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The Paradox of State-Funded Higher Education: Does the Winner Still Take It All?

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Abstract: Contrary to the overall tendency to increase student participation in the financing of higher education, Estonia abolished student tuition fees in 2013. We study the effects of this reform on the students' access to and progress in higher education, concentrating mostly on the changes in probabilities of rural and remote students being admitted (extensive margin) and graduating within a nominal time (intensive margin). We distinguish between four different outcomes: admission in general, admission to vocational education, admission to high-rank curricula, and graduation within nominal time. We confirm the tendency that a high socioeconomic status increases the probability of being admitted to high-rank curricula and reduces the probability of choosing an applied curriculum, and the 2013 reform did not change that. While the reform weakly improved rural students' tendency to graduate on time, it diminished the probability that they were admitted to high-rank curricula. So, paradoxically and contrary to the intention of the reform, higher state involvement in higher education financing has not improved the equity in university admission in Estonia in terms of either socioeconomic background or regional disparities. We claim that part of the explanation of that paradox lies in the conditionality of this reform and the combination of a scarce needs-based and a competitive merit-based student support system in Estonia. We see our broader contribution in emphasising the important role of support systems in the future analysis of the potential to improve students' access.

Keywords: financing of higher education; Estonia; regression discontinuity; mass higher education; regional disparity

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1. Introduction

Countries all over the world are increasingly aware of the importance of high-level skills in a successful transition to a knowledge economy. Therefore, it is no surprise that education in general, and tertiary education in particular, is at the centre of political debates in most developed countries, and the governance of higher education systems has been subject to continuous reforms and transformations. While these debates have different sources and rationale [1], their aims are attributable to two broad categories. First, educational efficiency, in which issues around finding a good match between education, the labour market and feasible funding, and the combinations of those in an era of higher education expansion, are the most salient [2,3]. Second, educational equity, in which there is concern about the inclusivity of mass higher education. The focus here mainly centres on questions of social selectivity in higher education, its stratification, and the increased need for the reconciliation of work and studies among today's student body [4,5]. Government responses to these challenges have been influenced by both global (such as the Bologna process or neoliberal ideas) and local forces (e.g., interest groups, political parties) [6,7], which has resulted in a variety of "worlds of higher education governance" with different implications for educational efficiency and equity. Comparative scholars have been intrigued by this variety, and there is an increasing understanding of how we ended up with higher education systems as such [8–10], what their distributional dynamics are [11–14], and what works best in making educational access more inclusive [15–17]. Our paper contributes to the latter by offering a quasi-experimental investigation of Estonian tuition-free higher education (hereinafter FHE) reform on extensive and intensive margins of student participation, thereby adding an empirical test towards the scholarly understanding of publicly funded higher education and its challenges when pursuing educational efficiency and equity.

The Estonian educational system has been reformed rapidly. Similar to other countries in the region [18], the last few decades have seen a radical shift from the Soviet state system to the era of liberalisation, followed by two decades of a dual-track system. In the latter, approximately half of students were selected by merit and studied free, while the remaining half paid tuition fees [19,20]. The FHE reform in 2013 ended this division by implementing a dominantly publicly funded "tuition-free" higher education system. FHE reform explicitly problematised inequality in educational access, but also had a strong efficiency argument [21], an issue that was driven by employers' organisations and other interest groups. The explicit social inclusion rhetoric itself might be seen as a deviating path, as until then equity concerns were largely ignored in Estonian educational debates [20].

In our paper, we aim at evaluating the impact of FHE reform on educational disparities in Estonia. We are interested in the reform's effects on both equity and efficiency, defined as the extensive and intensive margins in the literature on labour and education economics [17]. We follow the same division. In our study, we distinguish between three metrics of extensive margins: the probability of admission to higher education, the probability of admission to applied curricula, and the probability of admission to high-rank curricula. The intensive margin is measured by the probability of graduation within a nominal time.

Due to the absence of social background data in Estonian education databases, we operationalise disadvantages based on, first, the distance or time of travel from university; second, rurality; and, third, real estate prices of different areas (hereinafter, SES). Our estimation strategy is the following: First, we estimate logit regression to get the descriptive features of the data, e.g., SES and grade effects on university admission. Second, for the causal test, we use the regression discontinuity (RD) technique. Our panel census data originate from various sources. We match individual (student)-level data from the Estonian admission data warehouse (SAIS) with the Estonian Education Information System (EHIS) curriculum-level data, ending up with more than 70,000 observations.

We continue as follows. In the next section, we contextualise our analysis by introducing varieties of financing of higher education systems and their implications for students' access to HEI. We also introduce the Estonian higher education system and FHE reform to develop our hypotheses. Next, we discuss our data and approach, followed by analysis and discussion. We conclude by giving policy implications derived from the current experiment.

2. Literature Overview and Case Specificities

2.1. Varieties of Higher Education Financing and Educational Access

Educational systems in general, and higher education in particular, have been actively reformed, as higher education sits at the centre of societies' efforts to generate economic growth and provide social security in an increasingly globalised and "knowledge-based" context [2]. This urges governments to find a good balance between economic and social goals in designing reforms at the higher education level. Furthermore, the expansion of higher education forces governments to face a "trilemma" of low public costs, low private costs (tuition fees), and mass access to higher education to respond to those challenges [3]. This has led to a variety of routes of academic capitalism [2], indicating states' tendency to strengthen market principles in university governance and to shape competition in different ways. One consequence of those transformations has been higher tuition in many OECD countries [22], and the financing of HEI has moved toward greater cost-sharing by parents or students [4,15].

While higher education funding and subsidies are not the only components of the transformation toward academic capitalism, they are found to be of enormous importance in terms of educational access [8]. More specifically, the so-called "Worlds of Student Finance" affect students' enrolment behaviour and thereby shape patterns of social mobility and educational inequality [8,10,23]. Furthermore, these effects are asymmetric across socioeconomic and educational groups, as children with a disadvantaged background are much more responsive to the characteristics of the tuition and subsidy systems (ibid.). The literature distinguishes between two key components of higher education funding [8,15]: tuition fees and support. The division of the former depends on whether there are tuition fees in place, and if so, what are their level and coverage. Support, such as financial aid, at the same time, can take the form of grants and loans, the difference being that loans are repayable while grants are not. Grants are usually either merit or needs-based.

To approach that complexity in HEI systems' funding, Garritzmann [8] distinguished between "Four Worlds of Student Finance". According to that model, countries fall into four groups regarding their tuition-subsidy systems: a low-tuition–low-subsidy cluster (mainly continental European countries); a low-tuition–high-subsidy regime (mainly Nordic European countries); a high-tuition–high-subsidy system (mainly Anglo-Saxon countries), and a high-tuition–low-subsidy cluster (some Asian and Latin American countries). While the coverage of Eastern European countries remains patchy due to data deficiencies, this typology is a good yardstick for comparing HEI funding and emphasising the importance of the interplay between tuition and support in influencing educational access. Furthermore, in line with others [15–17] Garritzmann [8] indicated that from the perspective of educational access, high-tuition regimes (often categorised as privately funded systems) are not the only ones with barriers to educational access, as low-support countries might also have a detrimental influence on admission regardless of the level of tuition fees. This is mainly due to the (in)direct costs related to studies, such as accommodation and other living costs, which are especially relevant for students from remote areas. Thus, whereas in the case of high-tuition countries the problem of educational equity is explicit, in the case of inadequate support, access to higher education is unequal even without tuition fees due to other study-related costs. This is because, first, merit-based financial grants rarely improve the enrolment of the disadvantaged (extensive margin). Second, needs-based grants do not systematically increase enrolment rates (extensive margin), but they might instead improve the completion rates (intensive margin) of disadvantaged students.

Post-Soviet countries, including Estonia, predominantly belong to a modified version of the low-tuition–low-subsidy cluster [16,20]. The modification means that many countries in the region have relied on a dual-track system, where, for some students (usually the most academically fluent), studying is free, and others pay tuition fees. Those fees are paid up-front, i.e., a tuition fee that is payable at the time of matriculation, and thus is most frequently paid by parents [15]. This means higher barriers of entry, especially for disadvantaged students compared to a tuition fee that is deferred (ibid.). A dual-track system, which often indicates highly restricted merit-based entry to free or very low-cost higher education, was also in place in Estonia until the FHE reform in 2013. This means that before the FHE reform, almost half of students paid a fee [24], and the level of the fee was relatively high (according to 2007 data, even among the highest in Europe [25]). Since the FHE reform, however, there has been no tuition fee for full-time students who follow the curriculum in Estonian. Hence, this "free" is conditioned. Moreover, it is combined with need- and merit-based grants, and the inclusivity of those is questionable. The coverage and moreover the monetary value of the needs-based grant are very low [26], and the eligibility is dependent on parents' income until the age of 24. Thus, the eligibility follows the logic of the familialised youth citizenship model [27], and is often not in accordance with the actual model of family residence [28]. At the same time, merit-based grants are very competitive and/or targeted to incentivise students to study in specialties of national priority (smart specialisation such as ICT, health, teacher education; concrete list of curricula is decided by the ministry). In total, 25% of all students receive a needs-based grant [26].

In addition to funding, other increasingly relevant aspects shape students' educational access. The increased diversity of HEI is often accompanied by a higher stratification within different types of institutions, individual institutions, or degrees conveying a different level of prestige [4,29,30]. The higher the diversification, often accompanied by selective enrolment criteria, the higher the tendency for disadvantaged students to concentrate on low-prestige institutions or curricula. Reimer and Pollak [31] have shown, for instance, that students from advantageous backgrounds are attracted to courses in medicine, law, and veterinary science, as well as in natural sciences. In the Estonian system, there are also oligopolistic signs or signs of a two-tier system [19,32], meaning that even among the same types of HEI, some universities (Tartu University in particular) or disciplines have higher prestige, and have an important impact on higher education and research policy, from agenda setting to political leadership in reform implementation (see also Appendix A on high-rank curricula in Estonia). This indicates the importance of both horizontal and vertical differentiation in Estonian higher education, which is also conveyed in the labour market [33].

Additionally, in many countries, applied curricula and/or vocational institutions are more often a route chosen by lower-socioeconomic status (SES) students, despite countries' attempts to make the vocational choice more attractive [10]. In Estonia, vocational education has suffered from Soviet-era stigmatisation [34], and to cope with that, many former vocational education institutions acquired HEI status during reforms in the 2000s [20]. In addition to demand-side deficiencies, due to the rapid market reform in the early 1990s, essential structural reforms were long delayed, and the link between the labour market and vocational education broke down [18]. Today, even though students in many applied curricula are eligible for additional support not available to students in academic curricula [34], the share of students who pick professional HEI or other vocational tracks is still below the expected average [24], and it is predominantly youths from working-class backgrounds who overwhelmingly participate in it [34,35].

Finally, in addition to educational access, degree completion is another increasingly relevant issue of educational stratification, as study interruptions come about not only due to failing academically, but also because of financial stress [29]. Not only do students today often follow non-standard life routes when participating in society and combining studying, working and family life [36]—they are also increasingly forced to work [29]. Students in Latvia and Estonia have one of the highest intensities of working, and are most reliant on the share of self-earned income (60% in Estonia) (ibid.), both before and after the FHE reform. Working while obtaining higher education has penalties in the academic progression, especially in the case of high-intensity workers [37]. The drop-out rate of Estonian students was above 50% before the FHE reform in 2013 [24].

2.2. Why Does Funding Matter in Educational Access?

In theory, when financial friction is not present, the decision to attend university must be made based on its net returns. Since the cost of education—fees and living costs—only marginally affects net returns in a high-returns environment, the cost side should not have a large effect on decisions made. Nevertheless, cost, i.e., the financial barrier, has been argued to be a major factor in deciding on university-level education [16]. If so, households that are financially constrained must get compensated for providing equal opportunities. The total financial cost of higher education includes both direct costs, such as tuition fees and living costs, study materials, and health coverage, and indirect costs, such as foregone earnings. So, tuition is only one component of the total cost of higher education. Heller [38] has shown that low-income students seem to be particularly sensitive to the total cost of higher education for enrolment decisions. Financial need makes students more likely to work and for a higher number of hours [39]. Paid work reduces the time students can devote to studying, and Choitz and Reimherr [40] have shown that it is associated with needing more time to graduate and with a higher probability of dropping out before graduation.

In addition to financial barriers, the following mechanisms are discussed in the literature: lack of information about the net value of education, behavioural barriers, and other factors, e.g., negative self-identities or discrimination, which we will not discuss. From the behavioural perspective, Abbiati and Barone [41] have shown that there is no clear evidence that students with a disadvantaged background underestimate the benefits, while there is evidence about the overestimation of the costs of higher education being more common among disadvantaged families [42–44]. In addition, the present bias is stressed in the literature, meaning that while costs are salient in the present, the benefits are uncertain and distant [45]. In this regard, Hillmert and Jacob [46] show that disadvantaged students have a tendency to opt for more concrete rewards on the job market, and they might have different time preferences.

There are thus mechanisms that explain why students with a disadvantaged background are more affected by the financing of higher education than the average secondary school graduate, and alleviating the total costs of higher education can benefit them in particular.

2.3. "Free" Higher Education Reform in Estonia and Its Context

The HEI system in Estonia follows the European Bachelor–Master–PhD model, and there are two types of HEIs: universities (six) and professional higher education institutions (eight). Among them, there are also some private institutions. While Estonian tertiary education expenditure as a percentage of the GDP is slightly above the OECD average [47], the per capita expenditure is remarkably lower than average, and the wage premium from higher education is the lowest (ibid.). The critical change in the logic of HEI funding was initiated with the FHE reform, with which the previous dual-track system, when approximately half of the students paid fees (up to 30% of all budget), was transformed into a tuition-free system. The reform rhetoric emphasised the state's responsibility in compensating for that gap in funding, a promise that has been the object of criticism by recent audits as well as interest groups [24].

Estonian HEIs are selective, and the threshold or quota-based admission is mostly based on State-standardised central exam scores. Although the basic school system is comprehensive and relatively equitable considering international comparisons, schools in the centres of the largest cities (Tallinn, Pärnu, Tartu) still triumph at the top, as parents are extensively making their school choices without any balancing central allocation mechanisms [48]. In addition to that reputational divide between selective and non-selective schools, there is a slight urban–rural divide in school performance in Estonia [49]. This is partly a consequence of the diminishing enrolment in rural areas that also influences schools' budgets [50]. Furthermore, according to the latest PISA results, rural students in Estonia would outperform students in urban areas if they and their schools had the same socioeconomic profile [51].

The phrase "Free Higher Education Reform" (FHE reform) indicates changes that took place in 2011–2012 and that stipulated changes in 2013 to different regulations, after which higher education became free of charge for students studying full time in Estonian. This act aimed to make the higher education system in Estonia more equitable and more efficient, but also emphasised the need to decrease the fragmentation in the system [24]. The problem of equity concerned the access of different social groups, including rural students, students from disadvantaged backgrounds, and Russian minority students. The issue of efficiency specifically concerned the mismatch between HEI and the labour market, an issue raised by employers and international organisations such as the EU and the OECD [20], but also the low share of students graduating within nominal time and the HEIs' own ability to earn money [24].

A new funding system enacted by the FHE reform made HEI funding partly (20%) dependent on performance indicators, specified by a contract for three years between the university rector and the Ministry of Education and Research. As of 2021, there are six components taken into account in performance agreement funding, including efficiency-seeking, quality-enhancing, and societal impact indicators, whereas graduation within nominal time and the share of students in curricula of national priority are among the components with the highest weights in the funding formula [52].

Equity concerns changes initiated in the system of student support measures. Compared to pre-FHE reform, an additional needs-based grant was introduced, and the system of scholarships was closely linked with the priority disciplines. Additionally, former competitive merit-based grants (dependent on GPA and up to the university to decide) continued to exist. Thus, in addition to the opportunity for "tuition-free" education in at least the case of studying full time (75%), need- and merit-based grants are available. Needs-based grants are means-tested measures for disadvantaged students, and their eligibility is dependent on family income. Merit-based grants are competitive and for students in priority curricula. The list of these is subject to change yearly, but comprises mostly science, technology, engineering, mathematics, and teacher training curricula. While the reform package included needs-based support, it remains scarce and the coverage is low [26], thus, the actual take-up of support measures has shifted toward a merit-based system [53,54]. In 2013, most of the support comprised needs-based grants, while in 2018 more than half of the recipients got merit-based grants [24]. Furthermore, according to the Eurostudent survey [29], the rate of working during studies to cover living costs in Estonia (78%) is the fourth highest among European countries. This high share does not necessarily have to indicate financial hardship, as gaining experience on the labour market as a reason to combine studying with a paid job is common (for around two-thirds of the working students) in Lithuania, Estonia, and the Czech Republic. Still, 45% of students in Estonia claim that without their paid job they could not afford to study (ibid.).

One aspect that has an impact on living costs is the question of whether students must leave home to study. While Estonia is a small country, meaning that it is possible to reach universities within three hours from whichever area, except the islands, the share of students who live independently from their parents and are responsible for their accommodation cost is high (ibid.). Based on our data, approximately 5% of students attend a secondary school that is remote, as it takes more than 5 h to travel public transport either to Tallinn or Tartu (cities where all HEIs analysed are located). That low percentage is also partly explained by the fact that approximately half of the Estonian population lives either in Tallinn, Tartu or municipalities nearby.

To conclude, the conditionality of Estonia's system that makes "free higher education" available only for those studying in Estonian and full time (75%), its low level of support, and students' tendency to work intensively, make the inclusivity of FHE reform questionable. To test the inclusivity question empirically, we developed the following hypotheses:

Hypothesis 1 (H1). *(Extensive margin 1) Reform increased the probability of disadvantaged students being admitted to higher education institutions (hereinafter HEI);*

Hypothesis 2 (H2). *(Extensive margin 2) Reform increased the probability of disadvantaged students being admitted to applied (vs. academic) curricula;*

Hypothesis 3 (H3). *(Extensive margin 3) Reform increased the probability of disadvantaged students being admitted to high-rank curricula;*

Hypothesis 4 (H4). *(Intensive margin) The probability of disadvantaged students graduating within nominal time increased.*

3. Data and Tools

3.1. Data and Descriptive Statistics

Our data originate from the Estonian Ministry of Education and Research (HTM), where register-based data about the lower-secondary grades, location of the school, university admission, curriculum ID, and graduation statistics are indicated. We match individual-level data with the following public databases: curriculum-level data from SAIS and EHIS and real estate price information from the land register, which includes data on real estate transactions. To indicate time of travel and distances, we use Google Maps, so the distance from the university was measured as the fastest road by car from address to address and time of travel by minimum travel time by public transport.

In general, we derived 73,356 observations from a span of 10 years; approximately 7000 to 8000 students graduate from secondary schools annually, approximately 60% of them are admitted to a university the same year, and approximately 20% of them go to study in applied programs (see also Figure 1). There has been a decline in the student numbers admitted, and the causes could be related to both demand and supply. Demand is decreasing due to demographic changes, while the reform has incentivised universities to keep student numbers within strict limits financed by the state. The current analysis will include only local (Estonian) students (and most of them are admitted to curricula where the language of instruction is Estonian) and exclude all students from abroad who pay fees. The basis of dwelling data (e.g., variables rural, remote) is not home address but the address of the lower-secondary school that the students graduated from. This proximation is based on the assumption and legal statute that students are allocated to schools based on catchment areas or proximity priorities in urban areas. Based on the school address, we can compose categorical variables of location, or calculate distance or time from the school address to the university.

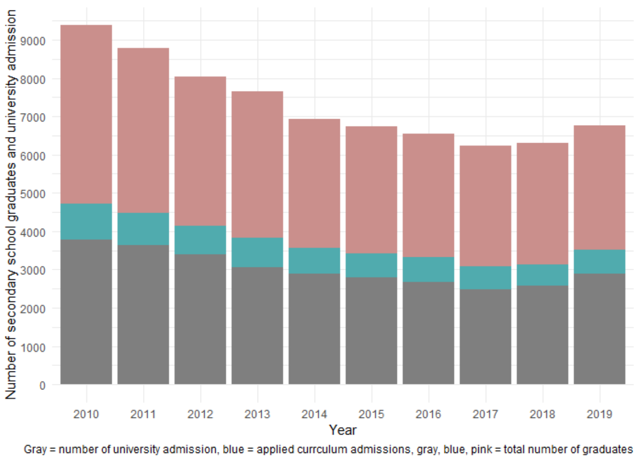

Figure 1. Descriptive features of the datasets.

We use the term "disadvantaged students" to refer to a broad class of lower socioeconomic (SES) status groups, and we identify these students using multiple strategies and proxies for operationalisations: (a) real estate prices in the area (*SES proxy*; 6 month average from 1 November 2020 to 30 April 2021); (b) binary dummy variables for the location of the dwelling/basic school (*remote, rural*); and (c) both distance from HEI (*distance from HEI*; for those who did not get admitted, the *distance from HEI* is an average from lower secondary location to Tartu and Tallinn) and *time of travel* to HEI with public transport.

Table 1 indicates descriptive statistics of the merged datasets. We have four binary student-level outcome variables. First, *admission HEI* indicates whether a student got admitted to any of the higher education institutions in the year of graduation. Second, *applied curriculum* indicates a binary measure of whether a student was admitted to the applied curriculum (vs. academic). Third, *high rank* is a variable indicating whether the curriculum the student got admitted to was amongst the most prestigious and/or "popular" ones, whereas the prestige is measured by the average grades of the admitted student (see list of popular curricula in Appendix A). The threshold of exam score average equals 4.3, which splits curricula into high- and not-high-ranked. In the list of popular curricula, there are 20 curricula, and approximately 15% of students are admitted to these. At the top of the list are the medical department curricula from Tartu University, followed by multiple natural science curricula; however, there are also some education science, language, and humanities curricula on the list. While most curricula listed follow the logic found in other countries [31], the popularity of some has a context-specific explanation. English, for instance, became popular in the early 1990s as a "window" to the Western world, and offered several career opportunities to graduates, as the number of English speakers was very low. Some changes in demand (e.g., in the case of social pedagogy) might also be caused by changes in the Occupational Qualification Standards of Estonia. Fourth, *nominal time graduation* is the variable measuring the intensive margin—whether the student graduates within three plus one years (or five plus one years in the case of some engineering curricula).

Table 1. Descriptive statistics.

Statistic	N	Mean	St. Dev.	Min	Max
Student level outcomes:					
Admission HEI (yes/no)	43,075	0.589	0.492	0	1
High rank (yes/no)	43,075	0.159	0.366	0	1
Applied curriculum (yes/no)	43,075	0.163	0.37	0	1
Nominal time graduation (yes/no)	43,075	0.328	0.469	0	1
Academic achievement of the student:					
Grade (average)	73,207	4.379	0.443	2.812	5.000
Exam score (average)	73,213	4.105	0.566	2.000	5.000
Student background)					
SES proxy (thousand Euro)	73,207	88	66	10	237
Remote (yes/no)	73,356	0.248	0.432	0	1
County centre town (yes/no)	73,356	0.103	0.231	0	1
Rural (yes/no)	73,356	0.104	0.309	0	1
Distance from HEI (100 km = 1)	43,075	0.978	0.817	0.009	3.310
Time of travel (1 = 60 min)	43,075	1.630	1.362	0.015	5.517

Legend: Rural = includes small town (centre of the county) and the entire county; remote = rural county without county centre (town).

3.2. Regression Discontinuity Design in Time

For the descriptive analysis of the extensive and intensive margins, we use logistic regression (logit), whereby we estimate the probabilities and report average marginal effects after logit. Our regression equation is:

$$g(E(y)) = \beta_0 + \beta_1 T + \beta_2 T x_n + \sum \beta_j x_j + e, \quad (1)$$

where $g(\cdot)$ is the logit function, and $E(y)$ is the expectation of the target variable (four outcome variables) related to linear prediction, where T indicates treatment (0 in case of all years before the reform year 2013, and 1 after that) and interaction effects with various independent variables (x's), which mostly indicate average exam grades or various SES measures. We are mostly interested in the interaction effect, β_2. For estimation, we used maximum likelihood.

For the causality test, we used RD. The application of RD design has been expanding due to the need for causal and more credible evaluation strategies, and due to relatively mild assumptions compared to other non-experimental techniques [55]. Because of the lack of cross-sectional variation by threshold (eligible or not for tuition-free higher education) in our data, our estimation technique is firstly regression discontinuity in time (RDiT), where, for all years $t > 2013$, the units are treated, and for all years $t < 2013$, the units are not treated; second, we use exam grades as a threshold, so all students below the average grade of 4.3 (maximum is 5) are not treated. However, RDiT, which uses the treatment date as the threshold, has many particularities compared to cross-sectional RD design. Hausman and

Rapson [56] give an overview of the pitfalls typical to RDiT research, originating mainly from autoregressive processes that describe time series data, and thus the identification and interpretation of short- and long-run effects are the core of the proper estimation of the treatment effects. Our data do not suffer from this deficiency. In our study, we know the date c (the academic year 2013/14) of a policy change, so for all dates $t < c$, the students are untreated and $t > c$ units are treated. There is no cross-sectional variation regarding treatment, thus alternative impact evaluation techniques (e.g., differences-in-differences) are not applicable. There can be some other confounders, such as increasingly selective admission to secondary schools together with “school migration”, demographic changes that decrease the number of secondary school graduates, and changes in the number of study places, which may change at the same time as the financing policy. In our design, all applicants to the university before the academic year 2013/14 are not eligible for “free tuition”, and those after are eligible.

In addition, there is one particularity originating from the data—our dependent variable is a dichotomous (0 or 1) variable. This leads us to firstly predict the probability as a latent variable for each student. In addition to this, we make the following assumptions: (a) no selection or strategic behaviour before c; (b) students did not postpone university because of anticipating the policy change. Then, the outcome can be modelled as

$$y_i = \beta_0 + \beta_1 T_i + f(r_i) + \epsilon, \quad (2)$$

where T_i is 1 in the case of treatment (the academic year 2013 onwards) and 0 for periods 2011 to 2013; r_i is the rating variable (in our case time). Bin is one year, and y_i can be any of the four outcome variables we have discussed in the previous section.

In estimating RD models, we use conventional specifications (Jacob, Zhy, and Somers, 2012): simple linear $y_i = \beta_0 + \beta_1 T_i + \beta_2 r_i + \epsilon_i$; linear interaction $y_i = \beta_0 + \beta_1 T_i + \beta_2 r_i + \beta_3 T_i r_i + \epsilon_i$; $y_i = \beta_0 + \beta_1 T_i + \beta_2 r_i + \beta_3 r_i^2 + \epsilon_i$; quadratic interaction $y_i = \beta_0 + \beta_1 T_i + \beta_2 r_i \beta_3 r_i^2 + \beta_4 r_i T_i + \beta_5 r_i^2 Ti + \epsilon_i$. We report only the best-fitting models. For estimation, we use R package rddtools (Stigler and Quast, 2015), which allows for estimating the models with binary dependent variables, using RDD generalised estimation. For the mean standard error (MSE-RDD) bandwidth procedure, the package uses Imbens and Kalyanaraman [57].

4. Analysis: From Extensive to Intensive Margins

4.1. Probability of University Admission

As stated in the section outlining the data, our register-based data have no background characteristics, so we use proxies to operationalise the disadvantaged status of students.

Our regressions in Table 2 and Figure 2 show, as expected, that university admission is merit-based, and this has not been affected by the FHE reform. In addition to average grades, socioeconomic status (standardised measure of SES indicated as *ses_proxy.z*) and the regional disadvantage (*rural* and *remote*) explain the probability of admission to university to a large extent. Both variables have signs, as expected, meaning that SES has a bivariate positive effect, and after controlling for grades, a negative effect, and regional disadvantage variables (measured by *distance* or *time of travel*) also have negative and significant effects.

We use logistic regression in the case of pooled data with treatment effects to test our first hypothesis. In Table 2, we see that the reform has a negative effect on the probability of admission; however, whether this is due to limited study places (supply side) or less willingness to apply to a university (demand side), we do not know.

However, we show (Table 2) that the interactions of the treatment variable with various measures of the disadvantage status are mainly insignificant or relatively small. Still, in model 7, we see that the reform has increased the probability of rural and remote students’ admission by 2% after controlling for the distance (or for time to travel, as Appendix B reveals). Hence, rural students who live less than 200 km from the universities have marginally benefited from the reform, while remote students (e.g., island communities or students from the mostly Russian-speaking north-eastern regions) have not. Still, the effect sizes are very small. To conclude, against our expectations (H1), the probability of disadvantaged students' continuation in HEI has not improved as a result of FHE reform.

Table 2. Probability of university admission (AME after logistic regression).

	Dependent Variable: Admission to University (Yes/No)						
Independent Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
exam score	0.258 *** (0.003)	0.258 ** (0.003)	0.258 *** (0.003)	0.263 *** (0.004)	0.264 *** (0.004)	0.264 *** (0.004)	0.272 *** (0.004)
ses_proxy.z	−0.006 *** (0.002)	−0.006 *** (0.003)	−0.019 *** (0.003)				−0.054 *** (0.003)
remote + rural			−0.056 *** (0.027)			0.000 (0.025)	−0.048 *** (0.028)
distance (100 km = 1)				−0.144 *** (0.003)	−0.138 *** (0.004)	−0.138 *** (0.004)	−0.158 *** (0.004)
treatment (T)	−0.004 (0.004)	−0.004 (0.004)	−0.011 ** (0.005)	−0.008 ** (0.004)	0.006 (0.008)	0.003 (0.008)	−0.002 (0.008)
T:remote rural			0.016 * (0.009)			0.016 ** (0.008)	**0.020** ** (0.009)
T:ses_proxy.z		−0.001 (0.009)	0.003 (0.008)				0.005 (0.009)
T:distance					−0.012 ** (0.006)	−0.014 ** (0.006)	−0.011 ** (0.006)
Observations Log Likelihood Akaike Inf. Crit.	73,356 −46,683.970 93,375.930	73,356 −46,683.950 93,377.900	73,356 −46,626.750 93,267.510	73,356 −45,377.290 90,762.590	73,356 −45,375.000 90,760.010	73,356 −45,370.440 90,754.880	73,356 −45,113.040 90,244.090

Notes: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. We also controlled for treatment effects on exam score and derived insignificant positive effects, so the system of merit-based selection has not been affected by the reform.

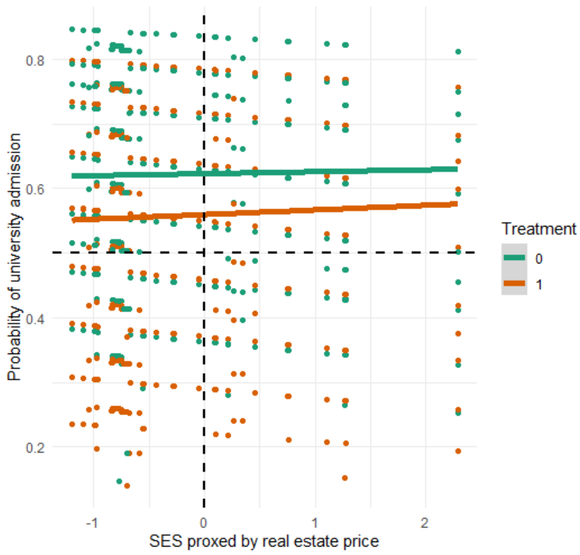

Figure 2. *Cont.*

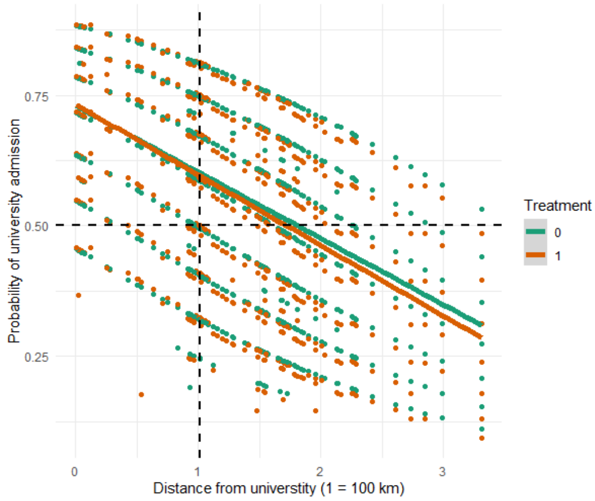

Figure 2. Probability of university admission before and after reform.

4.2. Distributional Effects: Who Goes Where?

The demand for a specific curriculum can not only indicate students' preferences (endogenous or not), but can also be dependent on the admission mechanism (threshold or quota-based), whereas we assume that the average national exam scores of the admitted students indicate the "degree of willingness to buy", determining the threshold for access to the positional good, operationalised either as the threshold for admission to the university or admission to the applied or high-rank curriculum. In general, we see that such average graduation exam thresholds are highly different by curricula—they are relatively low in the case of applied and high in the case of prestigious (high-rank) curricula.

4.2.1. Probability of Admission to Applied Program

For our second hypothesis, "H2 (Extensive margin 2), the increased probability of disadvantaged students to continue in academic (vs. applied) curricula", we follow a similar analytical strategy as in Section 4.1. In Table 3, we show that applied programs admit students with lower average exam scores, from lower SES backgrounds, and with rural backgrounds. The binary visualisations in Figure 3 reveal the same pattern.

Table 3. Probability of admission to an applied program.

	Dependent Variable: Admission to an Applied Program			
Independent Variable	**(1)**	**(2)**	**(3)**	**(4)**
exam score	−0.127 *** (0.003)	−0.127 *** (0.003)	−0.127 *** (0.003)	−0.127 *** (0.003)
ses_proxy.z	−0.029 *** (0.001)	−0.031 *** (0.003)	−0.027 *** (0.003)	−0.028 *** (0.003)
treatment (T)	−0.003 (0.003)	−0.002 (0.003)	−0.002 (0.003)	−0.005 (0.004)
rural + remote			0.016 *** (0.004)	0.011 * (0.006)
T:ses_proxy.z		0.004 (0.004)	0.004 (0.004)	0.007 (0.004)
T:rural + remote				0.010 (0.008)
Observations	43,218	43,218	43,218	43,218
Log Likelihood	−18,237.610	−18,236.910	−18,228.740	−18,227.910
Akaike Inf. Crit.	36,483.220	36,483.810	36,469.480	36,469.820

Notes: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

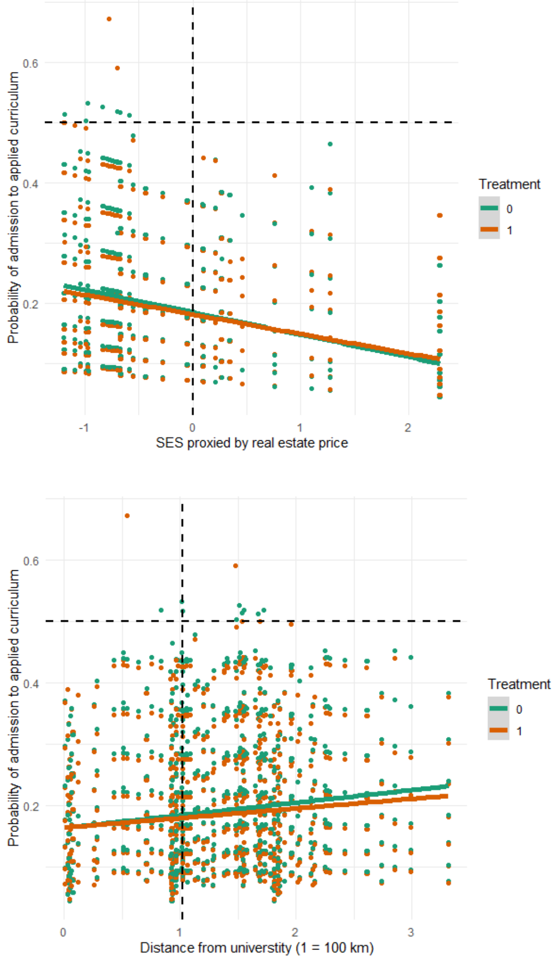

Figure 3. Probability of admission to applied program before and after the reform.

We also show that the popularity of applied programs slightly decreased after the reform, but the reform has not had any impact on SES or location effects, as all the interaction terms with the treatment (T) are statistically insignificant.

We can conclude that the reform has had no impact on admission to the applied program, so we can reject our hypothesis.

4.2.2. Probability of Admission to a High-Rank Curriculum

As indicated, a high-rank curriculum is a proxy for the most prestigious curricula. In the current case, we operationalise the metrics as a binary measure (0 or 1), so a curriculum (20 altogether) is considered a high-rank one if the average grade of admitted students is above 4.3. Altogether, approximately 17% of the student body was accepted to high-rank curricula.

Figure 4 reveals that FHE reform does not change disadvantaged (SES) students' access to high-rank curricula, but has a negative impact on rural students and high-performing students (Table 4). So, in general, Table 4 reveals that the probability of getting accepted to high-rank curricula is dropping *ceteris paribus*, while for students from remote areas and rural counties, it has dropped even more.

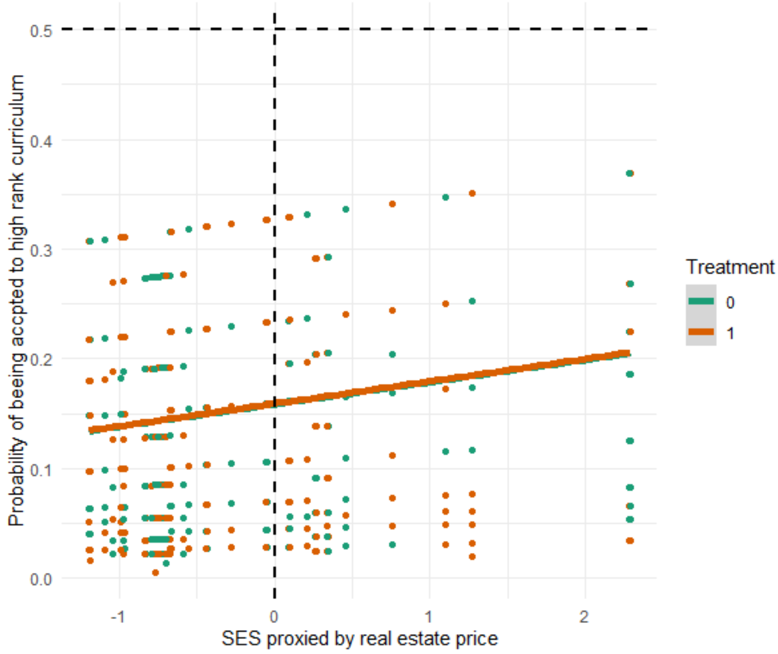

Figure 4. Probability of admission to a high-rank curriculum before and after reform.

Table 4. Probability of admission to a high-rank curriculum (AME after logistic regression).

	Dependent Variable: Admission to a High-Rank Curriculum (Yes/No)			
Independent Variable	**(1)**	**(2)**	**(3)**	**(4)**
exam score	0.166 *** (0.003)	0.165 *** (0.003)	0.165 *** (0.003)	0.143 *** (0.004)
ses_proxy.z		0.015 *** (0.002)	0.011 *** (0.003)	0.011 *** (0.002)
remote + rural			−0.014 ** (0.006)	−0.014 ** (0.005)
treatment (T)	0.003 (0.003)	0.003 (0.003)	0.007 * (0.004)	**−0.389** *** (0.043)
T:remote + rural			−0.014 * (0.007)	**−0.017** ** (0.007)
T:exam score				**0.075** *** (0.007)
treatment:ses_proxy.z		−0.002 (0.003)	−0.004 (0.003)	−0.003 (0.003)
Observations	43,075	43,075	43,075	43,073
Log Likelihood	−17,527.020	−17,483.540	−17,465.320	−17,407.470
Akaike Inf. Crit.	35,060.040	34,977.090	34,944.640	34,830.930

Notes: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

To test our hypothesis (H3), concerning whether the probability of disadvantaged students continuing in prestigious (*high rank*) curricula has increased, we again follow the interaction term coefficients. We see (Model 4 in Table 4) that our hypothesis is again rejected—all students have to achieve higher grades for admission to more popular curricula, but rural–remote students are affected negatively at most.

4.3. Probability of Graduation within Nominal Time (4 Years)

To conclude with a test of the hypothesis concerning the three intensive margin (H4), i.e., whether the FHE reform has delivered more graduation within the nominal time, the same analytical strategy is used. In Table 5, we see that students with higher exam scores have a higher probability of graduating on time, while the SES indicator has a negative effect—high SES students have the tendency to postpone their graduation. A similar insight can be derived from Figure 5 as well. Thus, rural and remote students have a higher probability of graduating on time.

Table 5. Probability of graduating within nominal time (AME after logistic regression).

	Dependent Variable: Graduation within Nominal Time		
Independent Variable	**(1)**	**(2)**	**(3)**
exam score	0.106 *** (0.004)	0.105 *** (0.004)	0.105 *** (0.004)
ses_proxy.z	−0.013 *** (0.003)	−0.010 *** (0.003)	−0.008 ** (0.004)
remote		0.087 ** (0.034)	0.024 *** (0.008)
Rural			0.021 * (0.011)
treatment (T)	−0.054 *** (0.004)	−0.056 *** (0.005)	**−0.060** *** (0.006)
T:ses_proxy.z	0.001 (0.005)	0.002 (0.005)	0.005 (0.005)
T:remote		0.002 (0.005)	0.018 (0.017)
T:rural			**0.029** * −0.012
Constant	−2.644 *** (0.086)	−2.662 *** (0.086)	−2.667 *** (0.086)
Observations	43,218	43,218	43,218
Log Likelihood	−26,986.690	−26,976.820	−26,966.130
Akaike Inf. Crit.	53,983.380	53,965.640	53,950.260

Notes: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Still, contrary to intuition, the treatment effect of the FHE reform, in general, is negative, meaning that the reform has not delivered the promised intensive margin goals. However, we see that the interaction effects of treatment and rural and remote variables are positive and weakly statistically significant (but marginal in size).

Hence, as concerns our fourth hypothesis, the increased probability of disadvantaged students graduating within the nominal time is an impact, as expected. On average, graduating within the nominal time has not been affected by the reform, but for remote students, the effect was positive and significant before and even more so after the reform. To conclude, H4 is confirmed, as there is an increase in the probability of graduating on time for disadvantaged students (in cases in which disadvantaged status is measured as a dummy of the location).

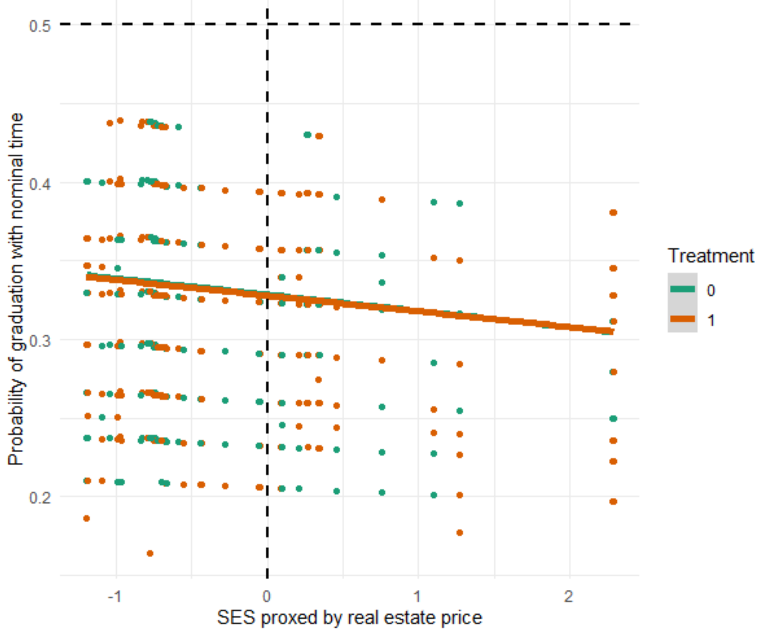

Figure 5. Graduating within nominal time, before and after reform.

4.4. Reform Outcomes: Regression Discontinuity Design

In testing the robustness of our estimates, we apply the *rddtools* package for the binary dependent variable. The visualisation of the average reform effects is given in Figure 6. As the right-hand side year effects show, there have been no major changes (even though nonlinear estimation models are used) for the average probability (AME) for all four outcome variables. The probability of university admission (see also intercept values in Table 6 for a subgroup of remote and rural students) is around 60%, and did not change during the years under consideration. The same applies to other outcome variables—the probability of admission to applied or high-rank programs, and the probability of graduation within nominal time.

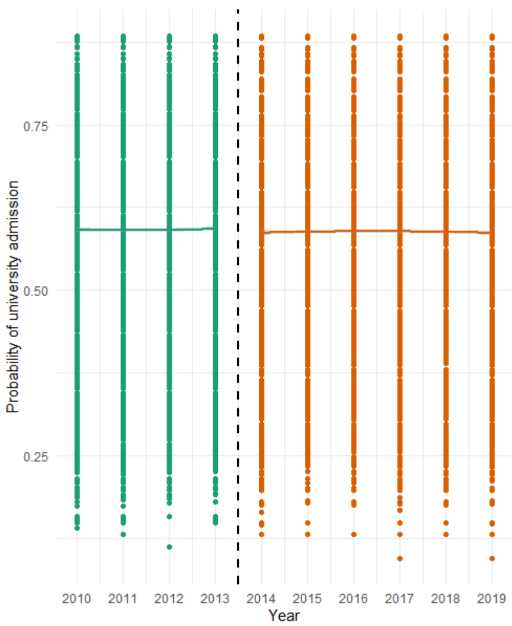

Figure 6. *Cont.*

Figure 6. RDD effects of the reform.

Table 6. Estimation with rddtool: AME after glm (logit) is reported (a subset of rural and remote students).

Independent Variable	HE	Applied	High Rank	Grade > 4.3	Nominal
Intercept	0.639 *** (0.008)	0.187 *** (0.008)	0.088 *** (0.005)	0.035 *** (0.004)	0.192 *** (0.007)
D (LATE)	0.016 (0.009)	0.008 (0.009)	−0.420 (0.005)	−0.032 *** (0.006)	0.007 * (0.007)
R	0.306 *** (0.004)	−0.001 *** (0.004)	−0.002 (0.002)	0.037 *** (0.010)	0.000 (0.003)
r right	−0.102 *** (0.004)	−0.001 (0.004)	0.002 (0.002)	0.245 *** (0.013)	−0.002 (0.003)
Observations	25,974	25,974	25,974	25,974	25,974
Left	9830	9830	9830	10,197	9830
Right	16,144	16,144	16,144	15,777	16,144
AIC	32,735	13,754	13,543	12,462	25,980

Notes: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table 6 reports slopes and intercepts for the subgroup of rural and remote students (n = 25,974). For the third hypothesis (high-rank curricula), we run an alternative model to RDDiT, with the average graduation exam grade as a threshold variable. In all cases, we report average probabilities as average marginal effects. We see that for the first model (H1 on the probability of the continuation in HEI), there is no treatment effect (LATE), whereas over the years the probability of HEI admission increased, and then dropped after the reform. As concerns our second hypothesis (H2) about the increased probability of admission to an applied program, we see a marginal decrease in the years after the reform, but no treatment effect. However, the probability of getting admitted to high-rank programs (H3) seems to have neither annual nor treatment effects, but we see the significant and large effect of grade inflation. High grades guarantee admission to high-rank curricula in increasing degrees, and reform has diminished the probability of high-grade receivers from rural and remote backgrounds getting admitted to high-rank curricula. Finally, in the last model (H4 about the graduation with nominal time), we see that graduation in nominal time has marginally increased for the rural and remote students, so we have a positive intensive margin.

To conclude, regression discontinuity models show local average treatment effects (LATE), and we find no support for our first and second hypotheses, i.e., FHE reform has not increased disadvantaged students' probability of continuing in HEI or in the applied curriculum. Still, we identify a strong rejection of the third hypothesis—reform has had a negative effect on the probability of getting admitted to high-rank curricula. Lastly, we find weak support for the fourth hypothesis—reform increases the probability of rural and remote students graduating on time.

5. Conclusions

We used a quasi-experimental design to show the effects of the higher education funding reform on disadvantaged students. In our reform setting, a dual-track system, in which half (the more academically fluent students) studied free while the other half paid tuition fees, was substituted with universal tuition-free studies. However, the reform did not make our case similar to the Nordic low-tuition–high-subsidy regime, because of the scarce subsidy or grant component.

We used the student-level register data from the period of 2010 to 2019, where 2013 is the reform year. Our analytic design was to estimate four different outcomes for disadvantaged students and identify the treatment effects of the FHE reform: on the probability of university admission (H1); on the probability of admission to an applied program (H2); on the probability of admission to high-rank curricula (H3); and on the probability of graduating within nominal time (H4). The first three are measures of the extensive margin (indications of educational equity in the literature), whereas the last is a measure of the intensive margin (indication of educational efficiency). We concentrated on disadvantaged students, a subgroup that was defined using various measures, such as SES proxy, and rural or remote location, to capture regional disparity and distance or time of travel to university.

We found that the reform affected neither the overall access to university nor the probability of choosing an applied curriculum among disadvantaged students. As such, we reject the first and the second hypotheses. We showed in the case of our third hypothesis that we can not only reject it, but the opposite is true—the probability of getting accepted onto high-rank curricula decreased after the reform for disadvantaged students. Moreover, it works not through background characteristics such as SES, but through rural and remote dwelling. Our fourth hypothesis was weakly confirmed—even though on average graduation within nominal time has not increased after the reform, it has increased in the case of rural and remote students.

Why has the tuition-free higher education reform not had a positive effect on the inclusion of rural students? One explanation could be related to the merit-based admission mechanism, whereby regional disparities are produced at the lower level of education by peer effects, even though we control for the grades. This explanation is related to the students' and their families' lack of complete information about the financial costs and benefits of post-secondary education. To support this explanation, some studies have shown that students often overestimate the tuition costs of further education, have inaccurate beliefs about the returns of college education, and are unfamiliar with what financial aid is available to them [58]. Dynarski and Scott-Clayton [59] note that this is more common among low-income students and among those who have fewer peers going to the university. So, it can be argued that reform itself is a signal that can reduce information asymmetry and attract more students from rural areas or lower socioeconomic backgrounds. It seems that this signal is too weak to compensate for the regional disparity.

Another explanation can be related to the financing system itself—in the current case, tuition-free financing is conditional on full-time (75%) study, meaning that working during the studies is a challenging option. Hence, an alternative explanation is related to the financial considerations and insufficiencies of needs-based grants designed to compensate for the disadvantages of dwelling or SES background. However, the evidence on needs-based aid is mixed, as Herbaut and Geven [16] find that only a few studies show a significant and large positive effect of needs-based grants on the extensive margin, but a significant and positive effect on the intensive margin. Still, it can be argued that the low-tuition–low-subsidy regime does not generate less stratification in higher education compared with the dual high-cost–low-subsidy regime, an argument that is also supported by Herbaut and Geven [16]—the size of the needs-based grant matters. Moreover, it can be argued that merit-based grants are hindering the more equal access brought about by the reform, as the causal evidence suggests that these types of grants can have negative effects on disadvantaged students (ibid.).

Additionally, it can be argued that reform logic is somewhat narrowly driven by natural sciences, wherein graduation within nominal time and the continuity and intensity (e.g., full time) of studies are justified as beneficial performance indicators, while in the cases of many alternative (e.g., social science) curricula, mixing work and studies can be beneficial to all stakeholders, and might be a preferred, rather than forced, choice for today's yo-yo youth [60].

Our main contribution to the quasi-experimental literature about the effects of higher educational funding on disadvantaged students is in showing that reducing the total costs of HEI financing does not bring about greater inclusion. More generally, in line with Garritzmann (2016), we see our contribution in highlighting the importance of student support systems, making the inclusion of data on student support, average working hours of students, etc., even more important for grasping the potential in improving educational access. Forcing students to study full time seems to fail in terms of educational access in the low-tuition–low-support context, and remains inadequate in light of many students' life-course choices. Furthermore, access to HEI alone does not help to "heal" fundamental social differences in a society. Universities are only the last step in a long educational process that reproduces inequalities (e.g., if better grades correlate with a higher socioeconomic background, merit-based enrolment will have an implicit unequal effect due to the inequalities in school systems). More broadly, our analysis shows that while the abolition of tuition fees did not have significant impact on access, it has increased the concentration of top students in high-rank curricula. Thus, the former explicit dual-track has been replaced by an implicit dual-track exemplifying the challenges of inclusive expansionist higher education under the low-tuition–low-support model.

While Estonia is a very small country, its history and the route of its HEI governance correspond well with the regional developments of many Central and Eastern European countries [18]. Thus, in emphasising the more general message of the importance of smart support systems, our results translate easiest to former Soviet countries.

The availability of registered data (not survey or sample data) strengthens our results. Still, our main limitations originate from the data and the data analysis method. First, we can only proxy student background characteristics—based on both SES proxy and dwelling location—so family income or parental education information is not available for us. Even though we rely on a quasi-experimental design that aims to determine the causal effects of interventions by comparing observations lying closely on either side of the threshold, the causality of RDD in time is questionable [56]. Secondly, although RDD has strong internal validity [61,62], it has less external validity [57] (p. 622). This means that our findings are not only time-dependent, but might also be case-dependent.

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Appendix A

Table A1. High-rank curricula based on average exam grade on admission.

Popular Curricula and Higher Education Institutions			
HE institution	Curriculum	Grade average	s.d.
Estonian Art Academy:			
	Graphic Design (Graafiline disain)	4.30	0.50
Estonian Aviation Academy:			
	Aircraft control (Õhusõiduki juhtimine)	4.65	0.33
	Air traffic control (Lennuliiklusteenindus)	4.40	0.52
Tallinn University:			
	Social pedagogy (Sotsiaalpedagoogika)	4.50	0.71

Table A1. *Cont.*

Popular Curricula and Higher Education Institutions			
Tallinn University of Technology:			
	Applied chemistry and genetics (Rakenduskeemia ja geenitehnoloogia)	4.57	0.38
	Applied economics (Rakenduslik majandusteadus)	4.48	0.44
Tartu Healthcare College:			
	Physiotherapist (Füsioterapeut)	4.48	0.41
Tartu University:			
	Medicine (Arstiteadus)	4.84	0.26
	Dentist (Hambaarst)	4.83	0.26
	Mathematical statistics (Matemaatiline statistika)	4.70	0.33
	Physiotherapy (Füsioteraapia)	4.68	0.35
	Pharmacist (Provisoorõpe)	4.68	0.34
	Mathematics (Matemaatika)	4.66	0.35
	Psychology (Psühholoogia)	4.62	0.38
	Genetics (Geenitehnoloogia)	4.58	0.39
	Economics (Majandusteadus)	4.55	0.42
	English language and literature (Inglise keel ja kirjandus)	4.46	0.41
	Special Needs Education (Eripedagoogika)	4.42	0.46
	Computer science (Arvutitehnika)	4.40	0.46
	Literature and cultural studies (Kirjandus ja kultuuriteadused)	4.38	0.43

Notes: 20 most popular curricula over the time, with a threshold at grade average = 4.3.

Appendix B

Table A2. Probability of university admission and time of travel.

Independent Variable	(1)	(2)	(3)	(4)	(5)	(6)
exam score	0.264 *** (0.004)	0.264 *** (0.004)	0.264 *** (0.004)	0.264 *** (0.004)	0.272 *** (0.003)	0.275 *** (0.005)
ses_proxy.z					−0.054 *** (0.003)	−0.054 *** (0.003)
time (1 = 60 min)	−0.086 *** (0.002)	−0.086 *** (0.004)	−0.083 *** (0.003)	−0.083 *** (0.003)	−0.095 *** (0.003)	−0.095 *** (0.003)
remote + rural				0.000 (0.006)	−0.048 *** (0.007)	−0.049 *** (0.007)
treatment (T)		−0.008 ** (0.004)	0.006 (0.008)	0.003 (0.008)	−0.002 (0.008)	0.023 (0.029)
T:ses_proxy.z					0.005 (0.005)	0.006 (0.007)
T:time			−0.007 ** (0.003)	−0.009 ** (0.004)	−0.007 * (0.004)	−0.006 * (0.004)
T:remote + rural				0.016 ** (0.008)	0.020 ** (0.009)	0.020 ** (0.009)
T:exam score						−0.006 (0.007)
Observations	73,356	73,356	73,356	73,356	73,356	73,356
Log Likelihood	−45,379.520	−45,377.290	−45,375.000	−45,370.440	−45,113.040	−45,112.640
Akaike Inf. Crit.	90,765.050	90,762.590	90,760.010	90,754.880	90,244.090	90,245.290

Notes: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

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