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# Why Finnish polytechnics reject top applicants

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## ABSTRACT

I use a panel of higher education clearinghouse data to study the centralized assignment of applicants to Finnish polytechnics. Many top applicants remain completely unassigned each year. The same applicants' future applications reveal that many of them should have been admitted to a different program immediately. The application system, however, discourages applicants from applying to multiple programs within the same year, while at the same time leaving them in the dark on the set of programs willing to admit them. Improvements to the application system have the potential to substantially reduce reapplications, thereby shortening long queues into Finnish higher education.

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## 1. Introduction

Economists have helped to create and improve the centralized application systems that assign students to schools or applicants to programs,<sup>1</sup> perhaps most famously in the redesign of school application systems in New York City and Boston (Abdulkadiroğlu, Pathak, and Roth 2005; Abdulkadiroğlu et al. 2005; Abdulkadiroğlu, Pathak, and Roth 2009).<sup>2</sup> Centralized application systems are used around the world<sup>3</sup> to help assign applicants to the programs they most want to attend, to help assign to each program its most suitable or most eligible applicants, and to help reduce or eliminate the simultaneous existence of unassigned applicants and unfilled seats.

Though the application system plays a central role in determining access to education, the real-world performance of application systems is often unsatisfactory, and we know far too little about the specific circumstances that make application systems fail in practice. Seemingly unimportant design choices have large effects on which applicants will be admitted where, and a poorly designed application system can have knock-on effects which degrade the functioning of the education system as a whole.

In this paper, I use a panel of Finnish higher education clearinghouse data to study the centralized assignment of applicants to Finnish polytechnic programs. I show that even if admission at Finnish polytechnics is highly selective in terms of the proportion of applicants admitted, polytechnics are not admitting the applicants with the highest matriculation exam grades or with the highest admission scores, leaving large numbers of top applicants unassigned each year. Applicants are limited in the number of programs they can effectively apply to, but do not know which programs would admit them.

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Large proportions of both rejected and admitted Finnish higher education applicants re-enter the application system in a later year. I create a series of counterfactual assignments in which I also include the original applicants' future applications and future admission scores. Many more top applicants are admitted in these counterfactual assignments, suggesting that their original rejection was unnecessary.

Of particular interest is the use of field-specific entrance exams as a selection device. The entrance exams not only make it harder for applicants to simultaneously apply to programs in more than one field, they also create a spurious year-to-year variability in admission scores which gives even correctly assigned applicants an incentive to reapply. Entrance exams can stop applicants from gaining immediate admission to the program they will eventually be admitted to through both of these channels.

Applicants' reapplications greatly inflate yearly applicant numbers, effectively creating long queues into Finnish higher education. An admission system which would immediately assign each applicant to the most preferred program they would eventually be admitted to could reduce or eliminate such queues, and thus has the potential to greatly improve aggregate educational and labor market outcomes.

## 2. Background

Schools or programs will commonly admit only a limited number of applicants each. When a program is oversubscribed, some kind of choice between applicants thus has to be made. For this purpose, applicants to each program are typically sorted into a priority ordering on the basis of eligibility criteria and admitted accordingly.

When applications to multiple programs are combined into a single application system, this can increase the efficiency of the assignment, among others by reducing the number of programs that end up unnecessarily undersubscribed when some admitted applicants accept a seat at a different program instead. In a centralized system, there is however typically more than one reasonable way to assign applicants to programs, and the mechanism designer has to make a choice on what assignment properties to prioritize.

Mechanism designers have typically concentrated on trying to assign applicants as much as possible in accordance with applicants' wishes on which program to attend, subject to an elimination of priority violations. An absence of priority violations is also called stability and implies that when two applicants apply to the same program, and the more eligible applicant is not admitted, the less eligible applicant is not admitted either. Stability comes at a cost to applicant welfare in the sense that applicants are assigned to programs they prefer less, and it is often possible to make improvements to an assignment if we are willing to relax or remove the requirement that the assignment be stable (e.g. Abdulkadiroğlu and Sönmez 2003; Kesten 2010).

Apart from an elimination of priority violations, a second common restriction on the assignment mechanism is that it should be strategy-proof: that applicants should not be able to improve their assignment by strategically misrepresenting their preferences. When a mechanism is not strategy-proof, this may create inequities between applicants who differ in their knowledge of the application system or in their willingness to game it. A lack of strategy-proofness can also be an obstacle to efficiency, for example when an applicant has an incentive *ex ante* not to apply to a desirable program that would in fact have accepted them *ex post*, for example because it turned out to be undersubscribed.

The Gale–Shapley student optimal stable mechanism, also called student-proposing deferred acceptance, has become the standard against which other assignment mechanisms are judged. It creates a stable assignment which Pareto dominates all other stable assignments in terms of applicant welfare, while also being strategy-proof for applicants (Gale and Shapley 1962; Abdulkadiroğlu and Sönmez 2003).

In theory, student-proposing deferred acceptance works well even if applicants do not know which programs are likely to admit them. Applicants are meant to list every single program they find acceptable in true order of preference, after which the admission system effectively applies to these programs on their behalf. In practice, there are limits to the number of programs applicants can list, causing applicants to omit programs which otherwise might have admitted them (cf. Haeringer and Klijn 2009). Constraints on the number of programs listed can be psychological rather than legal. Chen and Pereyra (2019) for example study the Mexico City high school match. Though the formal constraint on the number of programs the applicant can list is not binding, applicants fail to apply to schools which they would prefer to their actual assignment because they erroneously think that they would not be admitted.

When applicants do have accurate information on which programs would be willing to admit them, this can substantially improve the functioning of the admission system (cf. Luflade 2017). Under such circumstances, applicants do not need to take into consideration programs where they will not be admitted anyway, nor programs which they prefer less than a program which they know they would be admitted to. Though such applicants are not truthful about their preferences in a technical sense, they may re-create the student optimal stable outcome even in the absence of a mechanism that is strategy-proof (Fack, Grenet, and He 2019), by applying exactly to the most preferred programs that would be willing to admit them. On the other hand, when the admission decisions themselves cannot be predicted, but admission probabilities are known to each applicant, restrictions on the number of programs an applicant can effectively list can allow applicants to credibly reveal the cardinal strength of their preferences by applying to preferred but relatively competitive programs only if they strongly prefer them, and to safer programs otherwise (cf. Abdulkadiroğlu, Che, and Yasuda 2011).

In the literature reviewed above, priority orderings are primarily thought to confer rights on applicants.<sup>4</sup> They are restrictions on the set of legal assignments, not maximands in and of their own. Indeed, when priorities reflect programs' genuine preferences on whom to admit, they are often treated as illegitimate. There are, however, many settings where the policy maker may evaluate an assignment on the basis of welfare criteria that exceed preferences and rights of the individual applicant.<sup>5</sup> The policy maker may for example want to design the admission system in a way that does not put up undue obstacles to equality of opportunity in access to higher education programs, sometimes going as far as trying to encourage or guarantee a certain distribution of applicant types over programs, enforcing diversity within each program in terms of gender, socio-economic background, or ethnicity (cf. e.g. Echenique and Yenmez 2015).

Studies of application systems should be placed in a wider literature on the institutional determinants of educational access. Cohn et al. (2004), Machin and McNally (2005) and Cliffordson and Askling (2006) for example show how the choice of selection criteria affects the selection of applicants into types and levels of education. Hoxby and Avery (2012), Hoxby and Turner (2015), Dillon and Smith (2017) and Dynarski et al. (2018) show that many low income, high ability students unnecessarily fail to apply to selective colleges in the USA, while Campbell et al. (2019) show that conditional on age 18 exams scores, women attend university programs associated with lower earnings, and that low-SES students attend university programs that are both less academically selective and that are associated with lower earnings. The assignment mechanism forms an integral part of both the application and admission phases of the assignment process, and it should be expected to interact with it.

Society may care about the equality of opportunity in education both out of a concern for the applicants themselves, when applicants fail to attend programs we think would benefit them, and out of a concern for the rest of society, when both education programs and ultimately the labor market are faced with reduced access to top talent. There, however, also exists a conflict of interest between the group of applicants as a whole on the one hand and the rest of society on the other. Different applicants can be differentially suited to different programs in ways that are not perfectly correlated with the applicants' own preferences on which program to attend. Is the intended

purpose of the admission system for example to admit the most suited applicants into a country's medicine programs, or rather the applicants who most of all want to study medicine?<sup>6</sup>

Just as how a poorly functioning admission system may fail to place applicants at the programs they prefer, it may fail to place applicants at the programs the policy maker would prefer them to be placed, and an admission system can be evaluated in terms of how it selects applicants without taking a stand the political or pedagogical merits of the assignment the policy maker is trying to achieve. Dur et al. (2018) for example show how selection criteria are attenuated by mechanism design choices in the implementation of neighborhood priorities in Boston schools. The authors argue that while 50% of seats are reserved for applicants from the school's neighborhood, the mechanism assigns the reserved seats to a selection of applicants likely to be assigned to the neighborhood school anyway, greatly diminishing the potential effect of the quota.

Carvalho, Magnac, and Xiong (2018) study a two-stage selection process into a pair of medical schools in Brazil. A lower cost first stage is used to screen applicants before a higher cost second stage. Applicants have to choose which school to apply to before knowing their first stage examination result. The authors use estimated preference parameters to simulate counterfactual selection procedures, among others allowing applicants to apply to both schools' second stage examinations, and allowing applicants to choose which school to apply to after learning their first stage result rather than before it. When applicants can apply to both schools, each school effectively has more applicants to choose from, and more top applicants are admitted. Similarly, when applicants learn their first stage result before applying for a second stage examination seat, they can apply to the most preferred school that would accept them into its second stage examination, and in equilibrium the programs manage to select the highest scoring feasible applicants. A combination of applicant uncertainty and limits on the number of programs applicants can effectively apply to can thus be thought to attenuate selection compared to these counterfactuals.

Wu and Zhong (2014) use empirical variation in assignment mechanisms in China to study the effect of the mechanism used on applicant selection at a top business school. As should be expected, selection on the actual admission score is attenuated when applicants have an incentive to apply only to programs that would accept them, but are uncertain about which programs these would be. Interestingly, Wu and Zhong find that this mechanism nevertheless leads to stronger selection on applicants' subsequent university grades than mechanisms without uncertainty, likely because the admission score is a bad predictor of subsequent grades, and because the mechanism forces applicants to make strategic decisions based on their more accurate private assessments of their abilities instead.

In the present paper, I use Finnish higher education clearinghouse data to evaluate the role of the Finnish polytechnic assignment mechanism in selecting applicants. Though carried out in a similar spirit, a notable difference with the work of Carvalho, Magnac, and Xiong and Wu and Zhong is that I study the application system in its entirety rather than analyzing the assignment to one or two programs only. By using information on the same applicants across application years, I show that the Finnish polytechnic assignment effectively attenuates selection by unnecessarily rejecting top applicants.

The Finnish polytechnic assignment provides us with an example where applicants are asked to strategize in their applications while having poor prior information on the set of programs that would admit them. These features should in and of themselves already be expected to cause a poor assignment outcome. I highlight the additional role which entrance exams appear to play in creating what should arguably be seen as a misrepresentation of true admission criteria analogous to a misrepresentation of applicants' true preferences. Because applicants take and retake different entrance exams in different years, programs rank the same applicants differently in different years, giving applicants an incentive to reapply even if they were originally assigned to their within-year most preferred feasible program.

When applicants are made to strategize in their applications without knowing which programs would be willing to admit them, applicants' strategic behavior can become a signal of their

motivation to attend the specific program they focus their application efforts on. I show that Finnish applicants' strategic choices are indeed predictive of whether they are likely to reject the assigned seat, and of whether they are likely to reapply to a different program in a later year. Though an implicit selection on motivation may benefit applicants and programs alike, it however also seems plausible that the need for such selection would be much reduced in a more well-designed admission system.

This paper proceeds as follows. I describe the institutional background of higher education and higher education admissions in Finland in Section 3, the data and methods in Section 4, and the empirical results in Section 5. Section 6 concludes.

### 3. Finnish higher education applications

Finland provides 9 years of compulsory, comprehensive education, after which almost all students continue in approximately equal proportions to either an academically-oriented high school or to a vocational school. High school concludes with a set of nationally standardized and externally graded matriculation exams. Though students have a reasonable amount of freedom in choosing the subjects they want to take an exam in, they have to take into account that different higher education programs value matriculation exam grades in different subjects differently.

Higher education is provided by polytechnics, also called universities of applied sciences, and by universities. The former mainly offer bachelor programs, and the latter mainly combined bachelor/master programs. About half of each birth cohort ever enrolls in higher education, with total yearly admissions somewhat larger at polytechnics than at universities. Although it is not uncommon for vocational school graduates to apply to a polytechnic, high school graduates are the largest group of polytechnic applicants.

Finnish institutes of higher education generally do not charge tuition fees, and direct and indirect financial student support is relatively generous. Lifetime income differences between education levels are sizable (Koerselman and Uusitalo 2014), even after taxes and transfers.

Unlike some other countries, there is no national ranking of higher education programs in Finland, especially not one which would be generally known or accepted. Should one attempt to construct such a ranking oneself, it would look very different depending on whether one would rank by selectivity, by prestige, or by earnings. The lack of an unambiguous ranking is partially illustrated in Table 1, which shows for the eight main polytechnic fields both the number of applications per seat in 2011, and an earnings measure for field graduates in 2008, when the typical 2011 applicant was in high school. Though the health and social care field is the most oversubscribed, associated earnings are relatively low, and while engineering is among the least oversubscribed fields, its graduates have the highest earnings among polytechnic graduates.

Higher education applications are extremely competitive, with for example only about one-third of polytechnic applicants being admitted nationally each year. Rejected applicants are likely to

**Table 1.** Main polytechnic fields.

Field	Applications	Seats per application	Mean earnings
Health and social care	53393	0.07	26748
Engineering	25152	0.20	40971
Social sciences and business administration	25141	0.13	34341
Fine arts and culture	17658	0.09	23535
Tourism	11669	0.10	29853
Business information systems	3177	0.20	34500
Agriculture, forestry and the environment	3017	0.22	31135
Pedagogy	1710	0.15	27060

Notes: The table shows the number of applications of high school graduates to each of the eight polytechnic fields in 2011, as well as the number of seats per application. Mean 2008 earnings for 30–34-year olds having a degree associated with each field have been added in the last column.

reapply, often multiple years, and even admitted applicants often reapply. Re-applications are an important reason why the numbers of applicants per seat are so large. Applicants effectively queue into higher education, likely causing them to be admitted at an unnecessarily old age, and therefore also to graduate at an unnecessarily old age. The 2011 polytechnic applicants on which this study is based for example had on average graduated from high school already two and a half years earlier, and many of them would be older still when they were finally admitted to the higher education program they would eventually graduate from.

All higher education applications are made to a national clearinghouse. Polytechnic admission decisions are generally made centrally by the clearinghouse itself, while university admission decisions are generally not. In this paper, I analyze the 2011 centralized assignment of high school graduates to Finnish polytechnics. In total, 50,894 high school graduates applied to 16,655 seats in 440 programs, divided over 8 fields.

The application process starts in March, when applicants can apply to up to four programs in order of preference. Applicants must then choose which entrance exams to prepare for and take, typically in May or June. After the entrance exams have been graded, an admission score is calculated for each application. This score is mainly based on applicants' matriculation exam grade point averages and entrance exam results. The weights assigned to different matriculation exam subjects are typically shared within each field, and entrance exams tend to be shared as well. Extra points are awarded for the first listed choice, as well as for factors like relevant labor market experience. The relative weight of the different admission score components in determining the admission score can be seen in [Table 2](#).

Based on their submitted preference ordering and on their admission scores, applicants are assigned to programs through a centrally run program-proposing deferred acceptance algorithm, each applicant either being admitted to a single program or not being assigned at all. Admitted applicants then either accept their seat or reject it. A much smaller second round of offers is sent out by the programs themselves to make up for first-round rejections. The second round of the process ends at the start of the fall term in September.

The use of program-proposing deferred acceptance is remarkable since conditional on submitted applications and realized admission scores, it creates the program optimal stable assignment, i.e. the stable assignment which maximizes the quality of admitted applicants rather than applicants' welfare. A natural first question to ask is thus whether there is more than one stable assignment conditional on applications and scores, and whether there therefore is a different stable assignment which would redistribute welfare from programs to applicants. If the differences between the two assignments are large, the question which assignment to choose may be of political relevance.

Applicants have multiple reasons to strategize in choosing which programs to apply to. Among others, the fact that applicants receive extra points for their first listed choice implies that they will want to list a program first where they have a chance to actually be admitted. Similarly, the four-program limitation means not only that there may be programs acceptable to the applicant which the applicant is not allowed to list, but also that the applicant will need to use the four allowed applications wisely. Third, the applicant faces a strategic choice in which entrance exams to prepare for

**Table 2.** The relative importance of different admission score components.

Score component	Effective weight
Matriculation exam GPA	0.28
Entrance exam	0.43
Program listed first	0.05
Residual variance	0.23

Notes: The table shows the standardized square roots of the variance components of the admission score. Note that a comparison of component means would be uninformative. For example, a score component with positive mean, but with zero variance across applicants would not affect the priority ordering.

and take, typically concentrating all effort on a single application. Fourth, the use of a program-proposing algorithm may in and of itself already give applicants an incentive to strategize.

The lack of strategy-proofness may not be a problem in practice if applicants have accurate information on where they could gain admission. In that case they could apply to their most preferred feasible program only. There is, however, little reason to believe that would be the case in Finland. Though applicants receive good indications of their matriculation exam grades before they apply, and may be aware of previous years' admission score cut-offs, they however necessarily learn their entrance exam scores only after choosing where to apply and which entrance exams to take, adding a considerable degree of uncertainty to their application.

Only about a third of polytechnic applicants are admitted each year. It is, however, not the third of applicants with the highest grades that is admitted or even the third of applicants with the highest admission scores. Table 3 shows the proportion of applicants ranking in the top third, middle third, and bottom third of the programs they applied to who remained completely unassigned at the end of the main application round of 2011. When classifying applicants into thirds based on their program-specific matriculation exam GPA, as many as 54% of top third applicants remain unassigned anywhere. Even using the actual admission score, 34% of top third applicants remain unassigned.

Though it does not follow strictly, the low selectiveness on the admission score is a strong indication that there are large numbers of unassigned applicants which programs would admit over their actual assignment. One reason that top applicants are not assigned to these programs is that they do not apply to other programs than the ones they are rejected from. Table 4 shows descriptive statistics on the application level, i.e. for unique combinations of applicants and programs. In 50,894 applications, a program was listed first, in 40,532 second, in 30,443 third, and in 19,048 fourth. Only 19,048 applicants thus applied to the maximum number of four programs. The average number of programs applied to is 2.77.

Even if applicants do apply to more than one program, their admission chances are relatively low for programs listed second, third and fourth, with the probability of being assigned to a program being 27% for the program listed first, but only between 3 and 4 per cent for programs listed lower. This is partly due to the extra points given for the first listed program, but is probably also related to applicants' strategic choices on which entrance exams to take. The second row of Table 4 shows that in 59% of applications in which the applicant listed the program first, the applicant had also taken a valid entrance exam for that program. This proportion is lower for programs listed lower, and taken together the figures suggest both that participating in an entrance exam is costly to the applicant, and that applicants concentrate their efforts on the exam of their first listed program. In fact, less than 1 in 10 applicants took an entrance exam in more than one field, and when an applicant had a valid exam for a program listed 2 through 4, this is often because that program shares an entrance exam with the program listed first. In addition to observably low admission probabilities for programs not listed, there may be programs which applicants refrain from applying to altogether because they judge that they will not gain admission to the program without additional effort that would be better spent on their first listed application.

It may be unavoidable that some top applicants are rejected from some programs, but of importance is why they are not then assigned to a different program instead. One possibility is that rejected

**Table 3.** Proportion of applicants not assigned to any program by mean priority rank.

Priority criterion	Applicant priority tercile group		
	Highest third	Middle third	Lowest third
Matriculation exam	0.54	0.68	0.81
Admission score	0.34	0.76	0.95

Notes: The table shows the proportion of applicants who were rejected by every single program they applied to. Applicants are classified into three groups by their average rank across the programs they applied to. Even among applicants who on average rank among the top third of applicants at the programs they apply to, large numbers remain completely unassigned.

**Table 4.** Application-level statistics.

	Program rank in submitted list			
	Listed 1st	Listed 2nd	Listed 3rd	Listed 4th
Number of applications	50,894	40,532	30,443	19,048
Proportion with entrance exam taken	0.59	0.48	0.45	0.43
Proportion admitted	0.27	0.04	0.03	0.03

applicants find all other programs unacceptable. In that case, the rejection of top applicants is an almost necessary consequence of applicants' preferences, and perhaps not easily changed by policy. Another possibility is that top applicants do find other programs acceptable, but are rejected from them because they are disadvantaged by the application system in their applications to programs not listed first, perhaps even causing them not to apply to these other programs at all. The second question I try to answer is whether poor selectivity is a necessary consequence of applicants preferences, or whether there are unassigned top applicants that can be shown to find other programs than the ones applied to acceptable.

Application systems do not only select on observable characteristics but also on unobservable ones. It is possible that applicants' incentives to concentrate their efforts on a low number of applications helps them signal their motivation to complete the specific program(s) they apply to. A third question is whether there is any evidence that this would indeed be the case.

#### 4. Data and methods

I use data covering all applications to Finnish polytechnics that were made by high school graduates through the centralized clearing mechanism during the summer application rounds of the years 2011, 2012, and 2013. The data also contain information on university applications, even if admission decisions were typically made in a decentralized fashion for university programs. For polytechnics, the data contain the programs applied to in stated order of preference, matriculation exam grades, entrance exam scores, and the composite admission score. The final state of the assignment algorithm is also available, indicating which applicants were assigned seats where, and which assigned seats were accepted by applicants. I evaluate the 2011 assignment in my analysis, using information from reapplications in 2012 and 2013 to create counterfactual assignments for 2011.

Regrettably, the exact program identifiers used by the algorithm are not available. I therefore use combinations of polytechnic name and program name as proxies of program identifiers. Program quota are not available either, but since every single program is oversubscribed, I can use the number of simultaneous offers made by each program instead. I can replicate about 98% of application decisions by applying a standard program-proposing deferred acceptance algorithm to the admission scores. The slight discrepancy between actual and replicated application decisions may be explained not only by inexact program identifiers but also by applicants' failure to fulfill discrete admission criteria not captured in the admission score, for example when failing to prove their competency in the language of instruction at the polytechnic applied to. I use the replicated assignment as the benchmark to compare counterfactual assignments to, but base all descriptive statistics on the actual assignment.

The first question I answer is whether there exists more than one stable and therefore legal assignment conditional on submitted applications and admission scores. To do so, I apply an applicant-proposing deferred acceptance algorithm to the empirical applications and admission scores, and compare the resulting applicant optimal stable assignment to the program optimal stable assignment. Since the program and applicant optimal stable assignments form extremes of the set of stable assignments, when the two coincide, there is only one stable assignment consistent with submitted applications and realized admission scores.

Second, even in terms of the actual assignment criteria, many top applicants remain unassigned each year. Are there programs which these applicants would have found acceptable, and would have

been admitted to if it was not for the fact that they did not apply? Are there applicants who did apply to additional programs, but who were rejected because of the extra points awarded for their first choice, or because they did not take the entrance exam?

I observe applicants not only in the 2011 application round that I analyze but also in the application rounds of 2012 and 2013, when many 2011 applicants re-enter the application system. Under the assumption that programs acceptable to an applicant in 2012 and 2013 would also have been acceptable to the applicant in 2011 conditional on being rejected from the programs applied to in 2011, I use the panel structure of the data to create counterfactual applications in 2011, adding to the end of the submitted applications in 2011 the same applicants' 2012 applications to programs not applied to in 2011, and to the end of the resulting list 2013 applications to programs not applied to in 2011 or 2012. I additionally create multiple counterfactual admission scores based in different ways on the applicants' 2011, 2012 and 2013 applications. Using combinations of (counterfactual) applications and admission scores, I reapply the deferred acceptance algorithm to create counterfactual assignments, which I then compare to the original assignment.

In the first counterfactual assignment, I simply use the full 3-year list of applications combined with each applicant's associated admission scores at the programs the individual applied to. When the applicant applied to the same program more than once, I use the highest score. It should be noted that in this counterfactual assignment, applicants will receive extra points for the program that was listed first in each of the 3 years, as they did in reality, and that entrance exams will only be valid within the year they were taken, also as they were in reality. The result can be seen as a kind of accelerated assignment using the programs which 2011 applicants were going to apply to in reality, using the scores they were going to receive in reality.

The accelerated assignment simultaneously expands the list of programs applicants each apply to, and changes their relative eligibility at those programs. The next three specifications involve smaller changes to the original applications and admission scores, allowing us to get a sense of where the differences between the original and accelerated assignments are coming from. In the second counterfactual assignment, I remove the extra points for the first choice from the original scores. In the third, I instead add 2012 and 2013 score improvements for the programs applied to already in 2011 to the scores. In the fourth, I also add other 2012 and 2013 applications within the same fields to which the applicant applied to in 2011.

In the final three counterfactual assignments, I adjust or improve the first counterfactual score in different ways. In the fifth counterfactual, rather than somewhat arbitrarily assigning applicants extra points for their first choice within a given year, I remove all first choice points from the score. In the sixth, I extend the validity of the first entrance exam the individual takes within a field to all applications within that field that were made without an entrance exam, much like what would happen if all applications were actually made within the same year. In the last counterfactual, I combine the removal of first choice points with the validity extension of the entrance exams.

I evaluate the new assignments using three different measures. The first of these is the proportion of differently assigned applicants. If many applicants receive different application decisions when including their future applications and future admission scores, this suggests a deficiency in the application system regardless of which exact applicants were reassigned where.

We also want to know whether the apparent lack of selectiveness of the original assignment is affected. I do this by calculating the change in the mean matriculation exam grade percentile rank of admitted applicants at the program where they were admitted. One main advantage of using the matriculation exam grade ranks is that they are known for all applicants, also for programs which the applicant did not apply to. Though it does not matter much in practice, it should be noted that applicants are ranked somewhat differently in different fields, and that it thus would be theoretically possible to admit a number of top 1% applicants larger than 1% of the total number of applicants.

The matriculation exam only receives an effective weight of little over a quarter in the construction of the admission score, and it is possible that the other score components measure valuable traits not

captured by the matriculation exam. It is therefore of separate interest to see the degree to which the counterfactual assignment admits applicants who score higher overall. If we for example counterfactually admit an applicant the basis of a high score on a future entrance exam, the applicant may displace another applicant with higher matriculation exam grades but a lower entrance exam result. This would decrease selectivity on the matriculation exam, but increase selectivity on the admission score. For this reason, I also evaluate the counterfactual assignment in terms of the multi-year admission score used to construct the last counterfactual assignment: from which the first choice points have been removed, and for which the entrance exams have been made retroactively valid. Unlike the matriculation exam grades, this score is not known for each combination of applicant and program, and so I express the multi-year admission score in percentile ranks of the distribution of scores for each applicant's first listed 2011 program. Because different fields have different admission score scales, I calculate the percentile ranks separately by field.

It is possible that applicants' incentives to concentrate their efforts on a low number of applications helps them signal their motivation to complete the specific program(s) they concentrate their application efforts on. To investigate this, I estimate a series of logistic regression models using assigned applicants' submitted program ranking and assigned applicants' participation in a relevant entrance exam to predict whether they will accept the assigned seat, and whether they will re-enter the application system to apply for a different program in 2012 or 2013. Since both predictors and outcomes may differ systematically between applicants with different skill levels as well as between differentially selective programs, I control for an application-specific adjusted admission score from which I have subtracted the points awarded for the first listed program as well as the entrance exam result. I also control for the program-specific admission score of the program's lowest scoring admitted applicant. Because admission criteria differ between fields of study, I include as controls all interactions of these two variables with field of study.

## 5. Results

I start by applying an applicant-proposing rather than a program-proposing deferred acceptance algorithm to the empirical applications and admission scores. I find that not a single applicant is assigned to a different program under the applicant-proposing assignment than under the program-proposing assignment. Conditional on submitted applications, there is thus only a single way to assign applicants which is stable conditional on actual applications and admission scores, i.e. which does not violate applicants' priority rights for the programs they applied to. This finding is in line with the earlier literature, and simulations not shown here suggest that large differences between the two extreme assignments are extremely unlikely to occur in higher education admissions.<sup>7</sup>

Applicants only apply to a small number of programs each, and many top applicants remain unsigned anywhere. This could be a necessary consequence of programs other than the ones applied to being unacceptable to applicants. Many rejected applicants, however, reapply in later years, and not always to the same programs. This suggests that these other programs are also acceptable to the applicant, at least conditional on being rejected from the programs originally applied to. Similarly, applicants often receive higher admission scores to specific programs in future years, suggesting that the programs will admit them eventually.

I create seven counterfactual assignments by applying the original algorithm to seven counterfactual combinations of applications and admission scores which combine information from future applications in different ways. Applicants applied to an average number of 2.77 different programs each in 2011. When I add to the same applicants' application lists their 2012 and 2013 applications, the number of programs applied to increases by almost one program to 3.72. In other words, 2011 applicants on average applied to one additional unique program in 2012 and 2013. Applicants took an entrance exam in an average of 0.77 different fields in 2011, reflecting both the fact that some applicants took no entrance exam at all, and that less than 1 in 10 took an exam in more than

**Table 5.** Counterfactual assignments.

	Applications per applicant	Exam fields per applicant	Differently assigned applicants	Matriculation grade pct. rank improvement	Admission score pct. rank improvement
Original assignment	2.77	0.77			
(1) Accelerated assignment	3.72	0.98	16%	+1.27	+2.27
<i>Deviations from original assignment</i>					
(2) No first choice points	2.77	0.77	5%	+0.56	+0.53
(3) New applications in existing programs	2.77	0.82	8%	+0.09	-0.15
(4) New applications in existing fields	3.33	0.86	13%	+0.43	+0.89
<i>Deviations from accelerated assignment</i>					
(5) No first choice points	3.72	0.98	18%	+1.69	+2.79
(6) First exam valid across years	3.72	0.98	17%	+0.97	+4.06
(7) No first choice points, first exam valid across years	3.72	0.98	18%	+1.47	+4.60

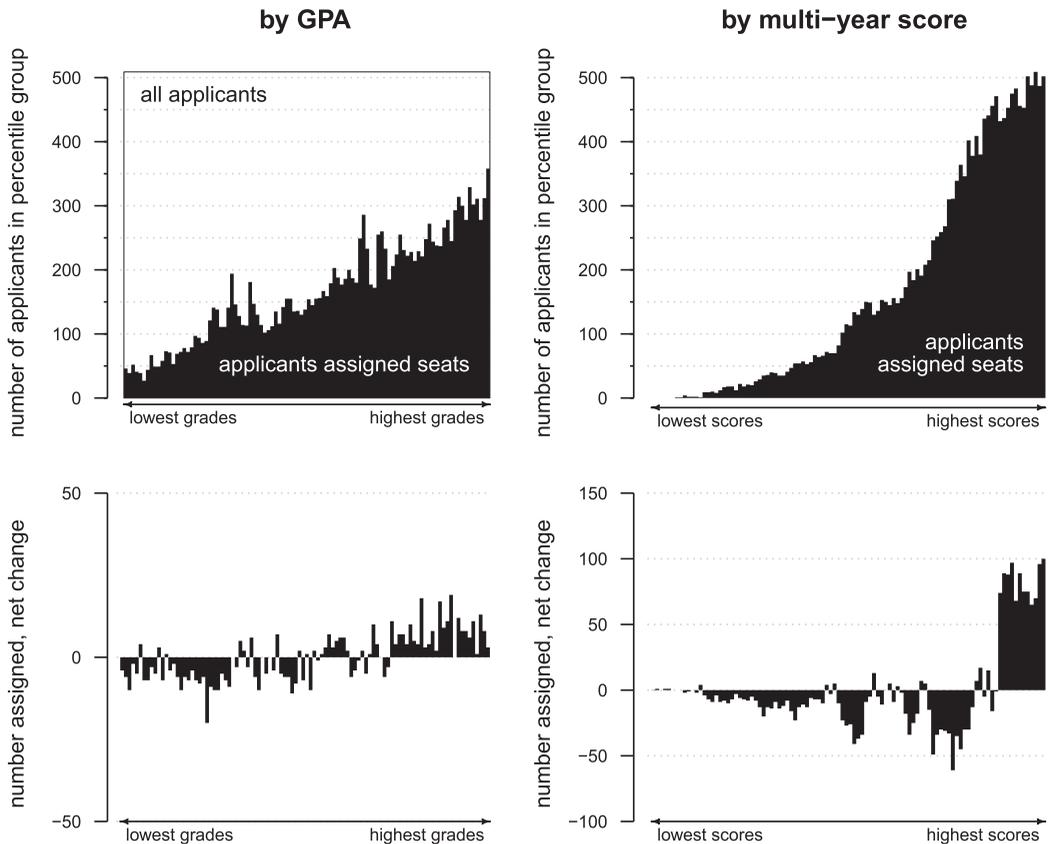
Notes: The table shows the changes to the assignment resulting from counterfactual changes to submitted applications and admission scores. Percentages and percentile ranks are calculated across all applicants. The empirical mean matriculation exam percentile rank of admitted applicants is 62.87, scaled so that a higher percentile rank implies a higher GPA. The empirical mean admission score percentile rank of admitted applicants is 77.32.

one field. When including the same applicants' 2012 and 2013 entrance exams, the mean number of different fields applicants on average took an entrance exam in increases to 0.98.

Table 5 shows the changes to the assignment that result from including applicants' future applications. When simply including applicants' future applications and future admission scores to the end of their existing application lists in Specification (1), we can see that 16% of applicants receive a different admission decision. Since less than a third of applicants get assigned at all, this should be considered to be a large number. As can be seen in the fourth column of the table, the counterfactually assigned applicants of Specification (1) had matriculation exam grades on average 1.27 percentile ranks higher than in the actual assignment. Again, the numbers reported are relative to the population of applicants, and the magnitude of this number should not be underestimated. If the change would have come about by rejecting 8 percentage points of previously assigned applicants, and admitting 8 percentage points of previously unassigned applicants, each newly assigned applicant would have to have had an average of 5 percentile ranks higher grades than the applicant she replaced. The fifth column of the table shows the change in selectivity in terms of the multi-year admission score, which increases by an even larger 2.27 ranks.

These results have also been illustrated in Figure 1. In the top left panel, admitted applicants have been sorted into 100 bins by their field-specific matriculation exam GPA rank at the program they were assigned to. Though there are clearly more applicants admitted with high matriculation exam grades than with low matriculation exam grades, sizable proportions of admitted applicants come from the lower part of the matriculation exam distribution. In the bottom left panel, the net change in the number of admitted applicants within each bin has been illustrated for Specification (1). The change is relatively smooth across the distribution, with more high ranked applicants being admitted, and less low ranked applicants.

The top right panel of the figure shows the admission score distribution of originally admitted applicants. Since the outcome measure is much closer to the actual selection criteria than the matriculation exam grades, selection is stronger, with for example no applicants with the very lowest scores admitted. The bottom right panel shows the change in selectivity on admission scores in the counterfactual assignment of Specification (1). Where the change in grade selectivity was smoothed out across the distribution, the change in admission score selectivity is much more discontinuous because of the stronger relationship between the outcome measure and the selection criteria. More applicants from the very top of the admission score distribution are admitted, and less applicants from the middle. Changes are smaller in absolute numbers at the low end of the distribution because few such applicants were admitted in any case.



**Figure 1.** The grade rank and admission score rank distribution of admitted applicants, and its counterfactual change. The top left panel shows the field-specific matriculation GPA rank distribution of admitted applicants. Because applicants' grades are weighted somewhat differently in different fields, there is not a single correct way to rank unassigned applicants, but a uniform rank distribution has been added to the figure for illustrative purposes. The bottom left panel shows the distributional change when applicants' future applications are also taken into account in Specification (1) of Table 5. Similarly, the top right panel shows the multi-year admission score rank distribution of admitted applicants, and the bottom right panel its change in Specification (1).

Table Rows (2) through (4) show results from different smaller changes to the original applications and admission scores, intended to shed more light on the mechanisms behind the assignment changes between the original assignment and the assignment of Specification (1). Removing the extra points for the first choice in Specification (2) has a relatively minor effect, leading to a different admission outcome for 5% of applicants, and increasing selectivity on either measure by about half a percentile rank.

Retaining the original applications in Specification (3), but allowing for admission score improvements when the applicant applied to the same program multiple times leads to a different decision for 8% of applicants. Matriculation grade selectivity changes very little, while admission score selectivity even decreases somewhat. This can happen for example when an applicant has a higher score in a future application only because the applicant listed the program first in that year. When we then counterfactually admit the applicant in favor of another, similarly scoring applicant, the assignment changes, but selectivity remains largely unaffected or even decreases. In Specification (4), I also include all other future applications within the same field as the programs the applicant applied to in 2011. 13% of applicants are now assigned differently, and some of the increase in selectivity from Specification (2) becomes visible. The remaining difference between Specifications (4) and (1) is that Specification (4) also includes applications in fields not originally applied to in Specification

(1). Comparing the original assignment, the assignments of Specifications (3) and (4), and finally of Specification (1), selectivity increases the most between specifications (4) and (1). This is consistent with the entrance exams forming a barrier to applying to multiple fields within the same year, causing pockets of top applicants to remain unassigned when the other programs they would want to apply to are in a different field from the fields they originally applied to.

In Specifications (5) through (7), I make different adjustments to the admission scores of Specification (1). Instead of somewhat arbitrarily awarding applicants points for their first listed choice in 2011, 2012 and 2013, I remove all first choice points in Specification (5). This has the effect of creating a different outcome for an additional two percentage points of applicants compared to Specification (1). Selection on matriculation grades and on the admission score almost necessarily increases when removing the first choice points, and we can see in the last two columns of the Table that this is indeed what happens.

Entrance exams tend to be valid for all programs within a field and application year. In Specification (6), I extend the validity of the first entrance exam taken within a field to all applications made by the same applicant to the same field without an exam. An applicant who applied to engineering in all 3 years, and took an engineering exam in 2012 and 2013 but not in 2011, will thus have the 2012 exam result added to their 2011 application. Doing so causes the entrance exam results to have a larger effective weight in the admission score. Because the entrance exam results are only partially correlated with the matriculation exam grades, this causes selectivity on the matriculation exam to be lower than in Specification (1). As should be expected, selectivity on the admission score is instead higher.

In the final specification, I combine the removal of the first choice points and the validity extension of the entrance exams in the last specification. 18% of applicants receive a different admission outcome compared to the actual assignment, matriculation exam selectivity increases by 1.47 percentile ranks, and admission score selectivity increases by 4.6 percentile ranks. All of these numbers are substantial.

The admission system implicitly and explicitly rewards applicants for strategic choices such as the order in which they list the programs they apply to, the entrance exams they take, and on how hard they study for them. We have seen that rewarding these strategic choices comes at a clear cost in terms of selection on matriculation exam grades and entrance exam performance. Applicants' strategic choices may, however, be associated with a valuable trait: that the applicant is serious about the application. This indeed seems to be the case. The first three columns of [Table 6](#) contain

**Table 6.** Listed preference order and entrance exam participation among applicants admitted in 2011 as predictors of their subsequent decisions.

Dependent variable	(1)	(2) Accepted seat	(3)	(4)	(5) Re-applied later	(6)
Listed program second	-0.118 (0.011)	-0.142 (0.012)	-0.161 (0.013)	0.111 (0.013)	0.121 (0.013)	0.117 (0.013)
Listed program third	-0.112 (0.015)	-0.135 (0.016)	-0.159 (0.017)	0.190 (0.017)	0.199 (0.017)	0.194 (0.018)
Listed program fourth	-0.188 (0.022)	-0.217 (0.022)	-0.250 (0.023)	0.215 (0.023)	0.224 (0.023)	0.217 (0.023)
Took entrance exam	0.244 (0.047)	0.175 (0.044)	0.172 (0.068)	-0.052 (0.045)	-0.025 (0.044)	-0.132 (0.071)
Adjusted applicant score		YES	YES		YES	YES
Program admission threshold		YES	YES		YES	YES
Field of study			YES			YES
Adjusted applicant score × field of study			YES			YES
Program admission threshold × field of study			YES			YES
Mean dependent variable	0.813	0.813	0.813	0.304	0.304	0.304
<i>n</i>	16655	16655	16655	16655	16655	16655

Notes: The table shows average marginal effect estimates from a logistic regression model of admitted applicants' choices. The adjusted applicant score is the admission score with the entrance exam result and the extra points for the first listed choice subtracted. Standard errors have been added in parentheses.

average marginal effect estimates from a series of logistic regression models, regressing whether the admitted applicant accepted the assigned seat on the program's position in the submitted application list as well as on whether the applicant participated in the entrance exam.

Column (1) shows that conditional on each other, the applicant is 11.8 percentage points less likely to accept the assigned seat when listing a program second instead of first, 11.2 percentage points less likely when listing it third, and 18.8 percentage points less likely when listing it fourth, and that the applicant is 24.4 percentage points less likely to accept the assigned seat when they did not take a relevant entrance exam. When controlling for the applicant's adjusted admission score and the selectivity of the program applied to in Column (2), and for both of these variables interacted with field of study in Column (3), the entrance exam coefficient is somewhat reduced and the preference order coefficients somewhat increased. All estimates are large in magnitude and significantly different from zero.

Columns (4) through (6) show estimates from a similar set of models, but with the outcome now being whether the applicant re-entered the higher education application system in 2012 or 2013. We see that applicants who were admitted at a program they did not list first were 10–20 percentage points more likely to re-enter the application system in one of the next 2 years. Admitted applicants who had taken an entrance exam for the program they were accepted to were less likely to reapply in a future year, but although the effect is of the expected sign, the estimate does not clear the 5% significance threshold. Since all other estimates are large and statistically distinguishable from zero, however, considered together, the elements of the admission score which are dependent on applicants' strategic choices are clearly jointly predictive of admitted applicants' subsequent decisions on whether to accept the assigned seat, and whether to try to gain entry to another program in a future year.

## 6. Discussion

I use a panel of higher education clearinghouse data to evaluate the selection of applicants into Finnish polytechnics. Many top applicants remain unassigned by the mechanism, both when evaluated in terms of their matriculation exam GPAs, and in terms of the actual admission score that determines admissions.

The number of programs each applicant applies to is low, and when a top applicant is rejected from a competitive program, there may not be another program which the applicant can be assigned to. While some applicants may find all programs not applied to unacceptable, large numbers of applicants can be observed to apply to at least one different program in one of the two subsequent years, suggesting that these additional programs would also have been acceptable immediately. Even at programs which top applicants do apply to immediately, many are rejected because they do not list that program first, or because they have not taken the relevant entrance exam for that program.

When immediately processing also applicants' future applications, programs are able to admit applicants with better matriculation exam results and higher admission scores, and many applicants receive a different admission decision. Relatively large increases in selectivity can be observed when specifically including applicants' applications to programs in fields not originally applied to, suggesting that the field-specific entrance exams may be an obstacle to a more immediate assignment.

When applicants have to concentrate their application efforts on a single program, but do not know where they would gain admission, applicants should apply to a more competitive program only if they value attendance at that program unusually highly, leading to self-selection on an otherwise ex-ante unobserved trait. Consistent with this idea, applicants admitted to Finnish polytechnics are more likely to accept the assigned seat, and more likely to refrain from trying to gain admission at a different program in a future year if the seat was at their first listed program, and if they took the relevant entrance exam.

Even admitted applicants frequently reapply, inflating yearly applicant numbers, and effectively creating queues into higher education. Finnish students have one of the highest graduation ages in the OECD (OECD 2014, Chart A3.1), and although various attempts have been made to encourage a more timely graduation (cf. e.g. Hämäläinen, Koerselman, and Uusitalo 2017), at least part of the reason for Finnish students' high graduation age is the high age at which they enroll in the program they will graduate from. Since the admission score components which depend on applicants' strategic choices on how to list programs and on which entrance exams to take are predictive of retention, it may seem attractive to argue that retention problems would be even worse if these strategic choices would no longer be used as selection criteria. The observed relationship between strategic choices and subsequent behavior is, however, not informative of applicants' behavior under alternate application rules. Quite the contrary, it seems likely that the poor performance of the admission system is the main reason why so many applicants refrain from attending and completing the program they were assigned to in the first place.

Rather than trying to predict which applicants will reapply, and rather than trying to stop applicants from reapplying altogether, it should be possible to immediately assign most applicants to their most preferred feasible program. One way to create a stable assignment with respect to applicants' true preferences would be to create a true applicant optimal stable mechanism by removing selection on strategic choices, thus allowing and encouraging applicants to list a large number of programs in their true order of preference. This may, however, not work as well as theory would predict. Applying to many different programs may be psychologically costly, and applicants may erroneously discount the possibility that they would be admitted at a competitive program. Applicants should therefore additionally be given reliable information on the set of programs that would be willing to admit them already before they make their final decision on where to apply, for example by placing the entrance exam earlier in the application process (cf. Fack, Grenet, and He 2019; Carvalho, Magnac, and Xiong 2018; Chen and Pereyra 2019).

Though immediately assigning applicants to their within-year most preferred feasible program would likely be beneficial, some of the problems in Finnish higher education admissions would remain. The selective taking and re-taking of entrance exams causes programs to rank applicants differently in different years, even when applicants' underlying traits remain unchanged. This generally gives applicants an incentive to reapply. Though fairness concerns may require that any exam can be retaken, selection criteria should be constructed in a way which avoids year-to-year variation in individual applicants' admission scores that is unrelated to year-to-year variation in their suitability to attend higher education.

## Notes

1. I will use *student* and *applicant*, and *school*, *program* and *college* interchangeably in what follows.
2. See Pathak (2017) for a recent overview.
3. Higher education applicants are centrally assigned among others (with)in Australia, Chile, China, Egypt, Finland, Georgia, Hungary, Ireland, Norway, Spain, Taiwan, Tunisia and Turkey (Helms 2008; Fack, Grenet, and He 2019).
4. This is perhaps the most clear in the work of Kesten (2010), who designs a mechanism which allows applicants to waive specific priority rights to the benefit of other applicants.
5. See Cantillon (2017) for a good overview of potential criteria the policy maker might use.
6. A discussion on how best to assign physicians to residencies is the source of a rare example of documented reasoning about how to handle the trade-off between applicant and program welfare (Roth and Peranson 1999, footnote 9). Roth and Peranson highlight that neither applicants nor programs base their stated preferences on full information. Because applicants' ex ante preferences over programs are thought to be much less noisy than programs' ex ante preferences over applicants, physician welfare should be targeted in favor of residency program welfare.
7. The size of the set of stable assignments can be large under some idealized conditions (Pittel 1989), and small under others (Azevedo and Leshno 2016). Typically however, the set is small (e.g. Roth and Peranson 1999). There are various known circumstances which tend to produce this result: when the number of applicants differs from the number of seats (Ashlagi, Kanoria, and Leshno 2017), when applicants each apply to a limited number of programs only (Roth and Peranson 1999; Immorlica and Mahdian 2005; Kojima and Pathak 2009), and when either program or

applicant preferences are correlated with each other (Roth and Peranson 1999; Holzman and Samet 2014; Ashlagi, Kanoria, and Leshno 2017). These circumstances are all common in higher education admissions.

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