1539
Art	2010	1961	2615	3252	2912
Sport	2508	2328	3039	3262	3374
Military	632	532	442	290	409
Theological	2510	2316	2645	4644	2673
Special	161	225	193	161	230

Source: INSSE, 2003

Annex 2. The data base; variables' definition and basic statistics

	Notation	Definition of indicators	Average	Standard deviation	Min	Max
Admission score (NTS) (between 5 and 10)	A_i	The average admission score of students admitted in school i in 2001; the individual admission score is a weighted average [(3*adm+cap)/4] of the NTS score-cap (the simple average of the scores obtained at Literature, Mathematics and an optional discipline) and performance in the lower secondary education-adm (the simple average of the annual scores obtained during the 4 years of lower secondary education)	7.41	0.82	5.75	9.66
Normalised admission score	An_i	The average normalised admission scores of all students admitted in school i in 2001. The individual normalised admission score is $\frac{A_{ij}-\overline{m^k}}{\overline{\sigma^k}}$, where $\overline{m^k}$ and $\overline{\sigma^k}$ are the population mean and standard deviation corresponding to score interval k to which the individual admission score A_{ij} belongs	0	0.3	-0.91	2.03
Number of enrolled students	$Admnr_i$	Number of students admitted in 2001 in school i	153	85	4	525
Growth rate of enrolled students	g	Logarithmic growth of students enrolled between 2001 and 2005	0.1	0.18	-0.75	1.73
Graduation score (between 5 and 10)	G_i	The average graduation score obtained by all successful graduates from school i in 2005	8.01	0.70	6.47	9.58
Normalised graduation score	Gn_i	The average normalised graduation score of all students in school i in 2005. The individual normalised graduation score is $\frac{G_{ij}-\overline{m^k}}{\overline{\sigma^k}}$ where $\overline{m^k}$ and $\overline{\sigma^k}$ are the population mean and standard deviation corresponding to score interval k to which the individual graduation score G_{ij} belongs				
Number of graduates		The number of successful graduates in 2005	155	92	15	869
NTN score	tit_i	The average score at NTN exam of the new hired teachers in school i in 2004	7.22	0.86	5	9.95
Normalised NTN score	$titn_i$	The average normalised NTN score of all teachers hired in school i in 2004. The individual normalised NTN score is $\frac{tit_{ij}-\overline{m^k}}{\overline{\sigma^k}}$ where $\overline{m^k}$ and $\overline{\sigma^k}$ are the population mean and standard deviation corresponding to score interval k to which the individual NTN score tit_{ij} belongs	0.02	0.71	-1.52	8.77
New teacher hires per school		The average number of teachers per school hired in 2004	3.97	3.08	1	31
New part time teacher hires		The average number of part time new teacher per school hired in 2004	2.92	2.29	1	16
Value added	A_i-G_i	The average achievement gain in school i of the cohort admitted in 2001	0.61	0.43	-0.52	2.57
Normalised value added	An_i-Gn_i	The average normalised achievement gain in school I of the cohort admitted in 2001	-0.06	0.29	-1.85	1.27

Notes: Number of high schools in data set is 1050, covering 1608600 students; schools included in the data set were those with admission scores in 2001, graduation scores in 2005 and newly hired teachers in 2004.

Annex 3. Basic statistics by score intervals

Table Basic statistics

		G1	G2	G3	G4	G9	G6	G7	G8	G9	G10
An_i	average	-0.5	-0.32	-0.19	-0.1	-0.03	0.03	0.1	0.18	0.29	0.56
	Stdev	0.09	0.03	0.02	0.02	0.02	0.02	0.01	0.02	0.03	0.21
	Min	-0.91	-0.38	-0.25	-0.15	-0.06	0	0.079	0.14	0.23	0.36
	max	-0.39	-0.25	-0.15	-0.07	0.002	0.078	0.14	0.23	0.36	2.03
Gn_i-An_i	average	0.33	0.14	0.04	-0.01	-0.07	-0.08	-0.13	-0.18	-0.23	-0.37
	Stdev	0.26	0,21	0.2	0.17	0.19	0.18	0.19	0.19	0.25	0.36
	Min	-0.49	-0,61	-0.46	-0.44	-0.95	-0.48	-0.61	-0.59	-0.96	-1.85
	max	1.27	0.99	0.7	0.51	0.94	0.53	0.45	0.51	0.54	0.54
$titn_i$	average	0.016	-0.05	-0.02	-0.05	-0.006	0.03	0.06	0.08	-0,02	0.21
	Stdev	0.67	0.6	0.68	0.56	0.63	0.66	0.64	0.7	0.67	1.11
	Min	-1.34	-1.52	-1.52	-1.42	-1.27	-1.37	-1.37	-1.52	-1.46	-1.37
	max	1.65	1.78	1.33	1.51	1.73	1.99	1.56	2.26	1.56	8.74
$admnr_i$	average	130	136	162	161	167	159	154	163	146	151
	Stdev	95	92	94	94	84	91	89	80	63	69
	Min	7	12	26	26	11	21	4	25	25	7
	max	430	400	475	437	375	383	525	375	325	400
teo	sum	26	30	36	39	50	57	61	73	70	83
eco	sum	2	4	12	4	5	4	6	2	5	6
ind	sum	49	48	38	43	35	32	24	22	18	8
agr	sum	19	19	16	9	9	7	4	1	2	0
for	sum	1	0	1	5	4	3	2	3	1	0
ped	sum	1	1	1	2	1	0	6	3	4	3
spo	sum	2	0	0	1	0	0	1	1	1	3

Schools are sorted in ascending order according to An_i and grouped into 10 equal sized groups of 105 schools