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Matching Strategies of Heterogeneous Agents under Incomplete Information in a University Clearinghouse

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Matching Strategies of Heterogeneous Agents under Incomplete Information in a University Clearinghouse

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Abstract

In actual school choice applications the theoretical underpinnings of the Boston School Choice Mechanism (BM) (complete information and rationality of the agents) are often not given. We analyze the actual behavior of agents in such a matching mechanism, using data from the matching mechanism currently used in a clearinghouse at a faculty of Business Administration and Economics at a German university, where a variant of the BM is used, and supplement this data with data generated in a survey among students who participated in the clearinghouse. We find that under the current mechanism over 70% of students act strategically. Controlling for students' limited information, we find that they do act rationally in their decision to act strategically. While students thus seem to react to the incentives to act strategically under the BM, they do not seem to be able to use this to their own advantage. However, those students acting in line with their beliefs manage a significantly better personal outcome than those who do not. We also run simulations by using a variant of the deferred acceptance algorithm, adapted to our situation, to show that the use of a different algorithm may be to the students' advantage.

Keywords: Matching, Application of the Boston Mechanism, School Choice, Strategic Behavior, Incomplete Information
JEL: C78, D47, D82

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1. Introduction

Assigning students to supervisors is one example of the type of many-to-one matching situations that is often referred to as a school choice problem. To tackle it different matching mechanisms have been analyzed, from a theoretical as well as from an empirical point of view. The most famous of these mechanisms are the *Boston School Choice Mechanism* (see Abdulkadiroğlu et al., 2011) and the *Deferred Acceptance Mechanism* (see Gale and Shapley, 1962) (from here on we will refer to them as BM and DA, respectively). While the DA has better theoretical properties,[1] there is evidence of students and parents preferring the BM over other mechanisms (see, e.g., Chen and Sönmez, 2006; De Haan et al., 2015), and some support (also from experiments) that show that the BM does perform quite well in real life situations (see, for example, Abdulkadiroğlu et al., 2011). However, it is often not measurable how well the BM actually does as compared to how well other mechanisms may perform, as data is lacking. Therefore, the satisfaction with the BM may not be as high when looked at it objectively. Still, the Boston Mechanism is widely used because it is easy to understand and due to the positive response of participants as found by Chen and Sönmez (2006).

In this work we analyze the clearinghouse used to allocate students to thesis supervisors at a faculty of Business Administration and Economics at a German university where a variation of the BM is used. Our paper ponders the performance of this mechanism using data from the actual matching mechanism, which shows us the preferences of students and which chair they were allocated to. Additionally we conducted a questionnaire amongst all students who participated in the matching mechanism. In the questionnaire we asked, among other things, which chairs they stated in the mechanism and whether those were also their true preferences.

We want to focus on one specific divergence between the theoretical analysis of the BM and its real life applications that has not received much attention in the school choice literature so far. While it is assumed that students have complete information, in most applications of the BM they do not have complete information about others' preferences. In our setting this is definitely true, as students do not know the preferences of the roughly 400 other students. At the same time, they also do not know exactly how well their overall performance compares to other students, as students have quite a large degree of freedom in choosing their courses so that you typically do not know who all is in your cohort and how you compare to them. Thus, next to analyzing the general behavior of students when facing such a mechanism, we also want to analyze the role of incomplete information in this setting and find whether there is a certain group of students that is benefitting from 'playing' this mechanism while other groups suffer its consequences.

Additionally, in any given year, after the matching has been completed, some students are unhappy with their allocation although usually around 90% of students were allocated to one of their stated top 3 choices. Surprisingly, a lot of the participants seem to be not as satisfied with the mechanism itself as previous analyzes of the BM used in practice suggest. In 2015, around 30% of the students stated that they were not satisfied with the mechanism. This begs the question as to whether the support for the BM over other mechanisms may be overstated in the literature, or if something in the setting at the considered university leads to a lesser performance. Thus, we analyze the behavior of students in the matching mechanism and also simulate outcomes with other possible matching mechanisms for comparison.

Our contribution to the literature with this paper is therefore two-fold. First, we look at the influence of incomplete information on the outcome of the BM. Incomplete information is widely studied in many fields of economic research except for the matching literature. Normally, it is assumed that in school choice students know the other students' preferences as well as the schools' (or chairs') priority. Obviously, this is not always the case, especially not in our case. The first to study the effects of incomplete information to matchings was Roth (1989) who showed that truth-telling might still be a dominant strategy in a setting where agents only know the probability distribution from which the others' preferences are drawn. Liu et al. (2014) showed that the set of stable outcomes in matching problems with one-sided asymmetric information is non-empty and under which conditions such a matching is also efficient. The consequences of incomplete information to a stable mechanism where theoretically introduced by Ehlers and Massó

[1] In the theoretical literature, the BM has received a lot of criticism, as it is not efficient, does not eliminate justified envy and is not strategy-proof, thus giving incentives to misrepresent one's preferences (see, e.g., Chen and Sönmez, 2006).

(2015) and empirically by Chen and Pereyra (2015). Nevertheless, there is still missing work on what is happening to an unstable matching mechanism which is not strategy-proof.

Second, we present *field* evidence on the actual behavior of students in this specific matching situation. We use the data we gathered from our survey to analyze whether students misrepresent their preferences when facing such a mechanism and whether they are able to actually improve their outcome by doing so. Here, our paper adds to the empirical evidence on the behavior of players in the mechanisms. Only few other papers have analyzed this question as a very recent working paper by De Haan et al. (2015), who also use a questionnaire to look at how students (parents) in Amsterdam behave in a type of Boston mechanism setting when choosing their secondary school. Another paper, which is close in intent to our paper, is by Dur et al. (2016). They show that in a variant of the Boston Mechanism used to allocate students to schools, sophisticated students who misrepresent their preferences are much more likely to be allocated to one of their preferred schools than sincere students.

The paper is organized as follows. In Section 2 we shortly introduce the data we collected and its different sources. Following this, we discuss school choice problems in general in Section 3 and how the mechanism used at a German university can be interpreted as a school choice problem in Section 3.1. In the course of this we relate our mechanism to the Boston Mechanism in Section 3.2 and discuss the behavior of chairs and students in Sections 3.2.1 and 3.2.2, respectively. Following this, in Section 4 we analyze the data with respect to the behavior of students in the mechanism under incomplete information and build a model in Section 5 to analyze the rationality of their expectations and their consecutive behavior. We show that this behavior favors sophisticated students (Section 6). In Section 7 we then shortly show a simulation of how a different matching mechanism would perform in our situation. Finally, we conclude in Section 8.

2. Data

In this paper we use data from a clearinghouse that is used for the distribution of Bachelor and Master theses amongst different chairs at the faculty of Business Administration and Economics at Paderborn University. The clearinghouse uses a mechanism that is very close to the standard BM. Here, we get the 'standard' school choice data: the allocation of students across chairs, as well as the students' preferences and their thesis type (Bachelor or Master). We supplement this data set with data gained from a survey among students who took part in the clearinghouse. We collect data on students' true preferences, their motivations and their estimation of chances at the different chairs, and some general information.

2.1. The Clearinghouse

Every term, students have the possibility to write their Bachelor or Master thesis at the faculty of Business Administration and Economics at Paderborn University (hereafter UPB). Since the winter term 2012/2013, a web-based matching mechanism is used to manage the allocation of students across chairs. The stated goals of this mechanism are to guarantee that each student will find a supervisor in the given term, and to spread the task of supervising theses fairly across chairs. To obtain this, the faculty implemented a web-based mechanism in which students state their preferences for chairs at which to write their thesis. Additionally, students are required to upload an overview of their current grades and a CV. Some chairs also asked for some additional material, such as a letter of motivation, a proposal, etc. Once all students have uploaded their choices, a quota is calculated to determine how many theses need to be supervised by each chair. To calculate this quota each Bachelor thesis is given a value of 1, each Master thesis a value of 1.5. The points are added up and the flex quota is calculated by $\frac{points}{FTE_{total}} * FTE_{chair}$, where FTE stands for full time equivalent position. The quota is called a flex quota because chairs are free to supervise more than their allotted number of students.

The mechanism at UPB is a round-based decentralized mechanism. In the first round each chair begins to fill its quota from only those students who consider the chair to be their first preference. Please note that in contrast to other school choice problems, the students do not fill exactly one slot each. If the student wants to write a Master thesis, she needs 1.5 slots, meaning the chair's quota diminishes by 1.5 points for each Master thesis. Students with Bachelor theses need one slot as it is argued that supervising Bachelor

theses is not as time consuming as supervising Master theses. If the chair has some free slots left after the first round, in the second round it is allowed to fill up the remaining slots with students who are still available and consider it their second choice. The mechanism works for three rounds as students are only allowed to name three preferred chairs. After three rounds the remaining students will be divided up between chairs that still have free capacities. From the clearinghouse, we get data on the students' stated top three preferences, which chair accepted them and in which round they were accepted.

2.2. The Survey

To analyze how students behave during the mechanism, we conducted an incentivized survey amongst those students who took part in the matching mechanism in the winter term 2014/2015 and in the summer term 2015.[2] We sent out the survey after the matching mechanism had already been conducted and students had started to write their theses. For the winter term 2014/2015 we received 66 completely filled out surveys (which corresponds to a response rate of 23.5%).[3] For the summer term 2015 we received 128 completely filled out surveys, which corresponds to a response rate of 30.3%. As we adapted the survey slightly before sending it out for the second time, most of our analysis will be based on those 128 surveys from the summer term. Amongst those students who participated in the survey, we ran a lottery of two 25 Euro vouchers for Amazon each term.

The survey consisted of 45 questions, covering basics such as age, gender and which major they were studying, as well as questions on the matching mechanism, also giving students plenty of room for their own comments. The questions that are most important to this analysis are those about the three chairs they stated as their top three preferences in the matching mechanism and how high they estimated their chances at these chairs. Next to this, we asked them to state the five chairs where they would have most liked to write their theses. From the difference between the two lists we inferred whether they misrepresented their preferences in the mechanism.

We also asked how content they were with the mechanism, the information they received and their allocation. Additionally, we asked some more general questions about their studies, the matching mechanism and why they chose the chairs they stated, in the end requesting them to fill out a list of up to 15 chairs where they would not want to write their thesis - for example, for reasons such as not having taken any courses at these chairs.

As we did not receive answered surveys from all students who took part in the mechanism, we performed a number of statistical tests to analyze whether there was any selection bias in the survey data. We therefore compared the data from the survey with the data from the actual mechanism to ensure that we indeed had a representative sample. We compared the data with respect to five different dimensions: the distribution of gender, type of thesis, allocation to a chair within one's preferences, allocation to first preference, and finally the ranking of chairs in terms of how often they were chosen by students. Performing χ^2 tests for the distribution of gender, thesis type, allocation to a chair within one's preference and allocation to one's first preference, we do not find any statistically significant differences between the survey data and the data from the mechanism.[4] This can be seen in Table 1.[5]

Concerning the frequencies with which any given chair has been selected as a first preference, we ranked the chairs according to how often they were chosen. We find that the distributions here are remarkably similar between survey and mechanism. All in all we can conclude that the survey data on students' preferences indeed is a representative sample for the data from the actual mechanism we observe.

[2] An English translation of the survey from the summer term 2015 can be found in the appendix.

[3] As we probably did not reach all students, since we had some incorrect email addresses and sent out the survey quite late in the term when some people might have already left the university, the actual response rate out of those students who received the email is probably closer to 30%).

[4] We also compared the distribution for allocation to the second and third choice and did not find any statistically significant differences either.

[5] The number of students in the test for the thesis type is only 127 in the survey (as compared to the 128 everywhere else) as one student wrote a special kind of thesis that students from different disciplines can write at the Economics faculty. As there are only very few of these theses, we are ignoring them in the analysis however.

	Gender		Thesis		Top3		First Choice	
Data	Female	Male	MA	BA	Yes	No	Yes	No
Mechanism	243	180	115	304	377	46	305	118
Survey	78	50	37	90	111	17	94	34
χ^2 Test	Pr=0.483		Pr=0.710		Pr=0.453		Pr=0.767	

Table 1: Whether the survey data is biased

3. School Choice

Our analysis contributes to the literature on school choice problems, as our matching mechanism can be characterized as a school choice problem. School choice problems (Abdulkadiroğlu and Sönmez, 2003) are a class of one-sided-matching problems. Following Abdulkadiroğlu and Sönmez (2003) such a problem consists of a finite set of students $s_1, \ldots, s_n$ and a disjoint finite set of schools $c_1, \ldots, c_m$, each with a finite set of available seats. The number of seats of a school c is called quota $q_c \geq 0$. The total number of seats should at least equal the number of students. Each student is looking for exactly one seat in a school. A student s has preferences over schools R_s. As there might also be an outside option, not all schools have to be acceptable for students. The students' preferences are not influenced by the other students' assignment. Schools rather have priorities than preferences over students. These priorities are normally institutionally given and are objective criteria such as whether a student lives within walking distance to a school or whether she has siblings already visiting the school. The biggest difference between the two groups is that while students might act strategically, schools do not. Students face incentives to be matched to one of their favorite schools and, thus, they might not report their preferences truthfully, in order to be better off in the end. Schools do not face this problem.

3.1. The Clearinghouse as a School Choice Problem

The clearinghouse at Paderborn University can be characterized as a school choice problem as follows. Students $s_1, \ldots, s_n$ are looking for exactly one seat at a chair $c_1, \ldots, c_m$, where each chair c has a quota q_c. In the clearinghouse the calculated quota depends on the size of the chair and on the amount of students who want to write their theses. Nevertheless, the chairs can supervise more theses than they have to or, in other words, extend their quota themselves.

The students have preferences over the chairs. It is obvious that these preferences should not be influenced by other students' assignments, as each student is writing her own thesis and does not have much contact with other students assigned to the same chair. As usual in school choice, our students have to submit only their top three preferences in the web-based clearinghouse, meaning that the length of the rank ordered lists (ROLs) is bounded. While this diverges from the theory on school choice, Pathak (2016) states that almost all school choice mechanisms observed in practice suffer from this. This is mainly due to the multitude of options and it can also be observed in our survey, as we asked the students whether they could have easily given preferences over more than three chairs. 70% denied this, and the other 30% stated that they would maximally want to give preferences over five chairs.[6] While we thus note this difference between our clearinghouse and the theoretical discussions of school choice problems, this is not a problem specific to our mechanism but a general divergence between school choice practice and theory.

To characterize the clearinghouse as a school choice problem, we assume that the chairs are not strategic players themselves but rather have priorities over students. First, chairs are not able to know all students as around 300-450 students write their theses at our faculty during each term. Thus, they have to rely on some objective criteria in order to prioritize students. Second, this assumption was confirmed by data

[6]For a more detailed discussion of the influence of bounded rank ordered lists on the different matching mechanisms see Pathak (2016); for an analysis of bounded ROLs on specific mechanisms see, e.g., Haeringer and Klijn (2009), for experimental evidence Calsamiglia et al. (2010).

that was collected in a Bachelor thesis on the clearinghouse (Steuber, 2014). Here, a survey was conducted amongst the different chairs participating in the matching mechanism in which the chairs were asked how important the following statements were for their selection of students: chosen courses, grades in related courses, documented interest and motivation, the grade point average, CV, and other factors. Steuber (2014) found that a large majority of chairs ranked these options almost identically. Chosen courses, grades in related courses, and documented interest and motivation were the most important decisive factors for 83% of the chairs. The average grade was the next most important point; the CV and other factors were less important. Thus, chairs not only have priorities, they also decide on the basis of the same priorities. Consequently, we treat our matching problem as a school choice problem on a one-sided matching market.

3.2. The Boston School Choice Mechanism

One widely discussed matching mechanism used in school choice is the so-called Boston School Choice Mechanism (BM).[7] As the mechanism used at UPB seems to be very close to the BM, we shortly introduce the BM and then show in which aspects our mechanism differs.

In the following, we follow the description of the BM given in Pathak (2011). Assume we have a set of students with strict preferences over the schools they would like to attend and a set of schools with priorities over students and a given number of available places. The students submit their list of preferences and then the mechanism begins. In the first round only the first choice of students is considered. Each school considers the students who listed it as their first choice and assigns places to fill their capacity, starting with those students that are highest on its priority list. If a school fills its quota in the first round, they exit the algorithm. If capacity is left after the first round, the school remains in the algorithm for the next round. Schools then only look at those students who are not yet matched and who listed the school as their second preference. Again the schools start with those students with the highest priority. The mechanism terminates when all students are distributed to a school of their choice or when those students that remain unassigned have exhausted their preference list.

While for the most part the mechanism used at UPB runs like a standard BM, there are, nevertheless, some major differences between the BM and the UPB mechanism. First, due to the bounded ROLs our mechanism is terminated after three rounds. Nevertheless, in school choice applications using bounded ROLs is the norm. Additionally, the mechanism used at UPB is not a centralized mechanism, as the BM, but a decentralized mechanism where chairs can decide on their own who they want to accept and who they want to reject. However, as pointed out in the previous section, chairs do not act strategically and we therefore treat the mechanism as a one-sided matching market. In the following two sections we will elaborate on how these differences affect students' and chairs' decision making.

3.2.1. The Chairs' Decision

In the BM it is assumed that we have a one-sided centralized problem and schools are not strategic players. In our mechanism, the chairs get to decide independently in each round which of the students that chose them in the given round they will accept. Thus, while the BM is a centralized mechanism in which a computer algorithm uses schools' priorities as the basis to decide which student to allocate to which school, we have a decentralized mechanism in which professors use their own ideas as the basis to decide themselves whom to accept. However, there is strong evidence that the chairs actually are non-strategic and all act by following the same priorities and that thus, the mechanism is comparable to the BM. This evidence comes from three different sources, a survey conducted among the chairs, the data from the actual mechanism and a simulation of the BM with the help of the results of the survey of the chairs and the actual clearinghouse.

As already pointed out a survey was conducted amongst the chairs to analyze how they decide on which students to accept. This survey shows two facts. First, all chairs decide on the basis of a list of objective criteria as it is impossible for them to know all the students. Second, this list of criteria is (nearly) the same for all chairs, making the decentralization unnecessary (cf. Steuber, 2014).

[7] For a list of places in which the BM has been used, see Abdulkadiroğlu et al. (2011, p.409).

To further analyze the chairs' decision, we first checked in the data of the actual mechanism how many chairs did not accept a student, who put the chair as his first preference even though there was still capacity left. As chairs are allowed to reject students although they have capacities left, a high number of unacceptable students would hint that chairs act strategically. Nevertheless, we find that out of 423 students in the summer term 2015 only 6 students (1.42%) were not allocated to their first priority, even though the chair still had capacity left. Thus, chairs do not seem to act strategically.

We also run a simulation of the BM with our survey data to test whether the outcome of the actual clearinghouse is comparable to the outcome induced by a BM. We assume that chairs simply give priority points on the basis of the answers in the chairs' survey and add these points up to calculate the prioritized order of the students (cf Table 2). We give a short example to illustrate the functioning of the criteria list. Imagine two Bachelor students have ranked a chair first and the chair has only one free slot left. The first student, s_1, has very good grades in the related courses and in her studies in general. This gives her $8 + 3 = 11$ points. The second student, s_2, did not have any related courses but has documented interest in the subject (she visited the chair already) and has good grades in her studies. This gives her $4 + 2 = 6$ points. Thus, the chair prefers s_1 over s_2 and will assign the free slot to s_1.

Criterion	Points
Priority for MA thesis over BA thesis	1000
Mediocre / good / very good grades in related courses	6 / 7 / 8
Priority for students with documented interest in the subject	4
Mediocre / good / very good average grades during their studies	1 / 2 / 3
Maximally obtainable number of points	1015

Table 2: The chairs' criteria points

For the simulation of the BM, we use these priorities of the chairs to rank the students for each chair as explained in the example above with single tie-breaking. As chairs are allowed to supervise more theses than they have to, or in other words, to extend their quota themselves, we need to allow for this in the simulations. We take this problem into account by defining the quota q_c as the maximum of the actual quota, which is obtained from the data, and the calculated quota. For the students' preferences we simply take the three stated preferences from the actual mechanism. Taking the information together it is now possible to calculate a matching with the help of a BM. As we use single tie-breaking in order to obtain the chairs' "preferences", we decided to simulate 250 rounds where each round uses another random single tie-breaking rule and take the average outcome to compare the simulated BM outcome with our actual clearinghouse outcome.

	Actual clearinghouse	BM simulation
1. Choice	72.1%	78.9%
2. Choice	9.69%	10.5%
3. Choice	7.33%	3.3%
Sum top 3	89.13%	92.7%
Not matched	10.87%	7.3%

Table 3: Results of the simulation and the clearinghouse

The BM in the simulation seems to produce very similar results in comparison to the actual clearinghouse (cf. Table 3). This impression is supported by various statistical tests. We do not find any significant difference between the simulation and the actual clearinghouse in terms of how many students are

matched to one of their top 3 preferences (χ^2 test with $p = .203723$). The Kolmogorov-Smirnov test finds no significant difference in the distribution of the allocation to preferences between the simulation and the clearinghouse ($p = .995$). And if we compare the best case of our simulation with the actual clearinghouse we find that about 88% of the allocations in the first round are the same in both mechanisms. Thus, we conclude that the mechanism used in the clearinghouse is actually a variant of the Boston School Choice Mechanism.

3.2.2. The Students' Decision

We have discussed above that in terms of what the chairs are actually facing, our mechanism is very close to the Boston School Choice Mechanism. Additionally, for the students it de facto presents the same incentives as the BM. In both cases the focus is on the first preference of the students. If they are not assigned to their first preferences, they might not get their second choice either as the chair's quota might already be filled. Students should therefore be careful when stating their preferences and might act strategically in order to get a preferred chair. As the chairs decide in the same way as in the BM, students also face the exact same decision they would face in the BM. Thus, if students would be accepted by a chair in the BM, they are also accepted in the clearinghouse. Thus, we are able to analyze the students' behavior in line with the literature on the BM.

4. Students' Behavior and Misrepresentation

Having shown that from the students' perspective the BM and the mechanism at UPB have the same incentives, we will now analyze how students behaved when facing this mechanism. We therefore first analyze whether they misrepresented their preferences during the matching mechanism. Following this, we control for students' limited information in the analysis of their rationality. As argued above, our mechanism shares the same incentives for misrepresentation as the often analyzed Boston Mechanism. For the BM, theory predicts that students should act strategically and manipulate their stated preferences in order to improve their match (Abdulkadiroğlu and Sönmez, 2003). To examine whether this prediction holds in our sample we asked the students to restate the preferences they already stated in the clearinghouse, as well as their true preferences. It turns out that almost three quarters of the students have manipulated their preferences in the clearinghouse. This is in line with the data that Chen and Sönmez (2006) find in their experiment, where around 80% of subjects misrepresented their choices. Surprisingly, this percentage does not differ significantly over gender, study achievements or type of degree. Running χ^2-tests to check for these factors, we do not find any statistical significance for differences in strategic behavior. You can find the results of the test in Table 4.[8]

	Gender		**Study Achievement**		**Experience**	
Misrepresentation	Female	Male	Good grades	Mediocre grades	Bachelor	Master
No misrepresentation	18	15	25	8	23	10
Misrepresentation	60	35	58	37	67	27
χ^2 Test	Pr=0.382		Pr=0.127		Pr=0.864	

Table 4: Misrepresentation for different participant groups

The results show that students act strategically in a clear pattern: almost all of them manipulate their third choice and also their second choice or even their first and second choice. Table 5 shows how misrepresentation is split up between the different preferences.

[8]We have also tested all possible combinations of misrepresented and truly stated prefereneces without finding statistically significant differences.

Manipulation	Frequency	Percentage
1st misrepresented	0	0
2nd misrepresented	8	6.25
3rd misrepresented	30	23.44
1st and 2nd misrepresented	2	1.56
1st and 3rd misrepresented	2	1.56
2nd and 3rd misrepresented	28	21.88
all misrepresented	25	19.53

Table 5: Misrepresented preferences

To analyze whether the use of misrepresentation is advantageous to students, we compared whether students who misrepresent are allocated to one of their top three preferences more often than those students who do not misrepresent, and who is more content with their allocation. Comparing our findings to the results discussed in Abdulkadiroğlu et al. (2015) and Pathak and Sönmez (2008) which state that honest players will be exploited by misrepresenting players in the Boston mechanism,[9] we do not find any evidence for this. Rather, our results seem to be in line with the intuition given in Abdulkadiroğlu et al. (2011) which states that honest players may well benefit from the presence of misrepresenting players, as those tend to not use overdemanded preferences as their first choice, even though they might have gotten a place there.

Looking simply at the allocation to their stated preferences, we find that there is no statistically significant difference between those students who misrepresented and those who did not misrepresent in whether they were allocated to one of their top three stated preferences or not (Fisher's exact test with $p = 0.758$). However, when looking at the allocation to their top three true preferences, we find that honest players get one of their top three true preferences 88% of the time, whereas misrepresenting players get one of their top three true preferences only 74% of the time. This difference is not only economically but also statistically significant ($p = 0.093$). While those students that get one of their top three true preferences are more content than those who do not ($p < 0.001$), we do not find any statistically significant difference in contentedness between misrepresenting and honest students (Fisher's exact test, $p = 0.279$).

5. Analysis of Students' Behavior under Incomplete Information

Obviously, students misrepresent their preferences and, thus, seem to act strategically. Unfortunately, as we have already seen they seem to fail in improving their personal outcomes. At first glance, students do not even seem to act rationally by misrepresenting. In the survey we asked the students to self-assess their chances at their stated and their true preferences. *Estimated chances* is a categorical variable with four possible answers: low, rather low, rather high and high. Under the BM we expect them to not give their true preferences if they estimate their chances to be relatively low there and instead name a chair where they at least think that their chances are as good as before, perhaps even better. But do they really act rationally in their decision of which chair to state as a first preference if they do not state their true preference? As can be seen in Table 6, we find that students do not act in such a way. Here we coded all those changes as sensible in which students gave a stated first preference for which they estimated their chances to be at least as high as for their true first preference. However, we see that 41% of students do not act in such a fashion. Instead, they state to prefer a chair where they estimate their own chances to be strictly lower than at their true first preference. Thus, a lot of students try to act strategically but actually fail in improving

[9]Please note that the terms of 'naive' and 'strategic' players are used in the literature. However, as this would actually be a misnomer here, since being honest is not necessarily naive, we use the terms honest and misrepresenting. In Section 6, we will discuss how truly sophisticated and naive players are impacted by our mechanism.

Sensible change from true to stated 1st preference	Frequency	Percentage
No	12	41.38%
Yes	17	58.62%

Table 6: Whether students state chairs at which they estimate their chances to be higher than at their true preference if they act strategically

their personal outcomes. We doubt, however, that this means that they act completely irrationally because the decision we are looking at is very important for students and has a great impact on their ongoing career.

5.1. Rationality under Incomplete Information

In theory, we expect that the students have complete information and are thus able to decide what is best for them. In this case we expect that the students report their preferences in such a way that they exploit the algorithm to maximize their payoff or, more precisely, get their most preferred possible true choice. Unfortunately, in reality we do not have fully informed students. In theory, each student knows the preferences of all other students and also the priorities and, thus, the resulting preference lists of the chairs. In reality, it is obvious that this is not true. Specifically, students know exactly their own preferences. They are able to state a list of chairs illustrating these preferences. But the students do not exactly know how they are ranked by the chairs. Of course, they are aware of their own performance at a chair and we can assume that the students know that the chairs base their priorities on the students' grades. Students do not know how the other students' preferences look like, although they might have some information on popular and less popular chairs. Roth (1989) has modeled a similar situation in a classical "marriage market", a two-sided matching market with a one-to-one matching problem. Following his model agents only know their own preferences and the probability distribution from which the preferences of the others are drawn. Thus, players formulate their utility functions defined over their possible mates depending on these probabilities. Roth (1989) assumes that the number of utility functions with positive probability is countable. He shows that in this framework truth-telling is still a dominant strategy if it was a dominant strategy in the complete information case. Obviously, this is not true for the Boston school choice mechanism as truth-telling is not a dominant strategy in the complete information case. Actually, there is no theoretical or empirical work dealing with incomplete information in the BM. While it is easy to see that without any information acting strategically is not possible, this claim can not be made for the case of imperfect information.

In the presented clearinghouse we observe an incomplete information case but not a zero-information case. Therefore, our application seems to fit in Roth's framework. As we have one-sided matching here, only one set of agents, the students, might act strategic and thus, is interested in the other agents preferences. The chairs are simply taken as objects and do not have utility functions. Additionally, a many-to-one matching might be interpreted as a one-to-one matching by cloning the agents that might be matched to more than one agent of the other set (Roth and Sotomayor, 1990). The assumptions of the model also fit to the clearinghouse setting. As Roth (1989) pointed out, the agents know the probability distribution from which the others' preferences are drawn. We assume here that students are aware of the fact that chairs decide mostly on the basis of grades but of course they cannot assess the chairs' preference lists as they do not know the other students' grades. Nevertheless, we assume that the students have some beliefs about the preferences of the other students and the resulting preference lists of the chairs. As Roth and Rothblum (1999) have discussed, little information might be sufficient to act strategically at least in a stable matching algorithm. We give in the following first (empirical) evidence that this is also true in the BM. We also show how acting strategically might be profitable in the incomplete information case.

We have already explained that the students have some beliefs about the preferences of the other students and the preference lists of the chairs. More precisely, the students have some beliefs about the students' aggregate demand for chairs instead of having beliefs about the exact preferences. This demand is represented by the occupancy rate of a given chair.

Definition 1. *The occupancy rate a_c gives the relation of the availability capacity of a chair c and the actual students' demand for c.*

If a chair's occupancy rate is believed to be relatively high and a lot of students thus want to write their theses there in comparison to the available quota, we expect a student to be more likely not to state her true choice in order to avoid the highly demanded chairs where it is relatively difficult to get a slot in comparison to less highly demanded chairs. In the questionnaire we asked students which chairs they thought had the highest occupancy rates and then analyzed whether students believed that their chosen chairs were amongst those or not. In the clearinghouse we coded as full all those chairs that had no more available capacity after the first three rounds of the matching mechanism and as empty those who had available capacity. If the students are not able to tell if their chosen preferences belong to the most highly demanded chairs, they actually have only limited information about the occupancy rate. We find that for the students' first preferences, stated as well as true, roughly three quarters of students are able to correctly choose if the chair they chose is full or not (73% and 78%, respectively). This number drops to roughly 60% for their third preference. Analyzing whether students systematically under- or overestimated the occupancy rate of their first chosen preference, we find that they significantly underestimate whether their first stated (and true) preference belongs to the fullest chairs (χ^2-test with $p < 0.01$ for both stated and true preferences). We therefore deduce that students indeed have only incomplete information about the occupancy rate a_c of any given chair c.

Students are also not aware of the chairs' preferences as they do not know the other students' performance exactly, although they know their own performance and have beliefs about how well they performed in comparison to the others. Additionally, with the help of the occupancy rate, although they have limited information they are able to calculate their chances to be one of the top candidates or at least to get a slot at this chair. We will focus on this self-assessment in the next section

Students are not fully informed with regard to various parts of the clearinghouse. Therefore, the question we want to answer now is whether the students act as rationally as they can.

Definition 2. *An agent, here a student, acts rationally under incomplete information if she chooses the strategy that maximizes her outcome given the incomplete information she has. Thus, she acts consistently with her beliefs.*

More precisely, rationality under incomplete information means that the students are able to evaluate whether they should tell the truth or choose another chair where they believe to have rather high chances.

To test our hypothesis that the students are rational under incomplete information we examine the following. This type of rationality requires that students know how to estimate their chances at a given chair to compare themselves to the other students and to compare their own chances at different chairs. Afterwards, they use these estimations as the basis for deciding whether they risk to choose their true choices as stated ones or if they should deviate and act strategically.

5.2. First Step: Estimated chances

We analyze whether students are able to estimate their chances correctly. Although the exact preferences of the other students taking part in the clearinghouse remain unknown, each student s has some beliefs about the popularity and therefore the occupancy rate a_c of each chair. Additionally, she assesses her own performance l_{sc} at the particular chair so far. These two factors determine the chances of success at the particular chair c the student believes to have $m_{sc}(l_{sc}, a_c)$.

Hypothesis 1 If student s expects the occupancy rate a_c at chair c to be low, she will expect to have higher chances $m_{sc}(l_{sc}, a_c)$ to be allocated to it than to chair $\hat{c}$ with a higher occupancy rate $\hat{a_c}$, ceteris paribus.

If a chair is not very popular and, thus, only a few students put this chair on a high rank in the preference list, the chair is more likely to accept the student s in order to fulfill its quota. The student will expect this behavior if she believes that the chair does not fulfill its quota after the first three rounds of the Boston School Choice Mechanism. As we have already pointed out, the exact occupancy rates remain unknown. In the survey *occupancy rate* is a dummy variable and simply states full or not full.

Hypothesis 2 If student s has a high performance l_{sc} at chair c, she will expect to have higher chances $m_{sc}(l_{sc}, a_c)$ to be allocated to it than to another student $\hat{s}$ with a lower performance $\hat{l}_{sc}$ at c, ceteris paribus.

Performance is an important factor for the decision-making of chairs. We assume that the students know this fact. Additionally, a good performance indicates a student's interest for the research topics offered at the particular chair. Therefore, we expect that the better the performance of a student s is at a particular chair, the higher she would estimate her chance to be allocated to it. We model *performance* as an ordinal variable with 6 possible outcomes: *no attended courses, no finished courses, bad performance, mediocre performance, rather good performance* and *good performance*. The students were asked to evaluate their performance for each chair on their true and stated preference lists separately.

If a student assessed her performance at the chair as good and the occupancy rate as low, the chances should be estimated to be high. Similarly, if she assessed her performance at the chair as bad and the occupancy rate as high, the chances should be estimated to be low. In the other cases, if the performance was good but the occupancy rate was high or the other way round, the behavior should depend on what the students believe to be more crucial. You could also say that this depends on their risk aversion. If students are more risk averse, their estimated chances would be relatively low in order to eliminate the uncertainty. The estimation of the chances might also depend on some other factors we control for:

$l \uparrow a \downarrow$ High chances	$l \downarrow a \downarrow$?
$l \uparrow a \uparrow$?	$l \downarrow a \uparrow$ Low chances

Table 7: Estimated chances depending on performance l_{sc} and occupancy rate a_c

Thesis Type
If a student writes a Master thesis, a chair gets a higher value for supervising her. Thus, a Master student is more likely to expect a higher chance of being allocated to a given chair than a Bachelor student.
Overall Performance
For a chair, also the overall performance matters in its decision-making process. Thus, the higher a student's overall performance in her studies is, the more likely it is that a chair accepts her. Students should also be aware of this fact. Therefore, we control for a student's overall performance.
Missing Credits
The amount of missing credits might also play a role. The more credits are missing, the longer it still takes for a student to end her studies. Thus, she might act more risk loving and estimate her chances higher than students in their last semester.

To see whether, given their beliefs about their own performance l_{sc} and the occupancy rate of any given chair a_c, students behave limited rationally, we first perform an ordered logit regression on their estimation of their own chance at their chosen (stated and true) preferences. We chose for the ordered logit measure, as the dependent variable (the students' estimation of their own chances at their chosen preference) is a categorical variable, ranging from low to rather low to rather high to high. The results of the regression analysis can be found in Table 8. In specification (1) we use just the two variables we are mainly interested in: *Assumption that the chair is full* and *Performance at the chair*. In specification (2) we add the control variables, which are, however, all not significant.[10] All ordered logit regressions are run only for

[10]We give the results for the regressions with the categorical variables here. However, also when the variables are taken as contin-

	True First		Stated First	
	(1)	(2)	(1)	(2)
Assume Chair is Full	-.8272**	-1.0556**	-.5339	-.5329
	(0.3841)	(0.4501)	(0.3754)	(0.4346)
Performance at Chair (base category: no courses)				
Bad	-.6684	-.9462	-1.4356	-1.7961
	(1.5661)	(1.8304)	(1.2754)	(1.6467)
Mediocre	-.4993	-.2403	-1.2198	-1.1207
	(0.7772)	(0.9041)	(0.7900)	(0.9650)
Rather Good	.4410	.6515	-.2814	.1635
	(0.6318)	(0.7057)	(0.6528)	(0.7435)
Good	1.6464**	2.0017***	1.2798*	1.5971**
	(0.6776)	(0.7688)	(0.6917)	(0.7837)
Study Results (base category: bad)				
Average		-.3691		-1.1214
		(1.7874)		(1.5107)
Good		.0871		-1.3424
		(1.829)		(1.5564)
Very Good		.1679		-1.2232
		(1.9385)		(1.6747)
Missing ECTS (base category: < 10				
$10 <$ Missing ECTS ≤ 20		-1.4947		-.8504
		(0.9666)		(0.9706)
$20 <$ Missing ECTS ≤ 30		-.9117		-.4449
		(0.8990)		(0.9168)
$30 <$ Missing ECTS ≤ 40		-1.3483		-.5470
		(1.0452)		(1.0375)
$40 <$ Missing ECTS ≤ 50		1.1891		.2433
		(1.5322)		(1.6157)
$50 <$ Missing ECTS ≤ 60		.0280		.5555
		(1.3235)		(1.3579)
Master		.4190		-.1264
		(0.4489)		(0.4348)
Observations	121	105	123	107
	Standard errors in parentheses $***p < 0.01, **p < 0.05, *p < 0.1$			

Table 8: Ordered logit of estimated chances at a given chair

those students who did not state that they were accepted at a given chair before the matching mechanism started.

As can be seen from Table 8, the only variables that significantly influence the way students estimate their chances at a given chair are their beliefs about the occupancy rate of the chair, which has a negative influence, and whether their own performance at the chair was good, which has a positive influence. This matches our Hypotheses 1 and 2 perfectly. Adding the controls does not change these results and shows that the students' own estimation of chances at a given chair does not depend on other factors. Interestingly, for their stated first preference the occupancy rate of the chair is no longer significant.

uous, none of the controls are significant.

5.3. Second Step: Strategical action

Given that students are able to estimate their chances at their first preference rather well, we will now analyze if they also behave according to our definition of limited rational behavior when deciding whether they should give a true first preference or act strategically.

Hypothesis 3 A student s who expects her chances m_{sc} to be relatively high at her true first, second or third choice c should be more likely to state her true first, second or third preference than a student $\hat{s}$ who expects her chances $\hat{m_{sc}}$ to be relatively lower, ceteris paribus.

If she expected the chances to be low, she would choose an alternative chair to state in the clearinghouse. Whether a student sticks to her true choice might also depend on some other factors we control for.
Gender
Other studies like Niederle and Vesterlund (2007) suggest that men are more often overconfident, e.g. by entering a tournament. Therefore, we expect women to deviate more often from their true choice in order to decrease their risk of staying unmatched.
Age
We assume that age might also play a role. Nevertheless, the sign of this interaction is not clear. On the one hand, older students have more experience and are thus better informed. So they are more sure in estimating their chances and, thus, do not deviate from their true choice so often. On the other hand, they might be more afraid of staying unmatched, because they want to finish their studies more quickly. In this case, older students would deviate from their true choices more quickly than younger students.

To test this, we use a probit analysis to see whether the students' own estimated chances are a good predictor of giving a true first preference or not. Again we first use a specification without controls and then with controls. The results can be found in Table 9, where as before we only look at those students who were not accepted at a chair before the matching mechanism started.

	(1)	(2)
Chances at true 1st preference (base category: low)		
Rather low	.0704	.1257
	(0.4677)	(0.4999)
Rather high	.7626*	.8957**
	(.3937)	(0.4184)
High	.7915**	.8588**
	(0.3658)	(0.3964)
Female		-.5392*
		(0.3116)
Age		.0850
		(0.0822)
Observations	125	111
	Standard errors in parentheses	
	$***p < 0.01, **p < 0.05, *p < 0.1$	

Table 9: Probit of stating one's true first preference

Looking at the results of the probit regression in Table 9, we find that as compared to estimated low chances at their true first preference, significantly more students will state their true first preference in the matching mechanism if they estimate their chances to be high or rather high. This matches Hypothesis 3. We also find that females are significantly less likely to state their true first preference. This result is in line with the gender gap which can be for example found in tournament entry(see Niederle and Vesterlund (2007), where the gender gap of entry into competitive environments is mostly attributed to more male

overconfidence).

Summing up, we find that incomplete information has an impact on students' behavior and their chances of success in the mechanism. While at first glance, in a setting with incomplete information, it may look as if students behave irrationally, when it is actually due to their incomplete information. At the same time, students still have an incentive to act strategically in such a setting. However, rational strategic action based on incomplete information may not necessarily lead to a successful allocation to a preferred chair, as it may be based on false beliefs about the occupancy rate of a chair or one's own performance as compared to other students' performance. To finalize our discussion of the allocation in a BM setting with incomplete information, we will in the next section analyze whether this mechanism favors certain groups of students.

6. Sophisticated vs. Naive Players

After analyzing how students behave in the mechanism, we can now draw conclusions as to whether a group of students benefits or suffers from this mechanism. As truth-telling is obviously not a dominant strategy and additionally, it is possible to act strategically to improve their own matching, it is now worth to have a look at the consequences of these results. Keeping in line with previous literature (see, e.g., Dur et al., 2016; Abdulkadiroğlu et al., 2015; Pathak and Sönmez, 2008), we firstly distinguish between sophisticated and naive players in our sample. However, we do not define students to be sophisticated simply if they misrepresent, as we have seen previously that simply misrepresenting does not mean that students' are actually acting in their own best interest. Also this ignores those students who do not misrepresent, but whose best option it also is indeed to not misrepresent. Therefore we only define those students as sophisticated who act consistently with their beliefs. Thus, this includes all those students who misrepresent if they estimate their chances at their stated choice to be higher than at their true choice, as well as those who do not misrepresent if they estimate their chances to be high at their true choices. Naive players, on the other hand, are those students who do not act consistently with their beliefs. According to this definition, we find that in our sample there are 72% sophisticated students and 28% naive students. Looking at these students in more detail, we see that there are no significant gender differences in whether a student is sophisticated or naive. Additionally, and somewhat surprisingly, we also do not find any significant differences between Bachelor and Master students in terms of their sophistication, as well as between good and bad students. We do find that those students we code as sophisticated are also significantly more likely to have stated that they understood the mechanism well ($\chi^2 = 2.7705, p < 0.1$).

	Sophisticated	Naive	χ^2
Allocated to 1st choice	87%	39%	$\chi^2 = 30.6478^{***}$
(Very) content with allocation	92%	64%	$\chi^2 = 15.9445^{***}$
Very content with allocation	71%	28%	$\chi^2 = 19.6047^{***}$

Table 10: Sophisticated vs. naive players

In Table 10, we regard only the first choice of students, as this is the one that is most important in our mechanism, as we have argued above. As can be seen in Table 10, we find that indeed those students that act consistently with their beliefs are allocated significantly more often to their first choice. In addition, we can see that they are also more content with their allocation than naive students. Even though, in our definition of sophisticated students, we do not assume anything about how justified their own estimated chances at a given chair are, we see that those students who act consistently with their beliefs seem to be able to obtain a better outcome from the mechanism.

Additionally, naive players also received a chair that they, according to the survey, would have liked to put on a veto list significantly more often than sophisticated players ($\chi^2 = 9.8682, p < 0.01$). This is a further indication that they were quite unsatisfied with the final allocation. All in all, it seems that those

students who act consistently with their beliefs are more able to 'play' the mechanism than naive students and that they benefit from this in terms of the outcome they achieve. That sophisticated players can use the mechanism to their advantage may also lead to overall more discontent over the mechanism as we see in our questionnaire that almost 30% of the students were not satisfied with the mechanism. As around 10% of the students did not get one of their first choices, this high number of unsatisfied students might also be driven by some of the naive students who feel exploited by the sophisticated students. Thus, in the following section, we will shortly introduce some simulations of what another mechanism where truth-telling is a dominant strategy might achieve in our setting. We analyze whether it would be possible to lead to an objectively more efficient outcome that will leave less people discontent.

7. Future Research and an Alternative Mechanism

As we have seen, the problems caused by using the described variant of the Boston School Choice Mechanism are manifold. A lot of students understand that misrepresenting their preferences might be beneficial for them. And sophisticated students are actually significantly better off than the naive players. Nevertheless, a lot of students also try to act strategically by misrepresenting but actually fail to improve their results due to incomplete information and false beliefs. Additionally, a lot of students (about 10%) are not matched to a chair within the three rounds of the mechanism and have to be allocated randomly. The BM not only has non-desirable theoretical properties but also issues in its practical use. Thus, the BM does not seem to be the best mechanism to use.

The algorithm which is used most frequently as an alternative is the student-optimal deferred acceptance algorithm (DA). It is optimal for the students, stable and, most importantly, strategy-proof. Thus, the students do not have incentives to misrepresent their preferences any more. As Roth (1989) has shown this particular feature holds in the incomplete information case. In order to assess whether the algorithm might be an alternative in our real-world problem and how great the improvement would be, we conducted simulations with a variation of the DA. Please note that we had to modify the DA to allow for the different amount of quota used by Bachelor and Master students (Master theses are valued with 1.5 points, Bachelor theses with 1 point of a chair's quota).[11] To make the results of the new simulations comparable to the already existing simulations of the BM, we use the same priorities of the chairs in order to get their preferences. For the students' preferences we take full preference lists, starting with the five true preferences from the survey. Additionally, we asked the students in the survey to fill out a list of up to 15 chairs where they would not want to write their thesis, for example because they did not take any courses at these chairs. This "veto" list is put to the end of the preference list. The positions of the remaining chairs in the list are filled randomly. As we use single tie-breaking in order to obtain the chairs' and students' preferences, we decided to simulate 250 rounds where each round uses another random single tie-breaking rule and take the average outcome to compare the simulated BM outcome with our actual clearinghouse outcome.

The results show that the DA works rather well in this example. Less than 5% are not matched to one of their first three true choices and more than 72% get their first choice. Actually, this number seems to be smaller than in the clearinghouse (cf. Table 3). But as the students do not have incentives to deviate from their true preferences, in the DA simulations around 72% get their true first preferences. Under the BM, students have incentives to deviate. Although it seems that almost 79% of the students get their first choice in the BM simulation, only less that 64% get their true first choice. More strikingly, the number of students who are not matched to one of their top three true choices is around three times higher in the BM simulation (see Table 11). We find a significant difference on the 1%-level between the simulations in terms of how many students are matched to one of their top 3 preferences (χ^2 test with p = .006199). The students are significantly better off under the DA. The simulations support the theoretical arguments that the DA is superior to the BM. Nevertheless, the success of the DA depends highly on the students' awareness that they cannot improve their results by misrepresenting.

[11] In future work we will give more details about the actual functioning and the theoretical properties of the algorithm.

	DA simulation	BM simulation
1st true choice	72.27%	63.91%
2nd true choice	18.96%	15.66%
3rd true choice	4.02%	5.63%
Not matched to top 3	4.75%	14.8%

Table 11: Allocation to true choices in the simulations

8. Conclusion

This work is one of the first that presents field evidence on the actual behavior of students in a school choice setting where the Boston school choice mechanism is used, with a focus on taking into account that the agents are not fully informed. We show that students still act strategically although the outcome is influenced heavily by the incomplete information scenario.

At Paderborn University a variant of the BM is used to allocate students to chairs for writing their Bachelor and Master theses. About 75% of the students misrepresent their preferences. Due to the great number of students and chairs participating in the clearinghouse, students are not fully informed about the other agents preferences although they might assess their own chances at a chair by taking into account how popular a chair is and how the students themselves have performed at the particular chair.

We find strong evidence that this kind of incomplete information has an impact on the students' behavior as well as their chances of success in the mechanism. By taking a closer look at the students' behavior we see that the students act rationally given the limited information. Nevertheless, rationality does not ensure a favorable outcome for the students although sophisticated players reach a significantly better personal outcome than naive students. The mechanism is not strategy-proof and still manipulable by not fully informed agents and students obviously react to the incentives given by the BM to act strategically. More precisely, the students are not fully informed about the other students' and chairs' preferences. By manipulating their preferences sophisticated students might improve their personal outcome. Nevertheless, failing to form the right beliefs or acting naive significantly decreases the student's allocation.

Thus, it is favorable to introduce another algorithm that reduces the problems mentioned above. Obviously, by using a strategy-proof mechanism the incentives to manipulate the preferences would vanish. We have found evidence that a variant of the DA would improve the students' outcomes and eliminate the problems that occur when students try to act strategically. It is crucial, that the DA might only be introduced if it is made really clear for the students that the algorithm actually is strategy-proof.

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Appendix - Translation of the survey:

The survey was done in German, as most students at Paderborn University speak German. The matching mechanism itself is also done completely in German, so we decided to also keep the survey in German. On the following pages we added a translation of the main survey. Additionally, in a separate survey we asked the students for their email addresses to run a lottery of Amazon vouchers. The German version of the survey can be obtained from the authors by request.

The clearinghouse at UPB - Survey

Personal Information

1. Gender
   - ☐ Male
   - ☐ Female

2. Age
   _____

Initiatives

3. Are you member of one particular or several student organizations?
   - ☐ No, I am not a member of any student organization
   - ☐ Yes, of AIESEC/IAESTE
   - ☐ Yes, of the Assoziation türkischer Akademiker (engl.: Association of Turkish Academics)
   - ☐ Yes, of Campus Consult (stud. Unternehmensberatung)
   - ☐ Yes, of Deutschsprachiger Multinationaler Muslimkreis e.V. (DMMK e.V.) (engl.: Group of German-speaking multinational Muslims)
   - ☐ Yes, of Du bist nicht allein (engl.: You are not alone)
   - ☐ Yes, of Europas Studenten bauen auf internationale Zusammenarbeit e.V. (Eurobiz) (engl.: European Students rely on International Cooperation)
   - ☐ Yes, of GoAhead!
   - ☐ Yes, of Hochschulgruppe Spieleabend Paderborn (engl.: Board Game Party Club Paderborn)
   - ☐ Yes, of Internationaler Studierenden-Kreis russischsprachiger Akademiker (ISKRA) (engl.: International Students Group of Russian-speaking Academics)
   - ☐ Yes, of Kickerliga Paderborn (Studylife Paderborn e.V.) (Kicker League Paderborn)
   - ☐ Yes, of Kurdische Studierendenvereinigung in Paderborn (KurdS-Pb) (Kurdish Student Club of Paderborn)
   - ☐ Yes, of Marketing zwischen Theorie und Praxis (MTP e.V.) (engl.: Marketing Between Theory and Practice)

- ☐ Yes, of Model United Nations – University of Paderborn (PaderMUN)
- ☐ Yes, of oikos
- ☐ Yes, of Paderborner lesbische und schwule Studierenden & Friends (PlusS) (engl.: Lesbian and Gay Students Paderborn)
- ☐ Yes, of Persisch Sprachige Studierende (PSS) (engl.: Persian-speaking Students)
- ☐ Yes, of Programmkino Lichtblick e.V. (engl.: Arthouse Cinema Lichtblick)
- ☐ Yes, of Studentenbibelkreis Paderborn (SBK) (engl.: Students' Bible Study Club Paderborn)
- ☐ Yes, of Suryoye
- ☐ Yes, of universal
- ☐ Yes, of UPB Racing Team
- ☐ Other: _____

4. Are you a member of one of the following student associations?
   Please choose only one of the following answers:

   - ☐ No
   - ☐ Yes, of Fachschaft Wirtschaftswissenschaften (engl.: Student Association of Economic Sciences)
   - ☐ Yes, of Fachschaft IBS (engl.: Student Association of International Business Studies)
   - ☐ Yes, of Fachschaft Winfo (engl.: Student Association of Business Information Systems)
   - ☐ Yes, of Fachschaft Wing (engl.: Student Association of Industrial Engineering)
   - ☐ Other: _____

Studies

5. What are you studying?
   Please choose only one of the following answers:

   - ☐ B.Sc. Wirtschaftswissenschaften (engl.: B.Sc. Economic Sciences)
   - ☐ B.Sc. IBS (engl.: B.Sc. International Business Studies)
   - ☐ B.Sc. Lehramt an Berufskollegs (engl.: B.Sc. Lectureship to Teach at Business Colleges)
   - ☐ B.Sc. Wirtschaftsingenieurwesen (engl.: B.Sc. Industrial Engineering)
   - ☐ Other Bachelor degree course

- M.Sc. BWL (engl.: M.Sc. Business Economics)
- M.Sc. IEM (engl.: M.Sc. International Economics and Management)
- M.Sc. IE (engl.: M.Sc. International Economics)
- M.Sc. IBS (engl.: M.Sc. International Business Studies)
- M.Sc. Wirtschaftsinformatik (engl.: M.Sc. Business Information Systems)
- M.Sc. MIS (engl.: M.Sc. Management Information Systems)
- M.Sc. Wirtschaftspädagogik (engl.: M.Sc. Economic Education)
- M.Ed. Wirtschaftspädagogik - Lehramt an Berufskollegs (engl.: M.Ed. Economic Education - Lectureship to teach at Business Colleges)
- M.Ed. Lehramt an Berufskollegs – Fachrichtung WiWi (engl.: M.Ed. Lectureship to Teach at Business Colleges – Speciality Economic Sciences)
- M.Sc. Wirtschaftsingenieurwesen (engl.: M.Sc. Industrial Engineering)

6. Are you studying in your prospective last semester?
   Please choose only one of the following answers:

   - Yes
   - No

7. How many ECTS did you still need to complete your studies prior to this semester?
   Please choose only one of the following answers:

   - Maximally 10 ECTS
   - More than 10 but a maximum of 20 ECTS
   - More than 20 but a maximum of 30 ECTS
   - More than 30 but a maximum of 40 ECTS
   - More than 40 but a maximum of 50 ECTS
   - More than 50 but a maximum of 60 ECTS
   - More than 60 but a maximum of 70 ECTS
   - More than 70 but a maximum of 80 ECTS

Area of Studies

8. What is your area of studies?
   Please choose all correct answers:

   - Management

- ☐ Marketing
- ☐ Personalwirtschaft (engl.: Human Resource Management)
- ☐ Besteuerung (engl.: Taxation)
- ☐ Controlling
- ☐ Finance
- ☐ Produktionsmanagement (engl.: Operations Management)
- ☐ Wirtschaftsinformatik (engl.: Business Information Systems)
- ☐ International Economics/VWL
- ☐ Wirtschaftspädagogik (engl.: Economic Education)
- ☐ Recht (engl.: Law)
- ☐ Ökonometrie/Statistik (engl.: Econometrics/Statistics)
- ☐ No area of studies
- ☐ Other: _____

9. How would you describe your performance in your studies so far?
   Please choose only one of the following answers:

   - ☐ Very good
   - ☐ Good
   - ☐ Average
   - ☐ Below average

10. What kind of thesis are you writing at the moment?
    Please choose only one of the following answers:

    - ☐ Seminar paper
    - ☐ Bachelor thesis
    - ☐ Master thesis

Personal Assessment of the Procedure

11. How well were you informed about the Matching Mechanism before you used it?
    Please choose only one of the following answers:

    - ☐ Very well
    - ☐ Well
    - ☐ Satisfactorily
    - ☐ Poorly

12. Were you informed early enough about the Matching Mechanism? Please use the comment field if you have any comments about the provision of information.
    Please choose only one of the following answers:

    - ☐ Yes
    - ☐ No

    Please write a comment about your decision:
    _____

13. Did you find all the information about the necessary documents for the Matching Mechanism on the homepages of the chairs?
    Please choose only one of the following answers:

    - ☐ Yes
    - ☐ Mostly yes
    - ☐ Mostly no
    - ☐ No

    Please write a comment about your decision:
    _____

Chairs

14. Was it easy to name three chairs?
    Please choose only one of the following answers:

    - ☐ Yes
    - ☐ No

15. Could you imagine naming more than three chairs in the future?
    Please choose only one of the following answers:
    - ☐ Yes, up to 5 chairs
    - ☐ Yes, up to 7 chairs
    - ☐ Yes, up to 10 chairs
    - ☐ Yes, more than 10 chairs
    - ☐ No

Other Applications

16. Did you use exclusively the Vergabeverfahren (engl.: competitive tendering procedure) of departments 1, 2, 4, and 5 of the Faculty for Business Administration and Economics to find a chair for supervision?
    Please choose only one of the following answers:

    - ☐ Yes
    - ☐ No, I applied as described below

    Please write a comment about your application method:
    _____

Understanding

17. Did you understand the Matching Mechanism?
    Please choose only one of the following answers:

    - ☐ Yes
    - ☐ Mostly yes
    - ☐ Mostly no
    - ☐ No

    Please write a comment about your decision:
    _____

The Matching Mechanism

18. Which chairs did you name as the 1st, the 2nd, and the 3rd choices?
    - ☐ Names of professors and chairs were given
19. How high did you estimate your chances to be accepted by your 1st, 2nd, and 3rd choices BEFORE the allocation to a particular chair?
    Please mark one answer for every choice:

	high	rather high	rather low	low	I don't know
1st choice	☐	☐	☐	☐	☐
2nd choice	☐	☐	☐	☐	☐
3rd choice	☐	☐	☐	☐	☐

20. Are you satisfied with the chair allocated to you?
    Please choose only one of the following answers:

    - Very satisfied
    - Satisfied
    - Less satisfied
    - Not satisfied

More Details about the Choice

21. Did you already take courses at your 1st choice?
    Please choose only one of the following answers:

    - Yes, with very good results
    - Yes, with good results
    - Yes, with average results
    - Yes, with below average results
    - Yes, not (yet) finished
    - No

22. Did you already take courses at your 2nd choice?
    Please choose only one of the following answers:

    - Yes, with very good results
    - Yes, with good results
    - Yes, with average results
    - Yes, with below average results
    - Yes, not (yet) finished
    - No

23. Did you already take courses at your 3rd choice?
    Please choose only one of the following answers:

    - ☐ Yes, with very good results
    - ☐ Yes, with good results
    - ☐ Yes, with average results
    - ☐ Yes, with below average results
    - ☐ Yes, not (yet) finished
    - ☐ No

Allocation

24. Which chair were you allocated to?
    Please choose only one of the following answers:

    - ☐ 1st choice
    - ☐ 2nd choice
    - ☐ 3rd choice

25. Did you write your thesis at this chair?
    Please choose only one of the following answers:

    - ☐ Yes
    - ☐ No

Contact in Advance

26. Did you contact the chairs before you chose them as your 1st, 2nd, or 3rd choice?
    Please choose all correct answers:

    - ☐ Yes, the 1st choice
    - ☐ Yes, the 2nd choice
    - ☐ Yes, the 3rd choice

27. If you contacted them, did you receive a positive answer in advance?
    Please choose only one of the following answers:

- ☐ Yes
- ☐ No

Satisfaction

28. Are you satisfied with the Matching Mechanism in general?
    Please choose only one of the following answers:

    - ☐ Very satisfied
    - ☐ Satisfied
    - ☐ Less satisfied
    - ☐ Not satisfied

Further Questions on Your Choice

29. Name five chairs which you think have the highest occupancy rates.
    - ☐ Names of professors and chairs were given

30. Name the five chairs where you would have most liked to write your thesis (this list may differ from your choices in the Matching Mechanism).
    - ☐ Names of professors and chairs were given

31. How do you think your chances stand with these 5 chairs?
    Please choose one answer for each chair:

	high	rather high	rather low	low	I don't know
1st chair	☐	☐	☐	☐	☐
2nd chair	☐	☐	☐	☐	☐
3rd chair	☐	☐	☐	☐	☐
4th chair	☐	☐	☐	☐	☐
5th chair	☐	☐	☐	☐	☐

32. If this list differed from your choices in the Matching Mechanism, what are the reasons?
    Please choose all correct answers:
    - ☐ To increase the chances to get any chair
    - ☐ To increase the chances to get the 2nd choice
    - ☐ To increase the chances to get the 3rd choice

- ☐ The “true” choice was pointless
- ☐ Preferences changed after the submission
- ☐ Chances for a better grade
- ☐ Other: _____

More Details about the “True” Choice

33. Did you already take courses at your “true” 1st choice?
    Please choose only one of the following answers:

    - ☐ Yes, with very good results
    - ☐ Yes, with good results
    - ☐ Yes, with average results
    - ☐ Yes, with below average results
    - ☐ Yes, not (yet) finished
    - ☐ No

34. Did you already take courses at your “true” 2nd choice?
    Please choose only one of the following answers:

    - ☐ Yes, with very good results
    - ☐ Yes, with good results
    - ☐ Yes, with average results
    - ☐ Yes, with below average results
    - ☐ Yes, not (yet) finished
    - ☐ No

35. Did you already take courses at your “true” 3rd choice?
    Please choose only one of the following answers:

    - ☐ Yes, with very good results
    - ☐ Yes, with good results
    - ☐ Yes, with average results
    - ☐ Yes, with below average results
    - ☐ Yes, not (yet) finished
    - ☐ No

36. Did you already take courses at your “true” 4th choice?
    Please choose only one of the following answers:

    - ☐ Yes, with very good results
    - ☐ Yes, with good results
    - ☐ Yes, with average results
    - ☐ Yes, with below average results
    - ☐ Yes, not (yet) finished
    - ☐ No

37. Did you already take courses at your “true” 5th choice?
    Please choose only one of the following answers:

    - ☐ Yes, with very good results
    - ☐ Yes, with good results
    - ☐ Yes, with average results
    - ☐ Yes, with below average results
    - ☐ Yes, not (yet) finished
    - ☐ No

Veto list

38. Are there any chairs where you did not want to write your thesis because you did not visit any courses there?
    Please choose only one of the following answers:

    - ☐ Yes
    - ☐ No

39. Were you allocated to one of these chairs?
    Please choose only one of the following answers:

    - ☐ Yes
    - ☐ No

40. Please create a “veto list” and choose the chairs where you did not want to write your thesis due to subject-specific reasons.
    Please choose between 1 and 15 answers.

    - [ ] Names of professors and chairs were given

Comments

41. I would have wished for the following to happen regarding the Matching Mechanism:
    Please write your answer:
    _____

42. Do you have any further comments regarding to the Matching Mechanism?
    Please write your answer:
    _____

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