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Matching between students and universities: What are the sources of inequalities of access to higher education?

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Abstract

It is assumed that a perfect balance between student academic achievement and the quality of the university they attend is beneficial both for students and higher education institutions (HEIs). Matching theory predicts the existence of perfect match between the two groups in the absence of transaction costs associated with university enrolment. However, in this study we show cases of mismatch situations in Russia under the Unified State Exam—the standardised student admission mechanism. The reasons for minimal transaction costs and the emergence of unequal access to HEIs were studied. Based on data on Moscow high school graduates who entered university, the determinants of the mismatch between the quality of universities and applicant abilities were assessed. Whilst overall favourable matching results are established, we show that individual student achievement results are subject to the influence of school and family characteristics. Thus, inequality of access can be formed at stages preceding higher education enrolment.

1 | INTRODUCTION

In the last decade, many papers have been published in Russia on the accessibility of higher education under the recent Unified State Exam (USE). In general, they are devoted to the effectiveness of specific education strategies for transition from high school to university. For example, it was shown that students from the most affluent families could benefit from more effective investment in coaching for entry to higher education and therefore have a greater choice of universities (Prakhov & Yudkevich, 2019; Uvarov & Yastrebov, 2014). On the other hand, applicants from disadvantaged households found themselves in a less favourable position because they had fewer resources to pay for pre-entry courses or classes with tutors and they often chose inefficient methods of

additional training (Burdyak, 2015). Another barrier is mobility. Although the introduction of the USE increased educational mobility for university applicants (Slonimczyk, Francesconi, & Yurko, 2017), in some cases, family income and characteristics of regional socioeconomic and education development could have a strong influence on the decision to move and hence on the accessibility to higher education (Anikina Lazarchuk, & Chechina, 2014; Pitoukhin & Semenov, 2011; Prakhov & Bocharova, 2019). Finally, these characteristics are important predictors of the choice of university (élite vs. non-élite) (Prakhov, 2016a). Recent studies emphasise the role of family factors (mainly income and parental education) in choosing a university and in the accessibility of higher education in general. In other words, it is not only the individual results of the USE that determine educational outcomes, but also the type of institution chosen and the admission strategy.

USE is the main mechanism for admission to universities.[1] In an ideal situation, the applicants' academic achievement, expressed in their USE scores, will correspond to the level of the university where they will enrol and have the greatest chance of graduating (Light & Strayer, 2000). However, there are other situations when such an *ideal* (*perfect*) *match* is not possible. First, less-capable applicants may enter universities with higher requirements (*overmatching*). In this case, students occupy the place of more capable students, which reduces the efficiency of resource allocation in higher education. This situation, however, is favourable for the applicants, since studying at a more selective institution will allow them to invest in human capital and obtain greater returns from higher education. A less favourable situation is when more capable entrants choose a less selective institution (*undermatching*) and receive an education that is of lower quality than they could have had on the basis of their abilities, as this may indicate the existence of inequalities in access to higher education and an unfair distribution of entrants among higher education institutions (HEIs).

This article studies the factors that determine the probability of such undermatching. For the Russian higher education system, the study of matching mechanisms as the final result of selection on the basis of USE scores has been especially relevant since the admission process underwent significant changes in 2009. The earlier system of separate high school and university examinations was replaced by the USE which is taken in high school and recognised by all Russian HEIs. Thus, in the context of a significant institutional transformation, it is important to know what potential barriers (other than those described above) can limit access to higher education with a standardised admission system. With the USE, it is possible to compare the quality of teaching among schools and of admission to various institutions. In particular, it makes it possible to evaluate how effectively university selection works, which factors determine the "failures" in the functioning of this mechanism and the barriers to higher education. This study analyses the mechanism of matching between the quality of HEIs and the abilities of students who are admitted to these institutions through the USE.

2 | MATCHING AND ACCESS TO HIGHER EDUCATION

Matching models are used for analysis in different fields, such as the labour market in medicine (Roth, 1984; Roth & Peranson, 1999) and sport (Fréchette, Roth, & Ünver, 2007); human resources (Haruvy, Roth, & Ünver, 2006; Roth, 1991), and university admission. The methodology used in this study was based on a two-sided matching model between applicants and universities and the educational production function. We start with the theoretical propositions of matching and describe the definition and conditions for a stable match. Next, we apply the matching approach to university admission. We then describe possible non-equilibrium mismatch situations and their determinants, based on the results of empirical studies. Finally, we link matching and access to higher education and introduce the educational production function and its determinants. The matching model was first proposed by Gale and Shapley (1962). They formulated conditions according to which a match between the university and the entrant is a situation where: (a) each applicant is either admitted or not to one of the universities; (b) each university either admits a certain number of students or does not accept anyone; (c) the applicants submit their application and enrol in the university and the university accepts them; (d) the number of students admitted to

universities is lower or equal to the quota of available places in the university. With USE, applicants send their applications to their desired universities and wait for the results. The universities rank the applications on the basis of USE scores and make an offer to eligible applicants (their number should not exceed the quota). The applicants either accept or do not accept one of the offers. The resulting distribution between students and universities is called matching. According to Gale and Shapley (1962, p. 10), matching can be either stable or unstable: "A stable assignment is optimal if every applicant is at least as well off under it as under any other stable assignment". A perfect USE match is when the applicants' ability corresponds to the quality of the university. However, unstable situations or matching imperfections may occur. They are often regarded as a sign of irrational admission, inefficiency and injustice in the higher education system (Bowen & Bok, 1998; Cooper & Liu, 2016). Moreover, research shows that students whose skill levels match the quality of the university have a much better chance of graduating (Light & Strayer, 2000). A correlation between college quality, completion rates and future earnings is also important (Dillon & Smith, 2017).

Since matching imperfections are regarded as adverse admission outcomes, we need to discover why bright high school graduates choose HEIs of a lower quality and how some students with a relatively low level of ability enter top universities. Most studies examine two alternative reasons for mismatches, often called "money" or "grit" (Cooper & Liu, 2016). The first concerns borrowing constraints: income plays an important role in college choice (Griffith & Rothstein, 2009; Lincove & Cortes, 2016; Smith, Pender, & Howell, 2013). For example, Hoxby and Avery (2013) found that students from low-income families with a high level of educational achievement were more likely to enrol in HEIs that offered a relatively lower level of education than that which they could attain. The main reasons were either a lack of awareness about their admission opportunities or possible cultural, social or family problems which drive these students away from universities that correspond to their abilities. The second factor is grit, which is influenced either by non-financial parental factors or tastes for education, or both (Cooper & Liu, 2016). For example, the role of information asymmetry in studies on matching in university admission has been cited in a number of works (Dillon & Smith, 2017; Hoxby & Turner, 2013; Lincove & Cortes, 2016). Dillon and Smith conclude that more informed students are more likely to enter colleges of a higher level, unlike their less-informed counterparts. Hence, one of the main predictors of mismatch is characteristics related to family income, cultural and social capital and information awareness.

We examined, in addition to family characteristics, the relationship between individual achievement, school characteristics and the probability of a mismatch. We argue that individual achievement is closely related to the balance between perfect matching and undermatching. Factors that influence educational achievement may also have an impact on access to higher education since students are admitted to HEIs on the basis of their USE results. In other words, in our framework, a mismatch is not the only mechanism of unequal access to higher education: inequalities may exist before admission and influence access to higher education through exam scores. Hence, we need to estimate the characteristics that influence student achievement because high achievers have a better chance of admission. To do this, we used the educational production function. Hanushek (1968) presented a conceptual model of educational production which allowed for the establishment of a statistical relationship between the inputs to education and the measure of its output—individual abilities. Usually, student abilities are expressed in the results of achievement which can be reflected in the scores in a standardised test.

Factors included in the educational production function are usually divided into two main groups: school and non-school. These factors may give some advantage or limit access to higher education when applicants are ranked on the basis of their educational achievement. Among the non-school factors are the influence of family income (Hanushek, Piopiunik, & Wiederhold, 2019), the number of books at home (Wössmann, 2003), parental education (Davis-Kean, 2005; Wössmann, 2003) and coaching for entry to higher education (Prakhov, 2016b, 2017). Among the school factors are the teacher factors. Many studies show that student performance is related to the teachers' cognitive abilities (Eide, Goldhaber, & Brewer, 2004; Hanushek et al., 2019; Hanushek & Rivkin, 2006; Rockoff, Jacob, Kane, & Staiger, 2011) but teacher education, gender and experience have an ambiguous impact on educational achievement (Hanushek & Rivkin, 2006). Time spent in the classroom (Jez & Wassmer,

2015) and class size (Cho, Glewwe, & Whitler, 2012; Finn & Achilles, 1999; Rivkin, Hanushek, & Kain, 2005) also matter. Hence, we propose the following analytical framework for the emergence of mismatch. First, individual achievement expressed in USE scores is determined by individual, family and school characteristics. Second, the probability of matching (and of mismatch) can be related to individual achievement. Moreover, we assume both an indirect (via USE scores) and a direct influence of family and school factors on the probability of matching.

3 | DATA AND METHODOLOGY OF THE STUDY

This article is based on a longitudinal study of students in Moscow schools. It began in 2012 when the participants were in 9th grade and were making decisions about their continued learning paths and their lives in general.[2] The data used in this study include three waves. During the first, over 5,000 schoolchildren were interviewed. The second took place two years after the beginning of the project when one group of respondents was in the final year of high school and was faced with a choice of university and further specialisation, whilst another group was either in secondary special education or had completed their studies in 9th grade (this group was not concerned with university choice and was excluded from a future analysis). The third wave was carried out a year later when former high school graduates had been either admitted to university or had failed to do so.

We used data on high school graduates from the Moscow region, i.e., students who studied in the region with the largest and most developed regional higher education market in the country. Most were also admitted to a university in the Moscow region. By focusing on these students, we avoided a number of transaction costs associated with admission to HEIs, e.g., costs of living in another city. In other words, we excluded the regional variation in socioeconomic development, the differences in the development of local higher education markets and the corresponding transaction costs. All students from the sample had equal opportunities for applying to a university (document submission). Hence, we assumed equal access to higher education based on the results of USE (i.e., the income factor was eliminated because students did not have to change region or spend additional money to live separately from their parents). The study of the education choices of Moscow students only allowed us to research the barriers to higher education in conditions of low transaction costs concerned with university choice and further education.

Data are from students who graduated from high schools and were admitted to the first year of university on a state-subsidised place, i.e., who studied for free and competed through their USE scores. The level of the university was determined by average USE scores of students who have successfully competed for access to state-subsidised higher education. The sample consisted of 826 observations.[3] We added information on how selective the universities were (an indicator of quality) by average USE scores among state-subsidised students. This information was obtained from the 2015 Monitoring of Admission Quality Survey.[4] We added information on subjects that were taken into account during the admission process for every student[5] in order to calculate average individual USE scores. This information was taken from the directory of universities in Moscow and the Moscow region (Kuznetsova & Shilova, 2016). Two variables, reflecting the quality of the university (the average USE score among admitted students) and individual student abilities (the individual USE average for each subject) were calculated. As a result of the adjustments, the total sample size was 518 observations, due to a number of non-response (missing) values.

The matching model is shown in Figure 1. The individual student scores (x) are on the horizontal axis (the average score for subjects that were taken into account when enrolling in a higher education institution). On the vertical axis we find the rating of the quality of the university. Ideal matching takes place when individual USE scores coincide with the rating of the university. The exact coincidence of the points is on the line of ideal matching, i.e., when $y = x$. In this article, for an ideal match, certain intervals were constructed (see below) which are also considered to be an ideal fit. The ideal matching area in Figure 1 is limited by the boundaries of ideal matching ($y = x \pm \alpha\sigma_{\Delta}$, where σ_{Δ} is a standard deviation of the difference between the rating of the quality of the university

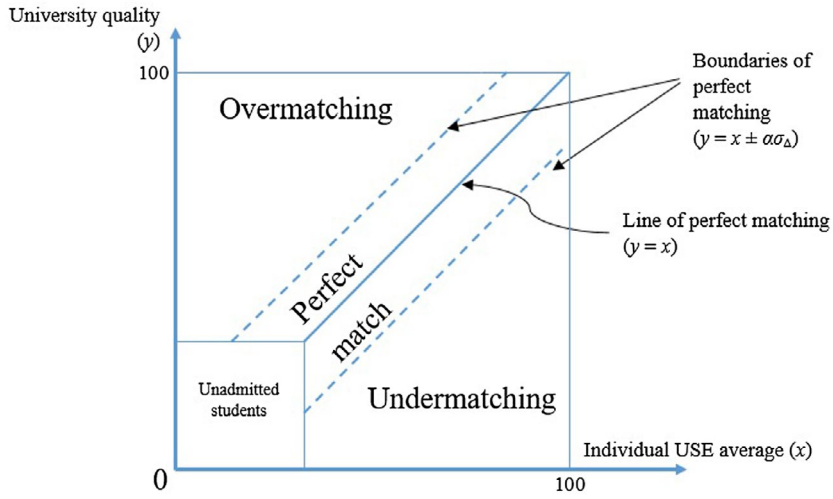

FIGURE 1 The graphic model of matching

TABLE 1 The difference between the individual average USE score of the student and the average USE score among admitted students. Descriptive statistics

Variable	Min.	Max.	Mean	*SD*	Obs.
Δ	−27.8	36.4	−0.63	8.47	718

Source: Authors.

and the individual USE score and α is a matching coefficient: for the line of perfect matching $\alpha = 0$; the greater the value of α, the wider the boundaries of perfect matching. Other areas in Figure 1 reflect a mismatch between individual results and the quality of the higher education institution; overmatching, when the university's quality is significantly higher than the individual's USE points, and undermatching, when applicants with sufficiently high USE scores are in HEIs with a low average USE score among admitted students. In the empirical models, we assessed the factors that lead to the emergence of the latter situation.[6]

Assuming a neutral role for the university in the matching process, we examined the process from the students' perspective. This corresponds to the nature of USE, as in most cases students are admitted only on the basis of their USE scores. In other words, universities cannot introduce their own requirements and manipulate the admission (matching) process.

In order to find out whether students' choice is a match, in the first stage we calculated the difference between their individual USE average and the level of the quality of the university: $\Delta = x - y$. Using Δ, we can formally determine mismatching. Thus, if $\Delta << 0$, then the personal average score of the USE applicant is much lower than the quality of admission to the university, which corresponds to overmatch. Conversely, when $\Delta >> 0$, the applicants' USE score exceeds the average score for the university where they enrolled, which is undermatching. Descriptive statistics on the variable Δ are presented in Table 1.

Table 1 shows the mean value of the variable Δ which is close to 0 and corresponds to a perfect match. For a number of entrants there are very significant discrepancies between individual USE results and the quality of the university they entered.

During the next stage, binary variables which estimate the probability of undermatching were created $\left(\Pr\left(\Delta > \alpha\sigma_\Delta\right)\right)$. In regression probit models, they are considered dependent variables. Variables take the value of 1 if $\Delta > \alpha\sigma_\Delta$ and 0 otherwise, whilst $\Pr\left(\Delta > \alpha\sigma_\Delta\right) = 1$ corresponds to undermatching. In the regression models, we

used the coefficients of matching (α) which equal 0.5, 0.75 and 1 in different specifications. Descriptive statistics for dependent variables are presented in Table 2.

Since the standard deviation of Δ is approximately 8.47, the boundaries of perfect matching are as follows: for $\Delta > 0.5\sigma_\Delta$: (−4.235; 4.235); for $\Delta > 0.75\sigma_\Delta$: (−6.353; 6.353); and for $\Delta > \sigma_\Delta$: (−8.47; 8.47). When establishing the narrowest border (for α = .5), 204 entrants (28.4% of the sample) were undermatched. There were 134 respondents (about 18.7%) in the "wider" borders at α = .75 and 98 entrants (13.6% of the sample) for the "widest" borders of matching (α = 1). Thus, favourable relations were established between individual USE results and the quality of admission to HEIs, as most students were perfectly matched or overmatched. Note that individual USE scores represent a function and are associated with the student's innate abilities and are influenced by external characteristics, such as family and school factors (Hanushek, 1968). Hence, an assessment of the educational production function was conducted. Individual average USE scores were used as the dependent variable. Descriptive statistics are presented in Table 3.

For the regression analysis, we used a system of simultaneous equations. According to the analytical framework of the study, we assumed that the probability of undermatching.

$\left(\Pr\left(\Delta > \alpha\sigma_\Delta\right)\right)$ was related to a set of characteristics, including individual USE results (x). At the same time, USE results are a function of individual, family and school characteristics. Therefore, in step one we estimated the educational production function and obtained the predicted values of USE scores ($\hat{x}$). In step two, we used $\hat{x}$ as one of the predictors of the probability of undermatching, together with other covariates. Thus, the regression models can be presented as follows:

$$\begin{cases} \Pr\left(\Delta > \alpha\sigma_\Delta\right) = f\left(F'\beta\right) \quad (1) \\ \hat{x} = G'\gamma \quad (2) \end{cases}$$

where F and G are the vectors of independent variables (F includes $\hat{x}$), $f(\cdot)$ is a probit distribution function, β, γ are vectors of regression coefficients.

Independent variables (F) include a student's individual, school and family characteristics: their gender, high school status, high school ranking, any change of school, class specialisation, their birthplace, the level of their mother's education, family status (single-parent family) and the number of books at home. Vector G includes the predicted values of the individual's USE average score, as well as their high school status and mother's education. We included these following results from previous studies and because of the importance of the information during the process of choosing a university (Dillon & Smith, 2017; Hoxby & Turner, 2013; Lincove & Cortes, 2016). Hence, we assume that the important sources of such information can come from schools and parents. In this case, top-ranked high schools can provide useful information about admission, as they often collaborate with universities and may guide high school graduates towards a more rational choice. Parents may assist their children

TABLE 2 Dependent variables. Descriptive statistics

Variable	Value	Obs.	Frequency (%)
$\Pr\left(\Delta > 0.5\sigma_\Delta\right)$	1	204	28.4
	0	514	71.6
$\Pr\left(\Delta > 0.75\sigma_\Delta\right)$	1	134	18.7
	0	584	81.3
$\Pr\left(\Delta > \sigma_\Delta\right)$	1	98	13.6
	0	620	86.4

Source: Authors.

TABLE 3 The individual USE average score for the subjects taken into account in admission. Descriptive statistics

	Number of obs. (frequencies)						
Variable	**41–60**	**61–80**	**81–100**	**Min.**	**Max.**	**Mean**	***SD***
x	94	370	254	42.33	97.33	74.79	11.70
	(13.1%)	(51.5%)	(35.4%)				

Source: Authors.

TABLE 4 Independent variables. Descriptive statistics

Variable	Min.	Max.	Mean	*SD*
Gender (=1, if male)	0	1	0.46	0.50
Individual USE average (out of 100)	42.33	97.33	74.79	11.70
School status (=1, if a special status)	0	1	0.54	0.50
School ranking (position)	1	350	208.5	125.45
High school in Top-300 (=1, if yes)	0	1	0.63	0.48
School change (=1, if yes)	0	1	0.1	0.30
Class specialization (=1, if any)	0	1	0.8	0.40
Place of birth (=1, if Moscow)	0	1	0.7	0.46
Mother's education (=1, if higher education)	0	1	0.77	0.42
Single-parent family (=1, if yes)	0	1	0.09	0.28
Number of books at home	5	650	291.7	220.25

Source: Authors.

by sharing their own experience in higher education. In other words, mothers who have a university diploma may be able to give good advice to their offspring.

Descriptive statistics of independent variables are presented in Table 4.

Next, we briefly describe the main characteristics of the independent variables. Of the students in the study sample, 54% were female and around 70% were born in Moscow. Individual USE scores ranged from 42 to 97 with a mean value of 75.

The status of a high school is a binary variable that takes the value 1 if the student has not studied in an ordinary school and 0 otherwise. Around 46% of the respondents were enrolled in high schools with no status. The variable "school rating" reflects the school's position in the Ranking of Moscow schools in the 2014–2015 academic year.[7] In this ranking, the top 300 schools in Moscow are ranked according to the results of their educational activity. The higher the position, the "better" the school. For all schools that were not included in this ranking, a position of 350 was assigned. In addition, we used a variable which showed if a high school belonged to the top 300; some 63% of the schools in the sample fell into this category.

The regressions also reflect whether a student changed school after the 9th grade; About 10% of students did so. The class specialisation is given by a dummy variable, which is 1 if there is a specialisation (e.g., with extra classes in mathematics or languages). 80% of respondents studied in classes with such a specialisation.

The level of the mother's (or stepmother's) education was considered as one of the family characteristics. In 77% of families, the mother or stepmother had a degree. Another family characteristic was family status. In the sample, 9% of students came from a single-parent family, with no one replacing one of the biological parents (i.e., a stepmother or stepfather). The number of books at home can influence educational achievement and was

considered an independent variable with values ranging from 5 to 650. On average, a respondent had 292 books at home.

Correlation coefficients were calculated for all independent variables. Only weak (up to .3) correlations were observed.

4 | THE RESULTS OF A REGRESSION ANALYSIS

The results of a regression analysis are presented in Tables 5 and 6. Table 5 represents a linear regression of individual USE scores. Since USE results are a function of school, family and other characteristics, one must identify which factors are the determinants of student performance. This reveals how the USE result is influenced by factors that are not directly related to a student's abilities. It is possible to draw conclusions about the limitations of the chances of obtaining high USE scores and the barriers to accessing higher education, even with low

TABLE 5 The determinants of student academic performance of schoolchildren (Step 1). Dependent variable: the individual USE average score (*x*)

Independent variables	1	2
Constant	70.867***	66.984***
	(1.975)	(1.746)
Gender	−6.352***	−6.354***
	(0.960)	(0.964)
School status	5.571***	5.903***
	(0.988)	(0.978)
School ranking	−0.011***	—
	(0.004)	
High school in Top-300	—	2.005*
		(1.029)
School change	0.349	0.571
	(1.721)	(1.729)
Class specialisation	2.189*	2.245*
	(1.180)	(1.184)
Place of birth	1.053	1.102
	(1.034)	(1.038)
Mother's education	3.012**	3.102***
	(1.173)	(1.182)
Single-parent family	−1.990	−1.607
	(1.813)	(1.813)
Number of books at home	0.004*	0.004*
	(0.002)	(0.002)
Observations	518	518
R^2	0.196	0.190

Note: Standard errors in parentheses.

***Levels of significance at 1%; **Levels of significance at 5%; *Levels of significance at 10%.

Source: Authors.

TABLE 6 The results of probit-regressions assessing the likelihood of an undermatch situation (Step 2; marginal effects)

Independent variables	Dependent variables					
	$\Pr(\Delta > 0.5\sigma_\Delta)$		$\Pr(\Delta > 0.75\sigma_\Delta)$		$\Pr(\Delta > \sigma_\Delta)$	
	1	2	3	4	5	6
Individual USE average	0.013***	0.012***	0.009**	0.009**	0.006*	0.006**
	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)
School ranking	0.000**	–	0.000**	–	0.000*	–
	(0.000)		(0.000)		(0.000)	
High school in Top-300	–	−0.072	–	−0.054	–	−0.068*
		(0.046)		(0.040)		(0.037)
Mother's education	0.084*	0.083*	0.022	0.020	0.036	0.038
	(0.047)	(0.047)	(0.042)	(0.042)	(0.036)	(0.036)
Observations	518	518	518	518	518	518
Pseudo R^2	0.025	0.024	0.016	0.014	0.016	0.018

Note: Standard errors in parentheses.

***Levels of significance at 1%; **Levels of significance at 5%; *Levels of significance at 10%.

Source: Authors.

transaction costs. In addition, when assessing the production function in education, for the first time in Russia, a "strategic" factor was used as the dependent variable. This variable reflects the results of only those subjects that are required for enrolment, i.e., those in which the student is most interested in the results of the crucial examination. The results of the regression analysis presented in Table 5 reflect the contribution of various resources to student performance.[8]

Individual factors (gender), school characteristics and family factors determine education outcomes measured by a student's USE score. Female students have USE scores that are 6.4 points higher on average than their male counterparts.

The magnitude of the previous factor is comparable to the coefficient for the type of school. Those applicants who studied in special schools (such as in schools with in-depth study of certain subjects) obtained 5.6–5.9 points more per subject than their peers from ordinary secondary schools. Among school factors, class specialisation is also statistically significant, which brings students to slightly more than 2 USE points per subject. Students who graduated from high schools from the top 300 gained on average 2 additional USE points. The rank of the school also affects USE results; the difference for students from the 1st school in the ranking and the 300th school exceeded 3 points for some students.

Among family factors, those students whose mother had completed higher education passed the USE exam with an average of 3 more points. The number of books at home also influenced USE results. Similar conclusions were obtained by Woessmann (2003) and Hanushek et al. (2019). School and non-school factors contribute equally to the final USE results. Factors such as place of birth, change of school and family structure (single-parent family) did not have a significant impact on the final USE results.

Thus, despite the relatively small proportion of applicants who are undermatched, USE results are influenced by a number of family and school characteristics. In conditions of low transaction costs, USE copes with the problem of accessibility to higher education by ensuring a match between the quality of the applicant and the university. On the other hand, unequal access to higher education may arise much earlier than the enrolment stage because of the presence of statistically significant differences between the effectiveness of the applicant and the

characteristics of the family and school. This raises questions about access to higher education, even within the same region.

What are the determinants of undermatching? The results of the regression analysis of the probit models (1) are presented in Table 6 (the second step of empirical evaluation of the system of simultaneous equation). In the results of the probit regression, average marginal effects are reported.[9]

The first important finding is that individual USE mean scores were statistically significant in determining the probability of a mismatch in all model specifications, regardless of the width of the boundaries of perfect matching. Higher USE results increased the probability of being in a weaker institution. One of the possible interpretations of this is the assumption that the higher the USE results, the more opportunities the applicant has to choose from. Hence, this choice can be more conscious, i.e., an entrant with high USE scores interested in a certain specialisation may not find a university of the appropriate (corresponding) quality. On the other hand, with higher USE scores, the value of the variable Δ also increases, which leads to this entrant being under-matched.

There was a statistically significant relationship between school ranking and the probability of undermatching in all model specifications. The lower the ranking of the school, the higher the probability of undermatching. Since school ranking can be considered a proxy for the quality of high school education, it can be concluded that the higher the quality of secondary education, the lower the probability of undermatching. Moreover, highly ranked schools can provide more accurate information on admission and university choice, since many cooperate with different HEIs. Hence, graduation from such a school can contribute to a higher probability of perfect matching.

Third, the mother's education is an important family characteristic. Table 6 shows that it is significant under narrow matching (columns 1–2). With wider borders of perfect matching, this variable becomes insignificant. In this case, the mother's attitudes and the advice she can offer were important. The remaining variables were insignificant in all the model specifications regardless of the matching coefficient. Hence, they were excluded from the final table.[10]

USE examination manages to provide a fair mechanism for admission to higher education; even when establishing narrow matching borders, a relatively small proportion of students enter weaker institutions. However, it is worth noting the influence of the quality of high schools on the matching outcomes. In the context of low transaction costs associated with admission, with the homogeneity of regional socioeconomic development and having all students from the same regional education market, the variation in the quality of schooling can also influence undermatching.

5 | CONCLUSION

This article examined the mechanism of matching the quality of the applicant and the university by USE examination. The possibility of unequal access to higher education was explored. The results show that during the admission process, favourable conditions for ideal matching or overmatching (when the level of the HEIs far exceeds the personal education achievements of students) are observed. Thus, depending on the coefficient of matching, the least favourable situation (undermatching), when applicants find themselves in universities with a lower level than their personal abilities, is relevant for 14% to 28% of entrants.

The probability of undermatching is affected by individual USE scores and the ranking of the high school. Nevertheless, it was empirically shown that USE results were influenced by a number of school characteristics (school type, class specialisation, school quality) and family characteristics (mother's education, number of books at home). These results indicate the presence of factors that are not directly related to a student's innate abilities and are important determinants of academic performance. From the point of view of ensuring equal access to higher education, it can be concluded that, although most entrants find themselves in HEIs that correspond to their abilities, the inequality of access to higher education occurs at earlier stages—in the family and in the school. Note that these results were obtained under the assumption of low transaction costs associated with

admission to university, since the empirical part of the study was based on data on students who graduated from Moscow high schools and entered universities in the Moscow region. Thus, a number of barriers related to the family—income status, regional economic development and the limited choice of university in regional higher education markets—were initially levelled. In conditions that are close to ideal, the inequality of access to higher education remains affected by factors prior to admission. The inclusion of students from different regions (when the corresponding regional variation is included) can lead to even greater effects, with an increase in the share of mismatched students. Therefore, conducting an analysis of matching on the Russian higher education market in general would be useful.

The results make it possible to identify problems associated with the existing mechanism for access to higher education, allow for the development of policy recommendations (including managerial decisions in education), and to identify areas for further possible research. First, in all models, the quality of high school education had a significant effect both on USE results and on the probability of undermatching. Thus, it is worth paying attention to the implementation of policies to improve the quality of school education, oriented towards a possible smoothing of inequalities between graduates from schools with special status and those from ordinary schools. We do not mean "averaging" the quality of teaching in Russian schools; rather, we are talking about the need to "pull up" backward education institutions to the middle level. For example, it is possible to conduct additional work to improve the skills of school teachers and the prestige of pedagogical education. Several years ago, incentive contracts in Russian schools were implemented. However, evidence shows that when school directors have autonomy in setting up the structure of teachers' rewards, the assessed activities may create weak incentives for the improvement of USE results in low-ranked schools. Hence, it is necessary to develop a contract design that would stimulate greater efficiency in the education process.

Moreover, we should regard high schools as an important information source: teachers may assist high school graduates in making the best choice of university. Schools that cooperate with HEIs have more opportunities to do so, but even low-ranked schools can improve their provision of information by working with high school graduates and by cooperating with universities. This is not difficult in Moscow and the Moscow region, since schools and universities are located in the same region with no geographical barriers to networking.

Second, despite the fact that we did not reveal a significant contribution of family factors to the probability of undermatching (with the exception of the mother's education in a number of models), family factors are significant in determining USE results. Therefore, it is worth paying attention to family investments in human capital. It has been shown that where the mother has completed higher education and there are a significant number of books at home, students achieve higher USE results. Thus, the level of cultural and social capital in the family is related to academic performance. Therefore, programs should be developed to support families with insufficient social and cultural capital to increase their awareness. It is also possible to organize support in the form of additional school activities for children from such families.

Closer collaboration between schools and families merits attention since school and family factors determine USE results and explain the gaps in achievement. Greater parental involvement in the schooling process, together with a school's active participation, creates a synergy effect that leads to the improvement of student achievement (Hill & Tyson, 2009; Jeynes, 2007; Wartman & Savage, 2008; Yang, 2017).

Among other things, the influence of gender on USE results and on the likelihood of undermatching was revealed. This conclusion should be treated with caution; according to some studies, the difference between male and female students is primarily attributed to the difference in their preferences and tastes (Zafar, 2013). The determinants of such gender differences would also be an interesting topic for possible future research.

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DATA AVAILABILITY STATEMENT

Data available on request due to privacy/ethical restrictions.

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ENDNOTES

[1] The proportion of students enrolled through the alternative pathways is relatively small: in our sample, around 87% were admitted solely on the basis of their USE results.

[2] This is a part of a number of panel surveys included in the project 'Trajectories in Education and Careers' run by the Center for Cultural Sociology and Anthropology of Education, National Research University Higher School of Economics. See https://trec.hse.ru/en/ for more details.

[3] Other cohorts that were not included in the sample are: (a) those who did not continue studies in high schools after the 9th grade, (b) those who did not enrol at university after the 11th grade, (c) those who were not admitted to university, (d) those who pay tuition for their studies, i.e., who were not admitted on a competitive basis.

[4] This is an annual survey of Russian universities. See https://ege.hse.ru/ for more information.

[5] For example, scores in Russian, Mathematics and Physics were only taken into account for some specialisations in Physics or Computer science, whilst for specialisation in Humanities students could submit their scores in Russian, History and Foreign language.

[6] There are a few alternative models of matching. For example, the incline of the boundaries of perfect matching may not be constant (in our case: 45°) and may depend on the score. They can be narrowed with an increase in the individual USE average score. Another variant of matching is student orientation towards last year's admission scores and the adjustment of university choice (having their USE results) to previous admission levels. The third explanation of matching is a broader one; if the brightest students belong to the top universities and their less-able counterparts are enrolled in the bottom universities, in general, this can be regarded as a perfect match. In this paper we study the case of simultaneous matching with same-year student scores and university quality with a continuity of scores (x and y).

[7] This ranking by the Moscow Department of Education is official. See: https://www.mos.ru/dogm/function/ratings-vklada-school/rating-2014-2015/.

[8] In the previous Russian studies on student performance, the educational production function was assessed by a regression of USE points earned in Russian language and Mathematics (both compulsory subjects) and the average score for all subjects taken on a number of characteristics. At the same time, a number of subjects that the student sat could not be taken into account by higher education institutions when enrolling: for example, Mathematics, which is a mandatory USE subject for graduating from high school, is usually not required when enrolling in a Humanities specialisation. Thus, such estimates of the educational production function in education could be biased, since they did not reflect the strategic nature of the dependent variable used.

[9] The variance inflation factor (VIF) was calculated to exclude the possible multicollinearity of independent variables. For all explanatory factors in the regressions presented, the VIF is approximately equal to one. Thus, this proves the absence of a linear interdependence between the variables.

[10] The additional models with the inclusion of the family income status were tested. As expected, income variables turned out to be insignificant, since this study examines students from the same region, and the variation in the family income in the sample is quite low. That is why the financial situation of the family was ultimately excluded from all regression models.

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