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EXAMINING THE EFFECTS OF OUTSIDE OPTIONS ON MATCHING OUTCOMES IN THE DA MECHANISM: AN EXPERIMENTAL APPROACH

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In countries with centralized admission systems, some applicants have access to outside options. This study aims to analyze how the presence of outside options for some applicants affects the decisions of all applicants in a centralized admission system under the deferred acceptance (DA) mechanism. I consider two cases: 1) when the length of the ranked ordered list (ROL) of educational programs that applicants can submit is unconstrained, and 2) the case of constrained ROLs. For each of these cases, I also examine whether integrating the outside option into the centralized admissions system affects the decisions of applicants, as well as the characteristics of the resulting matchings.

I find that, consistent with theoretical predictions, when the length of ROLs is constrained and the outside option is not integrated into the admissions system, participants without access to the outside option adopt a more cautious application strategy compared to those with such access, and are less inclined to truthfully list their top-ranked choice. However, contrary to theory, the incorporation of outside options into the system significantly alters the strategies and matching outcomes of the participants, even if the aftermarket is frictionless when the outside option is not integrated.

Keywords: experiment; matching markets; school choice; deferred acceptance mechanism; outside options

JEL classification: D47; I21; I24; I28

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1 Introduction

In countries with partially or fully centralized admission systems, many higher education applicants have access to options outside the centralized system, also known as off-platform or off-system options. While these outside options may not be as desirable as the top choices within the system, some may rank highly in applicants' preferences. For instance, educational programs at private universities can provide high-quality education comparable to, or even exceeding, the top-quality programs at the in-system state institutions.[1]

The impact of outside options on the functioning of centralized admission systems has not been extensively examined. This paper aims to investigate how the availability of outside options for some applicants influences the strategies adopted by all participants in a centralized university admission system that utilizes the Gale-Shapley or deferred acceptance (DA) algorithm. The outside option is assumed to be both desirable, ranking just below the top choice among the in-system options, and to have lower admissions criteria than the most desirable in-system options. These are common features of private educational programs that aim to provide quality education, but recruit from a smaller pool of applicants from higher-income families.[2]

In theory, when there are no restrictions on the length of the ranked ordered lists (ROLs) of educational programs submitted by applicants, the presence or absence of outside options for some applicants does not affect the strategies of all those participating in the admission system. This is due to the strategy-proofness of the DA mechanism, where applicants' optimal strategy is to submit lists that truthfully reflect their preferences for educational programs.

The theoretical finding that the presence or absence of outside options does not impact applicants' strategies has been a key factor behind the limited experimental research on this problem. However, existing experimental studies have often challenged the theoretical conclusions about the strategy-proofness of the DA mechanism.[3] Therefore, the first objective of this study is to empirically examine the theoretical claim that the availability of outside options for some applicants does not affect the strategies of all applicants in the DA mechanism when there are no constraints on the length of the lists submitted by applicants.

[1] In centralized admission systems, applicants apply to educational programs and / or institutions, depending on the organization of the admission process in a specific country. For the sake of consistency and without loss of generality, here I will assume that admission occurs to educational programs at higher education institutions.

[2] Some admission systems have places in the *same* educational programs that can be either in-system or outside options. For example, in Kazakhstan, tuition-free places in academic programs are distributed through the centralized mechanism, while full-tuition places in the same programs are also available, with lower admission requirements and a separate application process. The latter places can be viewed as outside options to the tuition-free places. In Russia, admissions to educational programs are centralized within each university. Each university is required to distribute the tuition-free, state-sponsored places via the DA mechanism, but they have a separate admission process for the full-tuition places in the same programs, which tend to have lower admission requirements.

[3] See Hakimov and Kübler (2021) for the review and Gonczarowski et al. (2024) for the experimental evidence on the challenges in conveying the strategy-proofness of the DA mechanism to the experimental subjects.

The first finding is that when the length of ROLs is not constrained and the outside option is not integrated into the centralized admission system, the low rates of truthful reporting among the participants lead to distortions in the stability of the matching outcomes. However, the strategies of applicants without access to the outside options and the matching outcomes for all participants do not differ significantly from the benchmark case where there are no outside options available. Thus, the hypothesis that when the ROLs are unconstrained in length and the outside option is not integrated into the centralized admission system, the applicants' strategies are not affected by the availability of outside options to some applicants, is not rejected.

In practice, most centralized admission systems place restrictions on the length of the ROL of programs that applicants can submit. The presence of such constraints undermines the theoretical strategy-proofness of the DA mechanism. Furthermore, the availability of outside options for some applicants can influence the optimal strategies adopted by all participants within the system, including those without such outside options.

Consider a simple example with two a priori identical applicants, 1 and 2, who both prefer program A over program B, and program B over not enrolling in either. Each program can accept only one applicant, and each applicant can apply to only one program. Additionally, applicants first apply to a program and then each is randomly assigned a priority common to both programs, such that each program is equally likely to prefer applicant 1 or applicant 2. In this game, there is no pure-strategy equilibrium. In mixed-strategy equilibrium, applicants are more likely to list program A than program B.

Next, consider the situation where applicant 1 has a readily available outside option that she prefers to program B, but not to program A. In this case, applicant 1 will always apply to program A. Knowing that applicant 1 has this option, applicant 2 is more likely to apply to program B, as the competition for program A has intensified.

The presence of outside options is expected to benefit the outcomes of applicants who have them. However, the impact on applicants without these options is more ambiguous. While these applicants may have a higher chance of enrolling in a program within the system, the likelihood of their enrollment in top-ranked programs may decrease due to the increased competition for these programs.

The second objective of this paper is therefore to examine how the availability of outside options for some applicants affects the strategies adopted by all participants in a centralized university admission system with a restriction on the length of the ranked ordered list of programs that applicants can submit. The study also examines the impact on the stability of matching outcomes and the likelihood of undermatching for applicants with and without access to outside options.

The second finding is that, as predicted by the model, when the length of ROLs is constrained, participants with access to the outside option adopt a more ambitious strategy compared to participants without such access. These participants are more inclined to truthfully list their top-ranked choice. Consequently, while participants without access to the outside option are prone to being undermatched, participants with the outside option almost never are.

Recent empirical studies provide further support for this result. Chrisander and Bjerre-Nielsen (2023) find that in Denmark's centralized university admissions system, which uses a variant of the DA mechanism, applicants with outside options are significantly more likely to truthfully reveal their preferences in their ROLs. Similarly, work in progress by Erlanson, Francesconi, and Yurko uses admission data from a large Russian university to show that applicants seeking both tuition-free and tuition-paying places (outside options to tuition-free places) are more likely to list less accessible programs as their top priority on their ROLs, compared to applicants applying only for tuition-free places.[4]

If the preferred choice is a tuition-free place in an educational program financed by the government, while the outside option is a full-tuition place in the same or similar program, these findings suggest that applicants who can afford the tuition are more likely to be allocated the tuition-free places compared to equally qualified applicants who cannot afford the tuition. This outcome is clearly undesirable for policymakers.

The availability of outside options for some applicants poses an additional challenge, as it requires the reallocation of seats after the algorithm's completion. Applicants with outside options can forgo the places they secured through the centralized admission system in favor of their outside options. As a result, higher education institutions must redistribute the vacated seats to applicants who were enrolled in programs with lower priority on their lists. This process can be opaque and involve time and communication costs, which are known in the literature as aftermarket frictions.

A recent article by Kapor et al. (2024) examines the impact of outside options in the presence of aftermarket frictions in the context of university enrollment in Chile. Their findings reveal that the availability of such options for some applicants, coupled with secondary market frictions, leads to an inefficient allocation of places in higher education programs and a decrease in applicant welfare. The authors' primary recommendation is to integrate the outside options into the admission system.[5]

The present study assumes that aftermarket frictions are negligible and that the reallocation of vacated seats after the assignment process is costless. Under these assumptions, the third research objective is to analyze how integrating outside options available to some applicants into the centralized university admission system impacts the strategies of all applicants, as well as other properties of the mechanism. This includes examining the effects both in the presence and absence of a restriction on the length of the ranked list of programs that applicants can submit. Theoretically, in the absence of frictions in the secondary market, the optimal behavior of applicants within the system should remain unchanged, regardless of whether outside options are integrated into the admission system.

The third finding unexpectedly rejects this hypothesis. When the length of ROLs is not constrained, I find that integrating the outside option into the system appears

[4] In Denmark, applicants can apply to a maximum of 8 educational programs. In Russia, applicants can apply to educational programs in up to 5 subject areas at each of up to five universities where they can submit their applications.

[5] Properly speaking, with this integration, the outside option would no longer be an option outside the centralized admission system, but rather a part of it that only some participants can apply for due to external factors like family income. Nevertheless, in this paper, I refer to these options as outside options regardless of whether they are integrated into the system or not.

to impact the decisions of applicants without access to the outside option, increasing their rates of truthful reporting. The reasons underlying this finding are not apparent and merit further investigation.

In the case of constrained ROLs, the situation is different, as the decisions of applicants with access to the outside option are the ones affected, and the explanation for this is more readily available in the experimental data. As the experimental design assumes that for applicants with access to the outside option, it is almost always available, reflecting common real-life features of such options, the outside option is a safer choice from the applicant's perspective than other in-system options.[6] As a result, when the outside option is integrated into the centralized system, the applicants with access to it appear to display the so-called "district school bias", as previously noted and explored in the seminal work by Chen and Sönmez (2006). This bias may lead applicants to prioritize the safer outside option, resulting in higher undermatching rates for them and more egalitarian matching outcomes for participants with and without outside options in the integrated case.

Several recent studies (Artemov et al. (2020), Hassidim et al. (2021), and Shorrer and Sóvágó (2023)) have examined ROLs submitted by applicants who apply for both tuition-free and full-tuition places in the same or similar academic programs through centralized admission systems using the DA mechanism. These admissions systems can be viewed as examples of centralized systems with integrated outside options, as only some applicants can afford to apply for full-tuition places.

The authors have identified and analyzed a type of preference reporting mistake that they refer to as "obvious": if applicants are asked to rank programs that differ solely in the availability of financial aid, it is implausible that an applicant would genuinely prefer a program without financial aid over the same program with financial aid. These studies indicate that such obvious misrepresentations can be detected in the lists submitted by 17–35% of the applicants.

The current study provides experimental evidence of the preference reporting mistakes observed in this prior research, and suggests that a bias akin to the "district school bias" may help explain this phenomenon.

This paper is related to previous studies examining the presence of outside options in centralized admissions, such as the work of Akbarpour et al. (2022) and Calsamiglia and Güell (2018). However, these prior studies have focused on the effects of outside options in the context of the Boston mechanism, rather than the DA mechanism examined in the present study.

This paper also builds upon the foundational work by Calsamiglia et al. (2010), which experimentally examined the effects of constraints on the length of ranked-order lists. More recently, Alcalde-Unzu et al. (2023) have conducted experiments with constrained ROL length. However, in their experiments, participants were only allowed to rank one school, leading to identical predictions for the Boston and DA mecha-

[6]For example, in Hungary, unlike Kazakhstan and Russia, applications for tuition-free and full-tuition places in academic programs are submitted through the centralized admission system, and the admission requirements are lower for full-tuition options. Applicants can rank up to three educational programs and two forms of financing (tuition-free and/or full-tuition) for these programs, but must pay a fee for any additional applications.

nisms. To my knowledge, there are no existing experimental studies investigating the impacts of outside options in settings with unconstrained or constrained ROLs for the DA mechanism.

The remainder of the paper is organized as follows. Section 2 describes the experimental design, the versions of the theoretical model being tested, and the key theoretical predictions. Section 3 provides details of the experiment. The results are presented in Section 4, and Section 5 concludes the paper.

2 Experimental design: model and predictions

This section outlines the theoretical underpinnings of the experiment. The study adopts a neutral language, using the distribution of prizes of varying values to represent the allocation of seats in a centralized university admission system, rather than directly referencing educational programs. This design choice aims to avoid potential biases stemming from participants' prior knowledge about decision-making in the admissions process, which could influence their choices in the experiment.[7] Accordingly, the model description also focuses on the distribution of prizes.

First, I outline the model and describe the different versions tested during the experiment, along with the main theoretical predictions. Then, I present some arguments supporting the modeling choices made.

There are three types of prizes with different values: $A > B > C > 0$. There are 18 prizes in total, with 6 prizes of each type, to be distributed among 24 experimental participants.[8] The participants have the same ordinal and cardinal preferences over prize types and the same expected priorities for these prizes. They have full knowledge of their own and others' preferences.

The timing is as follows. The participants submit ROLs of prize types. The priorities of prize types for participants are then randomly determined. Each participant is randomly assigned a number between 1 and 24, with a higher number indicating a lower priority for receiving a prize. The participants are matched to prize types via deferred acceptance (DA) mechanism with participants being the proposing side.

The experimental subjects are Russian university students, and the prize type values are set as follows, with the US dollar amounts in parentheses reflecting the exchange rate at the time the experiment was conducted:

1) Prize A: 600 rubles (approximately $6.50)

2) Prize B: 400 rubles ($4.33)

3) Prize C: 200 rubles ($2.17)

[7] The experiment's participants are first-year university students enrolled at a large Russian university. Russia's university admissions system is partially centralized, utilizing the DA mechanism to match applicants to educational programs.

[8] Any number divisible by four could have been chosen, but 24 is the most convenient group size for the experiment.

The prize type values are chosen to not differ greatly for two reasons. First, this reflects a more realistic scenario where program quality, while distinct, is not vastly disparate. Second, if the participants are risk-averse, the differences in utility derived from the payoffs become less pronounced.

In versions of the model with an outside option, some participants are also eligible to receive an outside option prize O worth 500 rubles ($5.40). Thus, for these participants, $A > O > B > C > 0$. Unlike the main prize types, the number of outside option prizes O is equal to the number of participants eligible to receive them.

Versions of the model. The experiment is conducted for seven versions of the model:

I. **Unconstrained ROLs**:

1) Unconstrained baseline: no outside option for any participants (control);

2) Unconstrained integrated outside option: outside option is integrated into the centralized system, available for 1/3 of participants (treatment);

3) Unconstrained non-integrated outside option: outside option is available for 1/3 of participants, but not integrated into the centralized system (treatment).

In version I.3) of the model with the non-integrated outside option, one third of the participants have an outside option prize O that they will receive if they do not obtain prize A through the algorithm. Any prizes B and C that become available are then redistributed to other participants without access to the outside option, based on their submitted ROLs and priority numbers.

In version I.2), the outside option is integrated into the centralized system. The one third of participants who have an outside option prize O must include it in their ROLs in order to be considered for it.

For the unconstrained ROLs versions of the model, the availability of the outside option does not impact the optimal truth-telling strategies of the participants, regardless of whether they have such options. Truthfully listing prizes from highest to lowest remains a weakly dominant strategy for all participants. In version I.2), individuals with the outside option should submit ROLs that include the outside option O: $\{A, O, B, C\}$.

Undermatching occurs if a participant with a higher priority score (a lower assigned number) is assigned a less desirable prize than another participant with a lower priority score. Matchings are considered stable when there are no undermatchings, and the degree of stability is inversely related to the frequency of the undermatchings.

The resulting matchings are evaluated for **stability**. In all versions of the unconstrained ROLs model, the matchings are predicted to be stable.

II. **Constrained ROLs**, participants can list at most two prize types:

4) Constrained baseline: no outside option for any participants (control);

5) Constrained integrated outside option: outside option is integrated into the centralized system, available for 1/3 of participants (treatment);

6) Constrained integrated outside option: outside option is integrated into the centralized system, available for 2/3 of participants (treatment);

7) Constrained non-integrated outside option: outside option is available for 1/3 of participants, but not integrated into the centralized system (treatment).

With the exception of version II.6), the constrained versions of the model mirror the unconstrained ones. In version II.6), the outside option is integrated into the centralized system and is available to two-thirds of participants. Inclusion of this treatment would allow testing whether the share of participants with access to the outside option affects the optimal strategies of all participants. The prediction is that it should not affect the optimal strategies of the participants with the outside option, who should always submit ROLs of $\{A, O\}$, but may affect the optimal ROLs for the participants without such an option available.

First, consider the baseline constrained setting without the outside option, which corresponds to version II.4) of the model. The optimal strategies for applicants no longer involve pure strategies. Instead, the equilibrium strategies involve mixing ROLs $\{A, B\}$, $\{A, C\}$, and $\{B, C\}$. Specifically, with risk-neutral participants, in equilibrium these lists are mixed in the approximate proportions $3 : 2 : 1$.

Note that these partial ROLs are not truthful in the conventional sense, but preserve the original ranking of prizes from highest to lowest with some prizes omitted. Nevertheless, for convenience, I will refer to these lists as "partially truthful" ROLs.

Consider these partially truthful ROLs. The $\{A, B\}$ ROL represents the most ambitious choice, as it includes the top two most preferred prize types among all participants. The $\{A, C\}$ ROL has the top prize but also includes a "safety option" in the lowest prize C. In contrast, the $\{B, C\}$ ROL adopts a "skip the impossible" strategy by excluding the most desirable prize type sought by all.

What happens to the optimal strategies of the participants when some of them have an outside option prize O available? For participants with the outside option in versions of the model with the integrated outside option, the optimal strategy is to submit the list $\{A, O\}$. For these participants in the non-integrated version II.7), the optimal strategy is to submit either the list $\{A, B\}$ or $\{A, C\}$, as they will receive the outside option prize O if they do not obtain prize A.

Participants without access to the outside option are expected to anticipate that competition for the most desirable prize type A will intensify when some participants have the outside option available. Consequently, these participants are likely to decrease the proportions of $\{A, B\}$ and $\{A, C\}$ lists in their mixed strategies, and increase the use of the "skip the impossible" $\{B, C\}$ list.

However, when the share of the participants with the outside option is very large, as in version II.6) of the model where two-thirds of participants have access to this option, the participants without the outside option have a dominant optimal strategy of submitting the list $\{A, B\}$ if they are risk-neutral. This is because they may still have a chance of winning the top prize type A, and are otherwise almost guaranteed to win prize type B due to the reduced competition for it.

The characteristics of the resulting matchings are also evaluated. First, **stability** is no longer guaranteed in these constrained versions of the model, as it is possible that some participants who submit $\{B, C\}$ lists are assigned higher priority than other participants who submit $\{A, B\}$ lists. Specifically, in simulations of the constrained baseline version II.4), approximately 76% of the resulting matches were found to be stable.

In the constrained versions of the model with the outside option, participants without access to the outside option prize may be undermatched, as they are less likely to be assigned the top prize type A. However, they are more likely to obtain prize types B or C compared to the constrained baseline scenario.

Modeling considerations: The model builds on the illustrative example from the Akbarpour et al. (2022) and is designed to be as simple as possible.

- The model limits the number of in-system prize types to three, with a capacity resulting in a quarter of participants remaining unassigned in the unconstrained baseline version. Alternatively, the three in-system prize types could be maintained, but the capacity for each adjusted to eliminate unassigned participants in the unconstrained baseline scenario. However, in the constrained version of the model, some participants may still not be assigned a prize, which complicates the comparison of the constrained and unconstrained versions.

  This modeling choice of having total capacity less than full is realistic, as in many university admissions applicants are not guaranteed a seat in some program. It also allows for a more straightforward evaluation of the effect of the presence of outside options on the welfare of the participants without such options.

- The number of in-system prize types is set to three, as with only two prize types available, the constrained case would limit participants to including only one type of prize in their ROLs. However, this would lead to two issues. First, the outcomes under the DA mechanism would be the same as those under the Boston mechanism. Second, when the outside option is integrated into the system, participants with the outside option would optimally use a mixed strategy.

- The vertical differentiation of schools and the common preferences of applicants are common features in many environments and help simplify the information structure.

- The participants submit their ROLs without knowing their priority scores. This assumption simplifies the information structure and eliminates the dependence of submitted ROLs on participants' own priority scores.

3 Experiment

The experiment was approved by the Institutional Review Board of the NRU Higher School of Economics, Committee on Interuniversity Surveys and Ethical Assessment of Empirical Research. The study was preregistered with the AEA RCT Registry.[9]

The participants in the experiment were first-year Bachelor's degree students enrolled at the International College of Economics and Finance and the Faculty of Economic Sciences (NRU Higher School of Economics, Moscow). At the time of the experiment, the students had not yet received any coursework on game theory.

The experiment involved a total of 302 students who participated in 14 experimental sessions held at the end of September and in November 2024. However, data from two students were excluded due to their submission of incomplete lists. Thus, the study included 300 experimental subjects, with each participant submitting ROLs for two versions of the model, resulting in a total of 600 observations.

During each experimental session, the participants first received instructions. They were informed that they would participate in two versions of the experiment involving the distribution of prizes, with the prizes and their quantities described to them. In each version, they would compete for these prizes in groups of 24 participants.

The participants were informed that whether they receive one of the prizes depends on their own decisions, the decisions made by the other members of the group, and a random component. The prizes would be distributed according to the following process:

1. Participants in the experiment submit rank ordered lists of the available prizes, with their most preferred prize listed first and their least preferred prize listed last.

2. Participants are randomly assigned numbers from 1 to 24, with lower numbers indicating higher priority eligibility for the prizes.

3. The prizes are then distributed according to a specified algorithm, the details of which were provided to the participants.

A simple example with two prize types (one prize of each type) and three participants was used to illustrate the workings of the algorithm. Each experimental session allocated approximately 30 minutes to the instructions, working through this example to ensure that the participants understood the mechanism of prize distribution and the optimal strategies for various scenarios.

The example prizes were renamed (X and Y instead of A, B, and C), and the task focused on the optimal decisions of the three example participants, using neutral language and avoiding direct advice to the participants themselves to prevent experimenter demand effects. Nevertheless, the logic and intuitions gained from this simpler

[9]Yurko, Anna. 2024. "Examining the Effects of Outside Options on Matching Outcomes in the DA Mechanism: An Experimental Approach." AEA RCT Registry. October 07. `https://doi.org/10.1257/rct.14481-1.0`

context were emphasized as directly applicable to the one the participants would be part of.[10]

Following the instructions, the participants took a 20-minute test to assess their understanding of the mechanism and optimal choices in the different versions of the experiment. The test consisted of 4 questions, the first two focused on the unconstrained version of the model, while the last two incorporated constraints and the possibility of outside options.[11] The test was incentivized for ICEF students with bonus points in their total Microeconomics course grade and for the FES students with monetary payments of 100 rubles per correct answer for each question.

After the test, the experimental subjects participated in two versions of the experiment, completing one after the other. For each version, they received additional written instructions and were asked to submit 12 separate ROLs. They were informed that their winnings for each version would be randomly determined based on one of the 12 submitted lists.

Note that the experimental setup involved subjects participating in multiple rounds and versions of the experiment, but no feedback or learning occurred between them. Participants were required to submit multiple lists (12) to accommodate the mixed strategy equilibrium prediction in the constrained versions of the model. The models typically tested in this literature are predicted to have pure strategy equilibria, and participants generally submit single lists only, unless they receive feedback between sessions that could affect their decisions.

For the versions of the model with outside option, there was additional detail in the instructions. Participants with the outside option prize O were informed that they were almost guaranteed to receive it, with a 99 out of 100 chance. This was done to incentivize them to submit ROLs of maximum allowed length.

After the main experiment, the participants also completed a bomb risk elicitation task designed to assess their risk preferences. This additional activity was included because the level of risk aversion can affect the optimal strategies of the participants in the main experiment. The bomb risk elicitation task offered financial incentives, with an expected average payout of 250 rubles per participant.[12]

The experimental sessions lasted 80 minutes each, and the participants earned an average payout of just over 1000 rubles ($11). Participants were also provided snacks.

[10]Note that in the experimental literature on mechanism design in school choice, it is common to provide explicit advice to experimental subjects, unlike in typical experimental economics studies. The rationale is that coaching and advice are often integral to real-world centralized matching mechanisms, and applicants are informed that they should truthfully report their preferences for educational programs. This literature is reviewed in Hakimov and Kübler (2021). More recently, Gonczarowski et al. (2024) conducted an experimental study to assess participants' comprehension of the DA mechanism and its strategy-proofness property, which were communicated through various approaches. The approach to providing advice in the current paper is most similar to the study by Braun et al. (2014).

[11]The test used a similar framing to the example employed to teach the mechanism, but increased the number of prizes to three (still renamed to X, Y and Z) and the number of subjects vying for them to 4 and 8, in order to assess whether participants could extend the intuition gained from the simple example to more complex environments. Participants were not provided with the correct answers and scores upon completion of the test.

[12]This data is not utilized in the analysis presented in this paper, but will be used in future work.

4 Results

This section begins by outlining the key hypotheses under investigation. The next subsection 4.2 presents the results from testing hypotheses regarding the decisions and strategies chosen by participants during the experiment. Subsection 4.3 analyzes the properties of the resulting matchings.

4.1 Hypotheses

Section 4 contains the results of testing the following main hypotheses.

Unconstrained ROLs: The theoretical model predicts that the availability of the outside option for some participants does not affect the strategy-proofness and stability properties of the DA mechanism. Thus, the two hypotheses below will be tested.

Hypothesis 1: The fraction of rounds in which participants report their true preferences over prizes, listing all prizes, is 1 for all participants, and this does not depend on whether the participant or their competitors have access to the outside option prize, regardless of whether the outside option is integrated into the centralized system.

Hypothesis 2 follows straightforwardly from Hypothesis 1.

Hypothesis 2: Participants without access to the outside option prize should employ the same strategies across all unconstrained ROLs versions of the model, as they are expected to submit truthful ROLs of three prize types in each version. Similarly, participants with access to the outside option prize should not exhibit any differences in strategies across the unconstrained ROLs versions, as they should rank all the prizes available to them in the system truthfully and completely in every version.

Undermatching occurs when an applicant with a lower assigned number is allocated a worse prize than another applicant with a higher number. The resulting matchings are stable when there are no undermatched participants.

Hypothesis 3: The resulting matchings are stable.

Constrained ROLs: The theoretical model predicts that participants without access to the outside option may optimally employ mixed strategies, submitting partial ROLs that preserve the original ranking of prizes, such as $\{A, B\}$, $\{A, C\}$, and $\{B, C\}$, which are here referred to as partially true ROLs. The mixing probabilities are predicted to be influenced by the presence and proportion of participants with access to the outside option prize. Moreover, the resulting matches are not expected to be stable.

Hypothesis 4: The fraction of rounds in which participants submit partially true ROLs of the maximum allowed length is 1 for all participants, regardless of whether they or their competitors have access to the outside option, and regardless of whether the outside option is integrated into the centralized prize distribution system.

In experimental groups where the outside option is integrated into the centralized system, participants who have access to the outside option will truthfully list it in all their submitted ROLs.

The next set of hypotheses postulates expected differences in the mixing probabilities of various types of partial ROLs for participants without the outside option, with particular focus on the prevalence of ROLs listing the top prize type A.

Hypothesis 5.1: In versions II.5) and II.7) of the model, where one-third of participants have access to the outside option prize, participants without the outside option are expected to submit a lower proportion of ROLs that include the top prize type A, compared to participants in the baseline model without the outside option.

Recall that participants without access to the outside option are expected to recognize that the competition for the less attractive prize types B and C will be relatively lower, as those with the outside option will not be competing for them. Consequently, these participants should increase the proportion of ROLs that include prize types B and C, at the expense of ROLs that include the top prize type A.

This holds true as long as the share of participants with the outside option is not too large, as in version II.6) of the model. When two-thirds of the participants have access to the outside option, the optimal strategy of the other participants depends on their attitudes toward risk, making the prediction less straightforward.

For risk-neutral participants without access to the outside option, submitting the list $\{A, B\}$ is the dominant strategy. By doing so, they have the opportunity to win the top prize A, while also being highly likely to receive the prize type B due to the reduced competition for that option. In contrast, risk-averse participants may choose to entirely avoid competing for the top prize A and instead submit a list with only the less desirable prize types B and C.

Thus, in version II.6) of the model, it is less straightforward to predict whether participants without access to the outside option would submit a larger, smaller, or the same fraction of ROLs including the top prize type A compared to the baseline version. The optimal strategy for these participants would depend on their attitudes toward risk.

Hypothesis 5.2: Integrating the outside option prize into the centralized system does not affect the mixing probabilities of various types of partial ROLs for participants without the outside option. That is, there are no expected differences in the share of ROLs that include the top prize type A for the participants without access to the outside option in versions II.5) and II.7) of the model.

This is due to the assumption of a frictionless aftermarket when the outside option prize is not integrated into the system.

Are participants with access to the outside option more likely to list the top prize A as first priority on their ROLs, exhibiting a more "ambitious" prize application strategy?

Hypothesis 6: Participants with access to the outside option are more likely to list the top prize A as first priority on their ROLs compared to participants without access to the outside option.

In version II.6) of the model, where two-thirds of participants have access to the outside option, participants without the outside option who are risk neutral may be just as likely to list the top prize type A as their first priority as those with the outside option.

Hypothesis 7: The percentage of stable matchings is less than 100%. Unlike the participants without the outside option, those with the outside option are never undermatched.

4.2 Decisions of participants

4.2.1 Truth-telling

First, consider hypotheses 1 and 4.

To test truthful preference revelation by the experimental participants, I examine their submitted ROLs. In all unconstrained versions of the experiment, participants are considered to be truth-telling if they submit ROLs of $\{A, B, C\}$, regardless of whether they have access to the outside option prize O. The exception is for participants with access to prize O in version I.2) of the model, where the integrated outside option requires truth-telling ROLs of $\{A, O, B, C\}$.

In the constrained versions II.5) and II.6) of the experiment where the outside option is integrated into the system, participants with access to the outside option prize O are truthful if they submit ROLs $\{A, O\}$. For all other participants and in all other constrained versions of the experiment, truthful preference revelation is defined as the submission of lists containing only two prizes, ranked from highest to lowest, such as $\{A, B\}$, $\{A, C\}$, or $\{B, C\}$.

Table 1 shows the proportions of participants who truthfully reported their preferences in all 12 of their submitted ROLs for each version of the model. The table also includes the number of participants for each version of the model.[13] Participants who submitted truthful ROLs in all 12 rounds are referred to as consistent truth-tellers.

The hypotheses 1 and 4 of all participants in all versions being consistent truth-tellers are rejected. Surprisingly, the lowest proportion of such participants is observed for the simplest case of unconstrained ROLs baseline.[14]

Table 2 shows, for each version, the average share of ROLs submitted by participants that preserve the original ranking of prizes from highest to lowest, out of the 12 lists each participant submitted. While this measure of truth-telling makes participants in all versions appear more truthful, the overall patterns and differences across versions and participant types are similar.

[13]Note that each experimental subject participated in the testing of two versions of the model. There was no feedback between the versions, thus, the observations for both versions are pooled to increase the number of observations.

[14]1) It is possible that the participating students may have doubted the simplicity of the task, believing that the optimal strategy could not be so straightforward. 2) Tables A.2 and A.3 in the Appendix compare the truth-telling rates across different versions of the model in Part 2 of each table. These tables show that the truth-telling rates are significantly lower in the unconstrained ROLs baseline compared to the constrained ROLs baseline.

Table 1 – Proportion of consistent truth-tellers: participants with all 12 ROLs preserving original ranking (partial in constrained cases)

Vers. numb.	Version	Number of partic.	Prop. all true	St. err.	95% conf. interval lower bnd	upper bnd
	I. Unconstrained					
1)	**Baseline**	52	0.308	0.064	0.154	0.423
2)	**Outside option integrated, 1/3 with outside option**					
	Have outside option	17	0.529	0.120	0.235	0.706
	Do not have outside option	88	0.443	0.053	0.307	0.534
3)	**Outside option non-integrated, 1/3 with outside option**					
	Have outside option	17	0.589	0.120	0.294	0.765
	Do not have outside option	88	0.352	0.051	0.227	0.432
	II. Constrained					
4)	**Baseline**	73	0.452	0.058	0.301	0.548
5)	**Outside option integrated, 1/3 with outside option**					
	Have outside option	23	0.435	0.103	0.174	0.609
	Do not have outside option	70	0.472	0.060	0.314	0.571
6)	**Outside option integrated, 2/3 with outside option**					
	Have outside option	23	0.348	0.099	0.130	0.522
	Do not have outside option	66	0.500	0.061	0.348	0.606
7)	**Outside option non-integrated, 1/3 with outside option**					
	Have outside option	18	0.722	0.105	0.444	0.889
	Do not have outside option	65	0.446	0.061	0.292	0.554
	TOTAL	600				

Note: The standard errors and confidence intervals are bootstrapped with a sample size of 10,000.

Does the availability of an outside option for some participants make participants without access to the outside option more or less truthful in their preference reporting? Table A.1 in the Appendix compares the truth-telling rates of participants in the control and treatment groups.

Note that throughout the paper, all comparisons are adjusted to ensure that observations from the same participant are not compared. If a participant participated in both versions being compared or in the same version but as different types, only their observations from the first version or type are included.[15]

[15]This adjustment does not affect the direction of the differences, though in some instances it lowers the statistical significance.

Table 2 – Average share of truthful ROLs submitted by participants (out of 12): average number of ROLs preserving original ranking (partial in constrained cases) divided by 12

Vers. numb.	Version	Avg. share of true ROLs (out of 12)	St. err.	95% conf. interval lower bnd	95% conf. interval upper bnd
	I. Unconstrained				
1)	**Baseline**	0.526	0.053	0.388	0.614
2)	**Outside option integrated, 1/3 with outside option**				
	Have outside option	0.765	0.087	0.525	0.902
	Do not have outside option	0.649	0.038	0.552	0.710
3)	**Outside option non-integrated, 1/3 with outside option**				
	Have outside option	0.706	0.092	0.456	0.853
	Do not have outside option	0.584	0.040	0.483	0.650
	II. Constrained				
4)	**Baseline**	0.748	0.032	0.663	0.799
5)	**Outside option integrated, 1/3 with outside option**				
	Have outside option	0.627	0.086	0.402	0.768
	Do not have outside option	0.798	0.029	0.719	0.845
6)	**Outside option integrated, 2/3 with outside option**				
	Have outside option	0.522	0.082	0.312	0.656
	Do not have outside option	0.802	0.030	0.721	0.851
7)	**Outside option non-integrated, 1/3 with outside option**				
	Have outside option	0.884	0.048	0.745	0.958
	Do not have outside option	0.760	0.032	0.674	0.812

Note: The standard errors and confidence intervals are bootstrapped with a sample size of 10,000.

Although in nearly all treatments, participants without the outside option exhibit slightly higher truth-telling rates using either of the two measures relative to the benchmark model with no outside option, the differences are small and not statistically significant. One possible exception is the difference in the average share of truthful ROLs for the version I.2) of the model with the integrated outside option, which is marginally significant at the 10% level.

A closer examination using individual-level data and a linear probability model with an indicator of whether a participant is a consistent truth-teller as the dependent variable suggests that sampling may be an issue. Specifically, when controlling for the test score obtained during the experiment, the difference becomes statistically significant at the 5% level. This indicates that participants without access to the outside option in version I.2) of the model were significantly more likely to report their preferences truthfully in all submitted ROLs, compared to participants in the benchmark model with no outside option.[16]

[16]Results are available upon request. The other reported findings were also investigated for ro-

Thus, the mechanism's strategy-proofness or lack thereof does not appear to be influenced by the availability of outside options, but only when the outside options are not integrated into the system.

Are participants with access to the outside option more or less truthful than participants without the outside option? Although the model predicts no difference in truth-telling behavior by participant type in all versions of the model, the data reveal different patterns.

Tables A.2 and A.3 in the Appendix provide the results of comparisons of truth-telling rates across different participant types within the same version (Part 1 of each table) and across different versions of the model (Part 2).

When the length of ROLs is constrained and the outside option is not integrated into the centralized system (version II.7 of the model), participants with access to the outside option show higher rates of truthful preference reporting. Specifically, the participants with access to the outside option have a 27.5% higher proportion of consistent truth-tellers (significant at 5% level) and a 12% higher average share of truthful ROLs (significant under 10%).

The higher rates of truth-telling observed among participants with access to an outside option are consistent with the empirical survey evidence reported by Chrisander and Bjerre-Nielsen (2023).

Surprisingly, integrating the outside option into the centralized system in the constrained ROLs case significantly reduces truth-telling by participants with the outside option, making them less truthful than participants without the outside option. Comparing version II.5) of the model, where the outside option is integrated into the centralized system, to version II.7) with the non-integrated outside option, reveals a significant decline in truthful preference reporting by participants with access to the outside option. The proportion of consistent truth-tellers is 28.7% lower, and the average share of truthful ROLs submitted by these participants is 25.7% lower. Both of these differences are statistically significant at 10% and 1% respectively. Consequently, with the integration, the average share of truthful ROLs for participants with the outside option is 14% lower compared to those without the outside option.

Note that this comparison is based on a small sample size of participants with the outside option, comprising 23 in version II.5) of the model and 18 in version II.7) of the model. To strengthen the analysis, the sample size should be increased with further tests.

However, the decisions of another 23 participants with access to the outside option in version II.6) of the model tell a consistent story. As the share of participants with access to the outside option increases from one-third in version II.5) to two-thirds in version II.6), the perception of increased competition for the top prize A makes these participants even less truthful. This further reduces the proportion of consistent truth-tellers by 8.7% and the average share of truthful ROLs by 10.5%.

This reduction in truth-telling rates for participants with access to the outside option may be attributable to what Chen and Sönmez (2006) termed the "district

bustness to inclusion of this control variable and found to be unaffected.

school bias," wherein these participants prioritize the safety option, which in this case is the outside option prize O.

In version II.5) of the model, participants with access to the outside option prize O who submitted non-truthful lists ranked the outside option O as their first priority in 73% of these non-truthful lists. As the proportion of participants with access to the outside option increased from one-third in version II.5) to two-thirds in version II.6), the truth-telling rates declined further, with the average share of truthful ROLs for participants with the outside option being 29% lower compared to those without the outside option, a difference significant at the 1% level. For these participants, the share of non-truthful ROLs prioritizing the outside option O as the first choice is 83%.

Does integrating the outside option into the centralized system affect truth-telling? In the constrained versions of the model, participants with access to the outside option exhibit a significant reduction in truthful preference reporting when the outside option is integrated into the centralized system, as described above.

Additionally, integrating the outside option increases the truth-telling rates of participants without access to the outside option, but only when the length of ROLs is not constrained: the proportion of consistent truth-tellers, but not the average share of truthful ROLs, is higher when the outside option is integrated into the centralized system.

This result is related to the previous finding that the availability of the outside option increases the truth-telling rates of participants without access to the outside option, compared to the benchmark case where no outside options are available, but only when the outside option is integrated into the system.

In summary, despite receiving detailed instructions on the prize distribution mechanism and being taught via simple example that truthfully listing prizes from highest to lowest is the optimal strategy, a considerable proportion of participants nonetheless reverse the ordering of prizes in their submitted lists. Consequently, truth-telling rates are significantly and substantially lower than one across all versions of the model and for all participant types.

When the length of ROLs is constrained and the outside option prize is not integrated into the system, participants with access to the outside option exhibit significantly higher rates of truthful preference reporting compared to participants without the outside option. However, when the length of ROLs is constrained and the outside option prize is integrated into the system, the truth-telling rates of participants with the outside option become significantly lower, as many of them prioritize listing their safety option prize O as their top choice.

When the length of ROLs is not constrained, the decisions of participants with access to the outside option do not seem to be affected by the integration of the outside option into the system, although the small sample size makes it difficult to draw a confident conclusion. Participants without the outside option are more likely to report their preferences truthfully when the outside option is integrated.

4.2.2 Constrained ROLs: strategies of participants without the outside option

In this subsection, I test hypotheses 5.1 and 5.2, which focus on the expected differences in the mixing probabilities of various types of partial ROLs for participants without the outside option in the constrained versions of the model. The main focus is on the prevalence of ROLs listing the top prize type A. A reduction in the average number of ROLs that include prize type A compared to the baseline version of the model without the outside option would indicate an increased use of the "skipping the impossible" strategy, where participants submit lists that include only prize types B and C.[17]

The results of the hypotheses tests are presented in Table 3.

Hypothesis 5.1 states that in versions II.5) and II.7) of the model, where one-third of participants have access to the outside option, participants without access to the outside option are expected to submit a lower proportion of ROLs that include the top prize type A, compared to participants in the baseline model without the outside option.

As shown in Table 3, the average share of ROLs that include the top prize type A, out of the 12 ROLs submitted by each participant, is lower in versions II.5) and II.7) of the model compared to the baseline. However, these differences are small and not statistically significant.

Recall that in version II.6) of the model, where two-thirds of participants have access to the outside option, the prediction regarding the fraction of ROLs including the top prize type A submitted by participants without the outside option is less clear-cut. The optimal strategy for these participants depends on their risk preferences.

As shown in Table 3, the difference in the average share of ROLs that include the top prize type A between the baseline model and version II.6) of the model is negative, small and not statistically significant.

Hypothesis 5.2 states that there should be no differences in the average fraction of ROLs including the top prize type A for participants without access to the outside option in versions II.5) and II.7) of the model. With a frictionless aftermarket, the integration of the outside option prize into the system should not affect the decisions of participants without access to the outside option prize. This hypothesis is not rejected.

In summary, while Hypothesis 5.2 cannot be rejected, the evidence does not support Hypothesis 5.1 regarding a greater prevalence of the "skipping the impossible" strategy among participants without access to the outside option when some other participants in the centralized system have access to the outside option. It appears that in all constrained versions of the model, participants without access to the outside option submit similar shares of ROLs including the top prize type A.

[17]Note that the focus is on whether prize type A is included on the ROL, not its order of priority. The key is whether the ROL only includes the lower prize types B and C, indicating the use of the "skipping the impossible" strategy.

Table 3 – Participants without outside option in constrained ROLs versions of the model: Average share of ROLs with prize type A (out of 12)

Vers. numb.	Particip. type	Numb. of obs.	Avg. share of ROLs with A (out of 12)	Diff.	Diff.: St. err.	Diff.: 95% conf. int. lower bnd	upper bnd
Baseline (4) versus Integrated outside option, 1/3 (5)							
4)	All	73	0.801	0.020	0.046	-0.068	0.112
5)	Without out. opt.	70	0.781				
Baseline (4) versus Non-integrated outside option, 1/3 (7)							
4)	All	73	0.801	0.037	0.044	-0.049	0.125
7)	Without out. opt.	65	0.764				
Baseline (4) versus Integrated outside option, 2/3 (6)							
4)	All	58	0.799	-0.065	0.045	-0.152	0.026
6)	Without out. opt.	49	0.864				
Integrated outside option, 1/3 (5) versus Non-integrated outside option, 1/3 (7)							
5)	Without out. opt.	46	0.817	0.015	0.051	-0.086	0.114
7)	Without out. opt.	42	0.802				

Note: 1) Comparisons are adjusted to ensure that observations from the same participant are not compared. If a participant was involved in both versions being compared or in the same version but as different types, only their observations from the first version or type are included. 2) The standard errors and confidence intervals are bootstrapped with a sample size of 10,000.

4.2.3 Prize A in ROLs of participants with and without outside option

In this subsection, I test Hypothesis 6, which states that in the constrained ROLs versions of the model, participants with access to the outside option are more likely to list the top prize type A as first priority on their ROLs compared to participants without access to the outside option, with a possible exception for version II.6) of the model.

I also test Hypothesis 2 for the unconstrained ROLs versions of the model, according to which there should be no difference in the proportion of ROLs listing the top prize type A as the first priority for the participants with and without the outside option, as they all should truthfully list A as first priority on all their ROLs.

For each version of the model with an outside option, Table 4 presents comparisons of the shares of ROLs out of 12 submitted by participants, with the top prize type A listed as first priority. These comparisons are between the submissions of participants with access to the outside option and the submissions of participants without such access.

In all versions of the model except II.6), the average share of ROLs with the top prize type A listed as first priority is higher for the participants with the outside option. However, this difference is large and strongly statistically significant only in version II.7) of the model with the non-integrated outside option and constrained ROLs length.

Table 4 – Participants with and without outside option: Average share of ROLs with prize type A as first priority (out of 12)

Particip. type	Numb. of obs.	Avg. share of ROLs with A as 1st pr. (out of 12)	Diff.	Diff.: St. err.	Diff.: 95% conf. int. lower bnd	upper bnd
I.2) Unconstrained ROLs: integrated						
With out. opt.	17	0.794	0.099	0.084	-0.075	0.253
Without out. opt.	71	0.695				
I.3) Unconstrained ROLs: non-integrated						
With out. opt.	17	0.735	0.039	0.090	-0.143	0.208
Without out. opt.	71	0.696				
II.5) Constrained ROLs: integrated, 1/3 with outside option						
With out. opt.	23	0.645	0.099	0.099	-0.098	0.289
Without out. opt.	47	0.546				
II. 6) Constrained ROLs: integrated, 2/3 with outside option						
With out. opt.	23	0.540	-0.090	0.095	-0.275	0.096
Without out. opt.	43	0.630				
II. 7) Constrained ROLs: non-integrated, 1/3 with outside option						
With out. opt.	18	0.884	**0.294**	0.071	0.150	0.429
Without out. opt.	47	0.590				

Note: 1) Comparisons are adjusted to ensure that observations from the same participant are not compared. If a participant was involved in both versions being compared or in the same version but as different types, only their observations from the first version or type are included. 2) The standard errors and confidence intervals are bootstrapped with a sample size of 10,000.

Thus, Hypothesis 2 is not rejected by this comparison, while Hypothesis 6 finds support only in the non-integrated outside option version of the model. The reason it is rejected for the constrained ROL length version of the model with the integrated outside option is that many participants with the outside option are subject to the "district school bias" and list the almost-guaranteed prize O as their first priority.

In summary, while the participants received detailed instructions on the prize distribution mechanism and were taught via simple example that truthfully listing prizes from highest to lowest is the optimal strategy, and that the presence of the outside option for some participants affects competition for the remaining prizes for the other participants, these aspects of optimal choices do not appear to be intuitive and are not manifested in the choices of many participants.

The only choice that is intuitive and aligns with the predictions of the model is that of the participants with access to the outside option in the constrained ROLs version of the model, when the outside option prize is not integrated into the system. The majority of these participants recognize that listing the top prize type A as their first priority is optimal for them, resulting in a large and significant difference in the rates of competition for the top prize type between the participants with and without access to the outside option prize.

4.3 Matchings

This subsection examines Hypotheses 3 and 7, which concern the stability of the resulting matchings and the undermatching of applicants in the versions of the model with unconstrained and constrained ROLs, respectively.

The Appendix includes Table A.4, which presents a comparison of the model's predictions and the experimental results for the main matching outcomes for all versions of the model. The results for both the model and the data were obtained by averaging 1000 simulations, using the predicted and the submitted ROLs, respectively.

Hypothesis 3 is rejected, as the share of stable matchings in the versions of the model with unconstrained ROL length is less than 1.

For the versions of the model with constrained ROLs, Hypothesis 7 states that the percentage of stable matchings is less than 100%. Participants with the outside option are never undermatched, unlike those without the outside option.

The results in Table A.4 for the constrained versions of the model show that between 1.6% and 24% of the matchings are predicted to be not stable. This statistic for the realized matchings is between 21.1% and 31%.

The largest difference between the predicted 1.6% and the experimental 21.1% is for the II.6) version of the model with the outside option integrated into the centralized system and available to two-thirds of the participants. It is large and strongly significant.

This difference is due to the sub-optimal decisions of many participants with access to the outside option, as the average share of their ROLs with the top prize type A listed as the first priority is only slightly above 50% instead of the predicted 100%. Consequently, nearly 21% of these participants were undermatched. This rate is similar to the undermatching experienced by participants without the outside option, as they too were much less likely than the model predicted to list prize type A as their top priority.

In version II.5) of the model with the integrated outside option available to one-third of participants, similar suboptimal behavior by participants with access to the outside option results in undermatching rates of 18.7% for these participants, instead of the predicted 0%.

The smallest difference between model predictions and experimental matching outcomes is observed for the constrained ROLs version II.7) of the model with the integrated outside option available to one-third of the participants. As predicted, these matchings are less favorable for participants without the outside option, who are less likely to receive the top prize type A and are more likely to be undermatched compared to participants with the outside option (37.4% versus 3.9%).

Recall that these findings assume a frictionless aftermarket. However, if there were additional costs associated with relocating the prizes vacated by participants with access to the outside option, the outcomes for participants without such access would likely be worse.

The theoretical predictions for the constrained ROLs versions of the model suggest that integrating the outside option into the system should not affect the matching outcomes when the aftermarket is frictionless. However, the experimental evidence contradicts this, revealing a reduced percentage of stable matchings, increased undermatching for participants with the outside option, and more egalitarian outcomes overall when the outside option is integrated into the centralized system.

5 Conclusion

Many countries have centralized university admission systems that employ versions of the deferred acceptance mechanism to assign applicants to educational programs. Concurrently, there exist opportunities that are either separate from the centralized admissions system and are not allocated through it, or are integrated into the system but accessible only to certain applicants due to external factors such as family income.

This study investigates how the availability of these options, referred to as outside options throughout the study, for some applicants affects the decision-making of all participants in a centralized admission system that employs the DA mechanism. Two scenarios are considered: 1) when the length of ROLs is unconstrained, and 2) when the length of ROLs is constrained. For each of these cases, the analysis examines whether integrating the outside option into the centralized admissions system influences the decisions of applicants, as well as the characteristics of the resulting matchings.

The main findings can be summarized as follows. First, when the ROL length is not constrained and the outside option is not integrated into the centralized system, the availability of the outside option for some applicants does not significantly distort the decisions and matching outcomes of the participants.

Second, when the length of ROLs is constrained and the outside option is not integrated into the admission system, participants without access to the outside option adopt a more cautious strategy compared to participants with such access and are less inclined to truthfully list their top-ranked choice. Consequently, they are less likely to be allocated their first choice and are more likely to be undermatched.

This finding suggests that if the preferred option is a tuition-free place in an educational program, while the outside option is a full-tuition place in the same or a similar program, applicants with higher incomes who can afford the tuition fees are more likely to be assigned to the tuition-free places compared to equally qualified applicants who lack the financial resources. This undesirable outcome occurs if the tuition-covering scholarship is merit-based, making admissions for the tuition-free places more competitive.

The first two results align with theoretical predictions, while the next one does not.

Third, contrary to the model's predictions, integrating outside options into the system significantly alters the strategies of participants and the resulting matching outcomes, even if the aftermarket is frictionless. When ROLs are unconstrained, this is due to the somewhat higher truthtelling rates of participants without the outside option. However, when ROLs are constrained in length, it is because many participants with access to the outside option make sub-optimal decisions, prioritizing the safer outside option due to a bias similar to the "district school bias".

When the ROLs are constrained in length, the integration of outside options into the centralized system leads to matchings that are less stable and more egalitarian. Specifically, participants with and without outside options have more comparable undermatching rates and probabilities of receiving their top choice.

The primary conclusion of this study is that the availability of outside options for some applicants affects the decisions of all participants and the resulting matching outcomes in the DA mechanism. The recommendation to integrate the outside options as much as possible into the centralized system should be carefully considered, particularly when the ROLs are constrained in length, as it may come at the cost of lower stability and higher undermatching rates for the participants with access to the outside options, but may also have equalizing effects, reducing the disparities between the matching outcomes of participants with and without such options.

A more straightforward policy recommendation to improve matching outcomes is to remove the restriction on the length of ROLs. When outside options are available to some applicants, even if they are not integrated into the system, eliminating the constraint on the ROL length leads to higher stability and lower undermatching rates for applicants without outside options compared to when the ROL length is constrained.

This paper makes a first step in exploring the effect of outside options on applicants' decision-making and matching outcomes in the DA mechanism. Some experimental treatments have small sample sizes that should be increased. Additionally, participants' decisions should be examined more thoroughly at the micro-level by incorporating controls for their characteristics, such as ability measures, socioeconomic status, and scores from the test assessing their understanding of the mechanism and its properties. These areas are left for future work.

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A Appendix: additional figures and tables

Table A.1 – Truth-telling rates in control versus treatment groups: participants without outside options

PART 1: Proportion of consistent truth-tellers

Vers. numb.	Particip. type	Numb. of obs.	Prop. all true	Diff.	Diff.: St. err.	Diff.: 95% conf. int. lower bnd	upper bnd
			I. Unconstrained ROLs				
Baseline (1) versus Integrated outside option, 1/3 (2)							
1)	All	52	0.308	-0.135	0.083	-0.296	0.029
2)	Without out. opt.	88	0.443				
Baseline (1) versus Non - integrated outside option, 1/3 (3)							
1)	All	52	0.308	-0.045	0.082	-0.205	0.116
3)	Without out. opt.	88	0.352				
			II. Constrained ROLs				
Baseline (4) versus Integrated outside option, 1/3 (5)							
4)	All	73	0.452	-0.019	0.084	-0.186	0.147
5)	Without out. opt.	70	0.471				
Baseline (4) versus Integrated outside option, 2/3 (6)							
4)	All	58	0.466	-0.065	0.097	-0.253	0.123
6)	Without out. opt.	49	0.531				
Baseline (4) versus Non - integrated outside option, 1/3 (7)							
4)	All	73	0.452	0.006	0.085	-0.158	0.172
7)	Without out. opt.	65	0.446				

PART 2: Average share of truthful ROLs submitted by participants (out of 12)

Vers. numb.	Particip. type	Numb. of obs.	Avg. share of true ROLs (out of 12)	Diff.	Diff.: St. err.	Diff.: 95% conf. int. lower bnd	upper bnd
			I. Unconstrained ROLs				
Baseline (1) versus Integrated outside option, 1/3 (2)							
1)	All	52	0.526	-0.123	0.065	-0.250	0.005
2)	Without out. opt.	88	0.649				
Baseline (1) versus Non - integrated outside option, 1/3 (3)							
1)	All	52	0.526	-0.059	0.066	-0.188	0.071
3)	Without out. opt.	88	0.584				
			II. Constrained ROLs				
Baseline (4) versus Integrated outside option, 1/3 (5)							
4)	All	73	0.748	-0.050	0.043	-0.135	0.035
5)	Without out. opt.	70	0.798				
Baseline (4) versus Integrated outside option, 2/3 (6)							
4)	All	58	0.744	-0.069	0.051	-0.168	0.030
6)	Without out. opt.	49	0.813				
Baseline (4) versus Non - integrated outside option, 1/3 (7)							
4)	All	73	0.748	-0.013	0.045	-0.101	0.076
7)	Without out. opt.	65	0.760				

Note: 1) Comparisons are adjusted to ensure that observations from the same participant are not compared. If a participant was involved in both versions being compared or in the same version but as different types, only their observations from the first version or type are included. 2) The standard errors and confidence intervals are bootstrapped with a sample size of 10,000.

Table A.2 – Comparisons of the proportions of consistent truth-tellers: participants with all 12 ROLs preserving original ranking (partial in constrained cases)

Vers. numb.	**Particip. type**	**Numb. of obs.**	**Prop. all true**	**Diff.**	**Diff.: st. err.**	**Diff.: 95% conf. int. lower bnd**	**upper bnd**
PART 1: Participants with versus those without outside option prize O							
	Unconstrained ROLs: integrated						
2)	With out. opt.	17	0.529	0.135	0.134	-0.128	0.396
2)	Without out. opt.	71	0.394				
	Unconstrained ROLs: non-integrated						
3)	With out. opt.	17	0.588	0.208	0.132	-0.056	0.460
3)	Without out. opt.	71	0.380				
	Constrained ROLs: integrated, 1/3 with outside option						
5)	With out. opt.	23	0.435	-0.012	0.126	-0.251	0.228
5)	Without out. opt.	47	0.447				
	Constrained ROLs: integrated, 2/3 with outside option						
6)	With out. opt.	23	0.348	-0.164	0.125	-0.407	0.083
6)	Without out. opt.	43	0.512				
	Constrained ROLs: non-integrated, 1/3 with outside option						
7)	With out. opt.	18	0.722	0.275	0.128	0.015	0.519
7)	Without out. opt.	47	0.447				
PART 2: Across versions							
	Baseline models: unconstrained vs. constrained ROLs						
1)	All	52	0.308	-0.224	0.109	-0.433	-0.007
4)	All	32	0.531				
	Unconstrained ROLs: integrated vs. non-integrated						
2)	With out. opt.	17	0.529	-0.059	0.170	-0.412	0.294
3)	With out. opt.	17	0.588				
2)	Without out. opt.	51	0.510	0.232	0.093	0.046	0.407
3)	Without out. opt.	54	0.278				
	Constrained ROLs: integrated vs. non-integrated						
5)	With out. opt.	23	0.435	-0.287	0.148	-0.572	0.010
7)	With out. opt.	18	0.722				
5)	Without out. opt.	46	0.413	-0.087	0.106	-0.293	0.119
7)	Without out. opt.	42	0.500				
	Constrained ROLs: integrated, 1/3 vs. 2/3 with outside option						
5)	With out. opt.	23	0.435	0.087	0.143	-0.174	0.348
6)	With out. opt.	23	0.348				
5)	Without out. opt.	70	0.471	-0.029	0.086	-0.194	0.137
6)	Without out. opt.	66	0.500				

Note: 1) Comparisons are adjusted to ensure that observations from the same participant are not compared. If a participant was involved in both versions being compared or in the same version but as different types, only their observations from the first version or type are included. 2) The standard errors and confidence intervals are bootstrapped with a sample size of 10,000.

Table A.3 – Comparisons of the average share of true ROLs submitted by participants: average number of ROLs preserving original ranking (partial in constrained cases) divided by 12

Vers. numb.	Particip. type	Numb. of obs.	Avg. share of true ROLs (out of 12)	Diff.	Diff.: st. err.	Diff.: 95% conf. int. lower bnd	upper bnd
PART 1: Participants with versus those without outside option prize O							
			Unconstrained ROLs: integrated				
2)	With out. opt.	17	0.765	0.136	0.096	-0.062	0.311
2)	Without out. opt.	71	0.629				
			Unconstrained ROLs: non-integrated				
3)	With out. opt.	17	0.706	0.067	0.100	-0.134	0.256
3)	Without out. opt.	71	0.638				
			Constrained ROLs: integrated, 1/3 with outside option				
5)	With out. opt.	23	0.627	-0.143	0.094	-0.330	0.038
5)	Without out. opt.	47	0.770				
			Constrained ROLs: integrated, 2/3 with outside option				
6)	With out. opt.	23	0.522	-0.292	0.091	-0.469	-0.114
6)	Without out. opt.	43	0.814				
			Constrained ROLs: non-integrated, 1/3 with outside option				
7)	With out. opt.	18	0.884	0.120	0.062	-0.004	0.238
7)	Without out. opt.	47	0.764				
PART 2: Across versions							
			Baseline models: unconstrained vs. constrained ROLs				
1)	All	52	0.526	-0.287	0.066	-0.415	-0.155
4)	All	32	0.813				
			Unconstrained ROLs: integrated vs. non-integrated				
2)	With out. opt.	17	0.765	0.059	0.126	-0.191	0.304
3)	With out. opt.	17	0.706				
2)	Without out. opt.	51	0.642	0.099	0.074	-0.046	0.244
3)	Without out. opt.	54	0.543				
			Constrained ROLs: integrated vs. non-integrated				
5)	With out. opt.	23	0.627	-0.257	0.099	-0.452	-0.066
7)	With out. opt.	18	0.884				
5)	Without out. opt.	46	0.759	-0.025	0.056	-0.134	0.086
7)	Without out. opt.	42	0.784				
			Constrained ROLs: integrated, 1/3 vs. 2/3 with outside option				
5)	With out. opt.	23	0.627	0.105	0.119	-0.130	0.333
6)	With out. opt.	23	0.522				
5)	Without out. opt.	70	0.798	-0.004	0.042	-0.086	0.079
6)	Without out. opt.	66	0.802				

Note: 1) Comparisons are adjusted to ensure that observations from the same participant are not compared. If a participant was involved in both versions being compared or in the same version but as different types, only their observations from the first version or type are included. 2) The standard errors and confidence intervals are bootstrapped with a sample size of 10,000.

Table A.4 – Properties of the resulting matchings: model versus data (obtained via 1,000 simulations)

Outcome	**Predicted**	**Data**	**Diff.**	**Diff.: St. err.**	**Diff.: 95% conf. int. lower bnd**	**upper bnd**
			I. Unconstrained ROLs			
1) Baseline:						
Stable matchings, share	1	0.831	**0.169**	0.077	0.042	0.333
All: share undermatched	0	0.169	**-0.169**	0.077	-0.333	-0.042
All: prob. of winning A	0.25	0.25	0	0	0	0
All: expected winnings	300	300	0	0	0	0
2) Unconstrained ROLs, integrated:						
Stable matchings, share	1	0.858	**0.142**	0.072	0	0.292
With out. opt.: share undermatched	0	0.118	-0.118	0.104	-0.375	0
Without out. opt.: share undermatched	0	0.154	-0.154	0.093	-0.375	0
With out. opt.: prob. of winning A	0.25	0.27	-0.019	0.182	-0.375	0.375
Without out. opt.: prob. of winning A	0.25	0.24	0.010	0.091	-0.188	0.188
With out. opt.: expected winnings	525.0	510.5	14.5	28.5	-37.5	75
Without out. opt.: expected winnings	370.3	355.9	14.4	49.0	-75	112.5
3) Unconstrained ROLs, non - integrated:						
Stable matchings, share	1	0.850	**0.150**	0.076	0	0.333
With out. opt.: share undermatched	0	0.090	-0.090	0.099	-0.250	0
Without out. opt.: share undermatched	0	0.180	-0.180	0.098	-0.375	0
With out. opt.: prob. of winning A	0.25	0.27	-0.025	0.181	-0.375	0.375
Without out. opt.: prob. of winning A	0.25	0.24	0.012	0.090	-0.188	0.188
With out. opt.: expected winnings	525.0	527.5	-2.5	18.1	-37.5	37.5
Without out. opt.: expected winnings	370.3	364.0	6.3	46.7	-87.5	100
			II. Constrained ROLs			
4) Baseline:						
Stable matchings, share	0.760	0.690	0.071	0.105	-0.125	0.292
All: share undermatched	0.240	0.310	-0.071	0.105	-0.292	0.125
All: prob. of winning A	0.25	0.25	0	0	0	0
All: expected winnings	297.0	295.3	1.7	10.1	-16.7	25
5) Constrained ROLs, integrated, 1/3 with outside option:						
Stable matchings, share	0.795	0.699	0.096	0.112	-0.125	0.333
With out. opt.: share undermatched	0	0.187	-0.187	0.132	-0.500	0
Without out. opt.: share undermatched	0.308	0.358	-0.050	0.153	-0.375	0.250
With out. opt.: prob. of winning A	0.34	0.26	0.087	0.183	-0.250	0.375
Without out. opt.: prob. of winning A	0.20	0.25	-0.043	0.092	-0.188	0.125
With out. opt.: expected winnings	534.4	506.6	27.8	29.9	-25	87.5
Without out. opt.: expected winnings	330.6	334.5	-3.9	51.6	-100	100
6) Constrained ROLs, integrated, 2/3 with outside option:						
Stable matchings, share	0.984	0.789	**0.195**	0.087	0.042	0.375
With out. opt.: share undermatched	0	0.208	**-0.208**	0.097	-0.375	-0.063
Without out. opt.: share undermatched	0.048	0.218	-0.170	0.160	-0.500	0.125
With out. opt.: prob. of winning A	0.25	0.23	0.017	0.091	-0.188	0.188
Without out. opt.: prob. of winning A	0.25	0.28	-0.033	0.182	-0.375	0.375
With out. opt.: expected winnings	525.1	513.1	12.0	14.0	-12.5	43.8
Without out. opt.: expected winnings	430.3	418.4	11.9	72.6	-150	150
7) Constrained ROLs, non - integrated, 1/3 with outside option:						
Stable matchings, share	0.795	0.738	0.057	0.106	-0.167	0.250
With out. opt.: share undermatched	0	0.039	-0.039	0.067	-0.250	0
Without out. opt.: share undermatched	0.308	0.374	-0.066	0.154	-0.375	0.250
With out. opt.: prob. of winning A	0.34	0.33	0.016	0.189	-0.375	0.375
Without out. opt.: prob. of winning A	0.20	0.21	-0.008	0.095	-0.188	0.188
With out. opt.: expected winnings	534.4	532.8	1.6	18.9	-37.5	37.5
Without out. opt.: expected winnings	330.8	325.0	5.8	52.9	-100.0	112.5

Юрко, А.*

Стратегии абитуриентов в централизованной системе приема в вузы при наличии внешних опций: экспериментальный подход [Электронный ресурс]: препринт WP9/2024/01/ А. Юрко; Нац. исслед. ун-т «Высшая школа экономики». – Электрон. текст. дан. (383 Кб). – М.: Изд. дом Высшей школы экономики, 2024. – (Серия WP9 «Исследования по экономике и финансам»). – 32 с. (На англ. яз.)

В странах с частично или полностью централизованной системой приема в вузы многие абитуриенты имеют доступ к внешним опциям. К таким внешним опциям относятся обучение на платной основе в государственных или в частных вузах, а также образование за рубежом.

Целью данного исследования является анализ влияния наличия внешних опций у части абитуриентов на стратегии всех абитуриентов в рамках централизованной системы организации поступления в вузы с использованием алгоритма Гейла-Шепли или отложенного зачисления (Deferred Acceptance, DA). Рассматриваются два случая: 1) когда длина ранжированного упорядоченного списка (РУС) образовательных программ неограниченна, и 2) случай ограниченного числа образовательных программ в РУС. Для каждого из этих случаев также исследуется влияние интеграции внешних опций в централизованную систему приема на стратегии абитуриентов, эффективность распределения мест в вузах и благосостояние абитуриентов.

Получены следующие основные результаты. Согласно теоретическим прогнозам, когда длина РУС ограничена, а внешняя опция не интегрирована в систему приёма, участники без внешних опций выбирают более осторожную стратегию по сравнению с теми, кто имеет такие опции: они реже указывают своим первым приоритетом наиболее предпочтительную опцию. Однако, вопреки ожиданиям, интеграция внешних опций в систему значительно меняет стратегии участников и итоговое распределение абитуриентов, даже если при отсутствии интеграции перераспределение на вторичном рынке происходит без дополнительных затрат.

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Препринт WP9/2024/01
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Исследования по экономике и финансам

Анна Юрко

Стратегии абитуриентов в централизованной системе приема в вузы при наличии внешних опций: экспериментальный подход

(на английском языке)

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