Matching Mechanisms on the Test Bench - Preferences, Design and Strategic Behavior

Der Fakultät für Wirtschaftswissenschaften der Universität Paderborn zur Erlangung des akademischen Grades

Doktor der Wirtschaftswissenschaften
– Doctor rerum politicarum –

vorgelegte Dissertation von

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geboren am 22.05.1994 in Moers

Paderborn, November 2025

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Acknowledgements

This thesis marks the end of one journey and the beginning of another. It was made possible by the many companions who guided, encouraged, and challenged me along the way. This time has been a winding road, filled with detours, steep climbs, beautiful discoveries, and unexpected views.

First, to my supervisor, Claus-Jochen Haake, who provided both the map and the compass, by introducing me to the world of Game Theory. Thank you for giving me the opportunity to follow this path, to explore what has become my main research focus, matching theory, and for all that I have learned from your feedback.

I consider myself truly lucky to be guided by not only one mentor but two. Nadja Stroh-Maraun, thank you for being my co-author, inspiring me to become a great researcher and stepping up when necessary. Thank you for listening, challenging me, your dedication and creating such a positive working atmosphere. I had the pleasure of attending conferences, writing papers, and sharing both the challenging and enjoyable stages of this journey with you.

I am grateful to the members of my PhD committee for being part of this process and for their commitment to guiding the final steps of my research. Thank you, Burkhard Hehenkamp, for the fruitful discussions we shared during *Research Wednesdays* and *Research Weeks*. Thank you, Daniel Beverungen, for the different perspectives you opened me up to and the discussions about equilibria.

My sincere thanks go to all my (former) colleagues at Paderborn University for being such great travel companion on this academic journey. I consider myself very lucky to have worked with so many great colleagues who created and continue to create a wonderful working atmosphere. Thank you for the international conferences we attended together, the jointed *Research Wednesdays* and *Research Weeks*, insightful discussions, valuable feedback and bringing fun into our days.

Special thanks to my co-authors Papatya Duman, Thomas Streck, Britta Hoyer and Nadja Stroh-Maraun for their collaboration and for the many insightful discussions that strengthened this work. Papatya, thank you, for being the perfect office mate: someone who shared not only research ideas and language skills but also my exact preferences for room temperature and window status. Thank you for traveling to several conferences with me and for sharing both the hard work and the fun. Thank you, Thomas, for the chocolate discussions, the Pub Quizzes you designed and lightening the mood.

I am deeply thankful to Stephanie Langenströer for her constant support, open ears, and kindness in helping me navigate academic matters. I sincerely appreciate the care and attention you've shown, far beyond what's expected, to me and the whole team. I would like to thank Alexander Koch for the good humor that made even the trickier days fun, deepening our mathematical understanding together, and sharing stories of our travels. Moreover, I want to thank my more recent colleagues, Marius Baltrusch, Jie Liu and Juri Krais. I am grateful for your contribution to the supportive atmosphere at our chair and for your help and encouragement as this dissertation approached its completion.

I would also like to thank all former chair members and student assistants for their valuable contributions to my research. I thank the SFB 901 and the Faculty for supporting my participation in international conferences and fostering valuable scientific connections.

This journey was shaped not only by those who walked beside me but also by those in the background, whose unseen contributions kept the path clear and my spirits high. I am grateful to my friends. Thank you for lightening my mood, for parties, for playing board games, the talks and for filling this journey with friendship. It is a blessing to have friends like you.

Thanks to my godchildren for taking my mind off work, making me laugh, and bringing so much joy into my life.

To my parents, who cheered me on from near and far and always believed in me. They gave me the confidence to take each new step and follow my own path. Thanks to my sister, whose company is always effortless and whose presence reminds me how good it is just to have each other. My family shared with me the joy of travel and to be curious about the world beyond my own.

Last but not least, I would like to thank my perfect match. Thank you for being by my side throughout this journey, for your invaluable support during the challenging phases of my thesis, and for the wonderful adventures we shared along the way. You have been my anchor wherever the road has taken me. Your presence made both the hard work and the breaks in between truly meaningful.

Paderborn, November 2025 *Sarah Kühn*

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CHAPTER 1 Introduction

How can we effectively assign students to schools, kidney donors to recipients, or doctors to hospitals, all while ensuring mutually beneficial matches? Matching theory provides the tools to address such problems by designing markets where who is matched with whom or what matters more than price considerations. Allocation is therefore not simply a matter of offering a higher price or solving an optimization problem based on valuations. Since each agent's valuation of potential matches is private, assignment problems in matching markets are better understood as the design of markets and mechanisms. These mechanisms must also identify and elicit the agents' corresponding preferences. Thus, preferences play a central role in determining outcomes in matching markets for indivisible goods and services, and they remain central throughout this thesis.

The analysis of matching markets has gained considerable attention over the past decades, particularly with the award of the Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel to Alvin Roth and Lloyd Shapley in 2012 (NobelPrize.org, 2012). Their important contributions influenced both theorists and the general public alike. Roth (2012) noted in his Nobel Prize Lecture: "We use a lot of tools in market design, because to understand existing markets and marketplaces, [...] you have to attack the problem from all directions." Hence, matching problems have been studied in theory, experiments, and empirical work, and their practical applications have expanded rapidly in recent years – a development that we explore in our own work.

Although the literature on matching is well developed, adapting existing models remains challenging. Even small modifications to a known model, design or mechanism can lead to significant changes in outcomes. This makes it necessary to carefully analyze how such adjustments affect theoretical properties and practical performance. Moreover, the goals of matching problems may vary across contexts, requiring shifts in perspective depending on the application and benefiting from generalized frameworks that cover a broader range. In this work, we[1] contribute to this discussion by answering the following question: *How do modifications to established matching models, designs, and mechanisms affect their performance and theoretical properties?* Preference elicitation and the role of outside options are at the core of our analysis. To this end, we combine theoretical, experimental, and empirical analyses, and run simulations where applicable.

In our research, we focus on a particular kind of market, as preferences determine who gets what. Let us consider a small example to introduce these matching markets. One of the most well-known matching markets in both theory and practice is college admissions. Since seats at colleges are a scarce resource, not every student can freely choose which college to go to. Admission to a college requires formal acceptance; you cannot simply choose to attend without being admitted. Instead, who attends which college depends on the preferences of both students and colleges. While students may prefer colleges that offer certain majors, colleges may prefer students with good grades or particular interests. Hence, colleges do not simply select students based on financial considerations. Comparable concepts emerge across a variety of allocation settings. For instance, consider the allocation of children to child care centers. Available slots are limited, and parents have specific expectations that each center should satisfy. At the same time, centers face capacity constraints and apply admission criteria to decide which children to admit. However, the larger such a market becomes, the less likely it is that all centers know all relevant children, and vice versa. The common assumption made by market designers in theory, that agents in a market are able to express preferences over all options, is not always applicable. Consider, for example, the dataset provided by a municipality in Germany, which we study in Chapter 3.5.

[1] Throughout this thesis, I use 'we' for consistency, although some chapters are co-authored while others were written independently.

Centers would have to form preferences over 2844 children. Consequently, the way preferences are elicited is crucial for determining the allocation in the subsequent step. We address this gap by relaxing prior assumptions and developing new approaches for eliciting and managing preferences. Specifically, we analyze the elicitation of preferences when agents are not fully informed about all available options and how preferences are elicited in experiments. Now consider that the problem becomes more complex when centers offer different types of slots depending on the time a child spends in care. While the college admission problem is well established and extensively studied, adding an additional dimension requires adaptations that should be evaluated prior to implementation.

Most studies of matching markets in the literature also retain features related to the outside option. Agents are usually assumed to have preferences over other agents or options on the other market side as well as the option of remaining unmatched. However, little attention has been paid to the impact that unmatched agents may have, or to the benefits they could bring to the market if they were matched. Incorporating such outside options explicitly into market design could improve outcomes. This thesis examines such a market where explicitly modeling the outside option reduces the number of unmatched agents. Collectively, these added dimensions underline the importance of a careful examination of preferences and their elicitation in the context of adapting standard matching models, designs and mechanisms.

This introduction provides the theoretical and experimental background on matching markets relevant to this thesis. Within this first section, we explicitly note which parts of the introduction are most closely connected to individual chapters and where we identify research gaps. We then outline how these gaps are addressed and present the contributions of each chapter in greater detail in Section 1.2.

Afterwards, this thesis proceeds as follows: In Chapter 2, we put the elicitation of preferences in experiments to the test. We examine how non-induced preferences in matching experiments affect participants' behavior relative to induced preferences used in earlier studies. For this purpose, we implement a school choice experiment and ask participants to act upon their own or induced preferences. In Chapter 3, we deal with different attempts to elicit preferences of children to allocate them to child care centers based on versions of the Deferred Acceptance Mechanism. We compare four mechanisms used in practice and theory and compare their advantages. In Chapter 4, we model a neighborhood help market with community costs for unmatched neighbors. Neighbors explicitly stating preferences not only about other neighbors but also the outside option allows us to implement a Pareto-constrained cost-minimal mechanism. We conclude in Chapter 5.

1.1 Matching Markets

The first design of a matching market was provided in 1962 by David Gale and Lloyd Shapley, laying the foundation for many following analyses, including ours. They model a marriage market, matching women to men, to describe the paring of individuals or groups. This marriage metaphor underlines the mutual nature of choice, you cannot simply choose, you must also be chosen. A set of women and a set of men aim to be paired with a member of the opposite set. To find mutually beneficial pairings, both sides state strict preferences over each other. Gale & Shapley (1962) define stability as a desirable property for evaluating a possible allocation. Stability ensures individual rationality and no blocking by any pair. On the one hand, individual rationality guarantees that each agent is matched to an acceptable partner, who is preferred over remaining single. On the other hand, a matching is not blocked by a pair if there exists no woman and man who both like each other more than their current match. Thus, no blocking ensures that no one finds a more desirable partner in the market who also wishes to deviate. A stable matching always exists and can be found by applying the Deferred Acceptance (DA) Mechanism. This mechanism plays a crucial role in Chapter 2 and 3. While we apply the DA and two other mechanisms in our experiment in Chapter 2, the DA is adopted in Chapter 3 to find an allocation for the child care allocation problem. Thus, this standard mechanism offers many possibilities for use in a variety of settings. However, modifications to it must be evaluated carefully. In the DA, one side of the market (men or women) proposes to the other side based on their preferences. The receivers tentatively accept their most preferred proposal among previous and new proposals and reject all others. Rejected proposers move on to their next preferred choice, and so on. Final acceptances are deferred until no proposal is rejected, at which point the mechanism terminates. The final allocation is optimal stable for the proposing side and it is a weakly dominant strategy for proposers to state true preference, i.e. the DA is strategy-proof for the proposing side. However, this does not hold for the receiving side. This framework is a two-sided, one-to-one matching market as both sides seek exactly one match.

While in Chapter 4 a one-to-one matching market comes into play, both, Chapter 2 and 3, examine a many-to-one matching market. Gale & Shapley (1962) further extent their two-sided model to a many-to-one matching market, matching students to seats at collages. While many results carry over from the one-to-one case (such as the DA producing a stable outcome), colleges may improve their match by not revealing their true preferences. Truth-telling is only a weakly dominant strategy for students in the student-proposing DA, but not for collages in any stable matching (Roth & Sotomayor, 1990). This underlines the importance to carefully evaluate changes to existing models. Gale & Shapley (1962) assume collages to have preferences over students. In following work, Roth (1985) assumes that colleges have preferences over assignments. At first, this difference may sound trivial. However, if a student becomes more desirable in the presence of a particular other student, the two options may not coincide. To ensure that a preference relation over a set of students, i.e. over assignments, can be represented by a list of preferences over individual students, preferences need to be responsive (Roth, 1985).

While colleges' strategic behavior needs to be considered in a collage admission problem, this may not be the case in school choice. Schools to which students want to be matched may not behave strategically. Depending on the degree of autonomy a school is given, school seats can be considered objects to be allocated to students, or schools can be treated as active players. To model this tension and to underline the differences between a school choice and a college admission problem, Abdulkadiroğlu & Sönmez (2003) model schools' priorities instead of preferences. These priorities are typically determined by local law, for example through walking distance or the presence of siblings already enrolled at a school. Models that consider one side's priorities rather than preferences are often considered to have an intermediate position between one-sided and two-sided matching markets. This structure is adopted across all chapters of the thesis and will be elaborated on for each setting in greater detail within the corresponding chapters. While the DA, e.g. the student-proposing version, can still be applied, Abdulkadiroğlu & Sönmez (2003) investigate a mechanism formerly used in a real-world school choice problem in Boston. The Boston mechanism (BOS), also called first-preference-first mechanism, proceeds similar to the DA with one significant difference: In each round, non-rejected students are irrevocably accepted. By that, in a round k, a student can only announce their k-th best choice and matched students and schools with exhausted capacity drop out. For this mechanism, Ergin & Sönmez (2006) show that the set of Nash equilibrium outcomes is equal to the set of stable matchings. However, this is only with respect to true preferences. When the BOS is applied, it is not safe to state true preference as the mechanism is not strategy-proof. It does not yield a stable outcome. However, as this mechanism is (still) commonly used in practice, we consider it together with the DA in our experiment in Chapter 2. Since the seminal paper by Abdulkadiroğlu & Sönmez (2003) not only Boston adjusted the mechanism used (Abdulkadiroğlu et al., 2005b) but also New York City (Abdulkadiroğlu et al., 2005a). This demonstrates how theoretical analysis can inform and improve the decision-making processes of market designers in practice. Just as Abdulkadiroğlu & Sönmez (2003) addressed this research gap in their analysis of the school choice problem, we aim to fill a similar gap in the context of child care allocation problems in Chapter 3 and neighborhood help problems in Chapter 4.

In contrast to theoretical predictions, experimental and real-world evidence shows that individuals do not always behave rationally or use dominant strategies such as truth-telling. As a result, observed rates of truth-telling are often far below 100%, even when it is a dominant strategy. Chen & Sönmez (2006) initiated the school choice matching experiment branch. Their experiment compares truthful preference reporting and the efficiency of the DA, BOS and Top Trading Cycles (TTC) mechanism (discussed in the subsequent paragraph) in a laboratory setting. They support that the proportion of truthful preference revelation under BOS is significantly lower than under the two other mechanisms. However, no mechanism is more efficient than the others (Calsamiglia et al., 2011). Following analyses focus on the amount and kind of information provided or the understanding of participants (among others Pais & Pintér, 2008; Chen et al., 2016; Hakimov & Kübler, 2021; Guillen & Hakimov, 2017; Koutout et al., 2021; Guillen & Veszteg, 2021). In general, absolute values of truth-telling in experiments strongly depend on the context of the study and are hardly comparable between experiments (compare Figure 2.1 in Chapter 2). Nonetheless, laboratory settings offer a key advantage: both true and reported preferences can be observed, unlike in most field studies. Only a few field experiments have managed to elicit participants' true preferences (Guillen & Hakimov, 2018; He & Magnac, 2018; Hoyer & Stroh-Maraun, 2020). However, we have to emphasize that the true preferences considered in experiments refer to induced preferences, meaning that participants get told what to like during the experiment. This raises a crucial question: Do induced preferences truly incentivize participants in the same way that non-induced preferences do? We fill this research gap in Chapter 2 by conducting an experiment with induced and non-induced preferences.

The degree to which schools are regarded as active and strategic agents determines how closely the school choice setting resembles a one-sided or two-sided market. As noted above, school choice, therefore, combines characteristics of both two-sided and one-sided markets, making it useful to examine the latter in more detail. In a one-sided market, as the term implies, only one side of the market has preferences. Agents are therefore allocated to objects or services that have no preferences of their own. The most famous example is the housing market by Shapley & Scarf (1974). Agents enter the market each endowed with a house that they would like to reassign among themselves. While agents will only agree to exchanges that leave them with a more preferred house, the houses themselves do not have preferences. Thus, stability is no longer a desirable property, as only the perspective of the agents needs to be considered. Shapley & Scarf (1974) define Pareto-efficiency as a criterion to evaluate whether an allocation can be improved for at least one agent while leaving all other agents no worse off. They introduce Gale's Top Trading Cycles (TTC) algorithm to create mutually beneficial exchanges among agents to find a Pareto-efficient matching[2]. In each round, agents point to the owner of their most preferred house among all available houses. At least one cycle is created and all agents in the cycle rotate their houses. This procedure ends, when all agents are matched to a house. It is strategy-proof (Roth, 1982) and yields an allocation that is Pareto-efficient (Roth & Postlewaite, 1977). The TTC can also be employed in the school choice problem (Abdulkadiroğlu & Sönmez, 2003). As stated previously, we build on this application in Chapter 2 by incorporating the TTC in our experiment. Of course, the exchange of houses and the school choice problem are not the only applications of such mechanisms. Additional examples include the allocation of thesis topics to students and organ exchanges. In the following, we briefly introduce kidney exchanges, since Chapter 4 incorporates both the housing market and the kidney exchange market, as introduced by Roth et al. (2004), as special cases. Both, the kidney exchange problem as well as our neighborhood help problem in Chapter 4 are one-to-one markets.

There are two ways for a patient in need for a kidney transplant to receive a donation, from cadavers or from living donors. If no compatible living donor can be found, a kidney exchange may involve two incompatible donor-patient pairs swapping their donors. Roth et al. (2004) combine these exchanges with a waiting list for cadaver kidneys. A pair willing to donate to someone on the waiting list will in return be prioritized when a compatible cadaver kidney becomes available. They suggest the Top Trading Cycles and Chains (TTCC) mechanism which allows for cycles as in the TTC and chains which includes patient-donor pairs pointing to the waiting list. However, the kidney exchange model only allows for patients who are accompanied by a donor. How can we adapt the model and the mechanism if patients with and without donors enter the market, and altruistic donors are willing to donate a kidney

[2]For a commemorative and summarizing overview see Morrill & Roth (2024) and Afacan et al. (2024).

without being paired with a specific patient? These considerations are of great importance to find matches not only for kidney exchange problems. In any market where help, here in the form of donated kidneys, is given and received, this consideration plays a crucial role. However, the TTCC may not be directly applicable in every context, as it does not apply to the neighborhood help market. In Chapter 4, we introduce a new mechanism, the Neighborhood Top Trading Cycles and Chains (NTTCC) mechanism. It allows for a more diverse set of agents and applications than the TTCC. By that, we create a Pareto-constrained cost-minimal mechanism. This also allows the NTTCC to be applied in kidney exchange markets with paired and unpaired patients and donors. Since Roth et al. (2004), research on organ exchange has expanded significantly and every year additional countries join kidney exchange programs[3]. This example highlights the dynamic interplay between theory and practice, a connection that our analyses in this thesis likewise aim to advance.

Hatfield & Milgrom (2005) explore certain similarities among all of these matching markets and extend the models presented above by adding contractual terms. In their example a matching consists of a doctor and hospital agreeing on a contract. However, the same model could be applied to students and collages agreeing on certain terms, e.g. scholarships. Thus, we are getting back to many-to-one matching markets. Alternatively to hospitals forming preferences over the set of allocations, preferences may be represented through choice functions. In contrast to comparing two sets of doctors, the choice function approach specifies which subset a hospital would choose from any given set. A central assumption for proving the existence of stable allocations in such a market is substitutability. A hospital's selection rule is said to satisfy substitutability if, whenever the hospital chooses a particular contract from some set of available contracts, it also continues to choose that contract from every smaller set of contracts that still contains it. Given substitutability and the irrelevance of rejected contracts, there exists a stable matching. Hatfield & Milgrom (2005) introduce the Cumulative Offer Process (COP) which generalizes the student(doctor)-proposing DA for matching with contracts to

[3]For a summary on Kidney exchange programs in Europe see Biró et al. (2019).

find such a stable matching. The Hatfield and Milgrom model was further adapted to situations where preferences may not be substitutes. Such examples include bilateral substitutes by Hatfield & Kojima (2010), the matching with slot-specific priorities by Kominers & Sönmez (2016) and the cadet-branch matching by Sönmez & Switzer (2013). In Chapter 3, we apply parts of their considerations to a child care allocation problem with care durations. In this case, care durations are a special version of contracts. However, the number of options over which preferences must be formed increases when contracts are incorporated, since preferences then concern not only hospitals but also the individual contracts each hospital offers. Therefore, complete preference elicitation often becomes unrealizable in practice.

Providing background information on the markets studied in this thesis and identifying existing research gaps allows us to proceed to the specific contributions of each chapter. We summarize the types of matching markets described so far in Figure 1.1. The topics covered in this thesis are marked accordingly. It should be noted, however, that this overview is not intended to be complete.

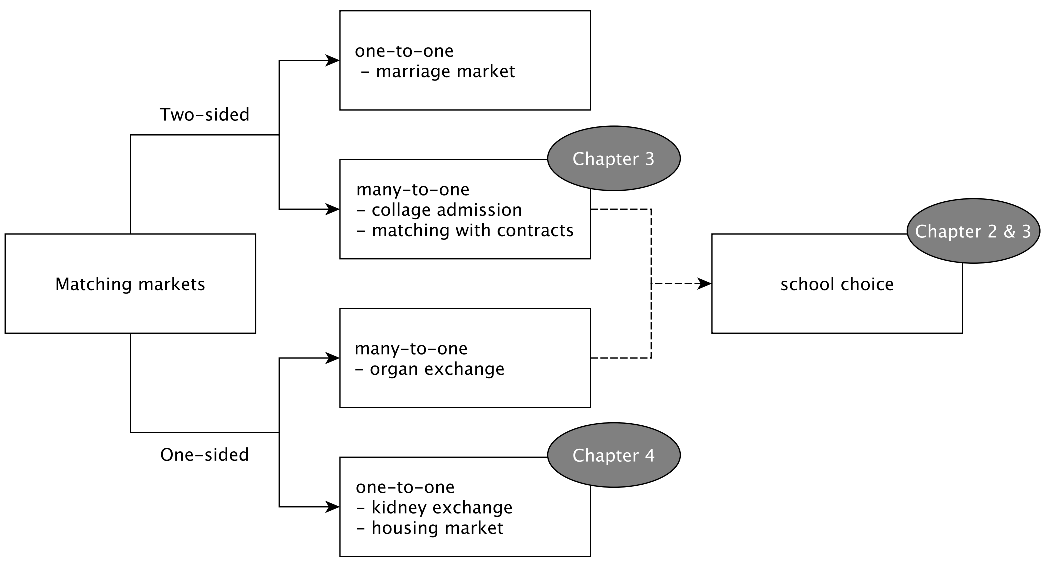

Figure 1.1: Overview Matching Markets

1.2 Contributions

As we have seen, the matching literature has grown considerably in recent decades. Nevertheless, as practitioners increasingly apply matching models, theorists are called upon to provide a stronger theoretical foundation for these applications. This need is particularly evident when existing market designs must be adapted to accommodate specific requirements or contexts. In the following sections, we outline how this thesis addresses such gaps in the literature and briefly summarize the contributions of each chapter.

This thesis places particular emphasis on preferences and mechanisms. Preferences are central to identifying an allocation, but the manner in which they are elicited builds the foundation of each mechanism. We demonstrate how preferences are addressed in school choice experiments, child care allocation, and neighborhood help problems, particularly in contexts where standard models fall short.

As outlined earlier, school choice has been extensively studied from theoretical, empirical, and experimental perspectives. We therefore begin our analysis with the school choice market. Chapter 2 serves as a natural starting point, as it examines the original school choice model and the mechanisms that remain unchanged, whereas the subsequent chapters focus on specific models that have not been discussed in this manner in the existing literature. The reason is straightforward: Chapter 2 presents the analysis of a school choice experiment, whereas Chapters 3 and 4 focus primarily on theoretical analyses.

There are numerous school choice experiments shedding light on participants' behavior. While some studies focus on the differences between mechanisms, others focus on the impact of provided information on participants. However, experimental analyses have typically relied on induced preferences to study participants' behavior and to derive policy implications (see Hakimov & Kübler (2021) for a detailed survey). Thus, the experiment prescribes the participants' preferences rather than allowing them to emerge naturally. From a practical standpoint in the conduct of an experiment, such an approach may appear reasonable, but it is far from reality. This led us to consider whether the participants might have been affected by this experimental setup. In Chapter 2 we fill this gap by analyzing a matching experiment with and without induced preferences. It carries the title **"Non-induced Preferences in Matching Experiments"** and is coauthored by Papatya Duman, Britta Hoyer, Thomas Streck and Nadja Stroh-Maraun. By incorporating non-induced preferences, we extend the experiment by Chen & Sönmez (2006). We run the experiment with a treatment group with non-induced preferences and a control group with induced preferences. In order to capture both types of preferences, we construct a scenario in which participants imagine being assigned to different departments of a chocolate company following the same structure as students would be assigned to schools. Each department corresponds to a particular chocolate variant, and allocation is based on participants' stated preferences for these variants. The experiment is conducted in two stages, with only stage one differing between groups. In the first stage, the control group receives induced preferences as in a standard matching experiment, while the treatment group is asked for personal preferences over chocolate variants. In the second stage, participants state an order in which they want to apply to the departments within the chocolate company. A matching mechanism, which participants are informed about in advance, then uses these reports to allocate participants to departments.

This allocation and the preferences from stage one determine participants' payoffs. Being matched to a department that corresponded to a more-preferred chocolate type resulted in a higher payoff, while being allocated to a less-preferred type yielded a lower payoff. Thus, monetary incentives are based on participants' induced or non-induced preferences. As discussed earlier, there are three mechanisms most frequently used and studied to date. We therefore compare the treatment and control groups under BOS, DA, and TTC, implementing a 3×2 design.

Consistent with many other matching experiments, the majority of participants do not report their preferences truthfully, even when it is a dominant strategy. This tendency is particularly pronounced in the control group, where we find significantly lower levels of truth-telling compared to the treatment group. Moreover, we show that efficiency is reduced by non-truthful behavior in all groups, with the decline again most evident in the control group.

However, we do not observe significant differences across the mechanisms. Taken together, our findings highlight the importance of accounting for the non-induction of preferences when designing future matching experiments.

Our experiment shows that the formation of preferences plays a crucial role and needs to be considered when designing experiments. As policy implications are driven by the results of experimental and theoretical analyses, we further want to see how allocation problems are dealt with in real-world applications. Consequently, how preference elicitation is designed in matching problems is of particular interest, as it may differ from previous theoretical assumptions. We analyze how real-world applications reflect or challenge existing theoretical frameworks and how theoretical analyses improve the usage in practice. To this end, in Chapter 3 and 4 we provide theoretical analyses of two practical markets: the child care allocation market and the neighborhood help market. While the former is already in practical use, the latter has not yet been implemented, but would benefit from the introduction of a centralized structure as proposed. We supplement the theoretical analyses of the child care allocation market by simulations based on real-world data and provide a unique perspective on its characteristics.

Let us begin by taking a closer look at Chapter 3, entitled **"Child Care Allocation Mechanisms: Navigating Incomplete Preference Elicitation"**. As the title suggests, we study the allocation of children to child care centers. In Germany, every child over the age of three is legally entitled to care in a child care center[4], even though there is a shortage of qualified staff. As a result, the market is characterized by excess demand and is highly competitive. At the same time, centers retain a high level of autonomy in selecting children when demand exceeds capacity. Nevertheless, most centers rely on objective criteria in making their admissions decisions, such as prioritizing siblings or children from the local neighborhood. Since the preferences and priorities of both sides of the market matter, stability represents a desirable criterion for evaluating an allocation. Because centers rely on objective criteria, only parents are expected to behave strategically. Thus, up to this point, we consider a two-sided matching market that shares many similarities with school

[4] §24 of the Social Code Book VIII (SGB VIII)

choice. However, school choice problems model only part of the problem. What makes our model different from a school choice model are care durations. Centers and parents agree on contractual terms that reflect the amount of time a child spends in care. Hence, seats at a center are differentiated by predefined duration terms, and we model the child care allocation problem with care durations. To make the DA applicable to this setting, we could simply ignore durations. Then no modification would be necessary, as the existing literature already provides the required framework. However, allocated centers and families still have to discuss how many hours a child stays in care each week. In practice, this actually happens: children are allocated to centers, and bilateral discussions within each center determine the care duration. It is quite intuitive that this may cause problems: Who gets a certain duration if two families prefer the same duration, which is only available once? What if both parents are working and the longest available duration is not offered by the allocated center? We later refer to this way of implementing the DA as *2DA*, since the DA is first applied to allocate children to centers and then used again to allocate durations among the children within each center. Our analysis aims to shed light on these implementations, which apply versions of the DA that have not been put on the test bench before their implementation. We will compare three practical mechanisms with a theoretical mechanism, the COP.

The COP by Hatfield & Milgrom (2005) for matching with contracts may be applied, as durations can be interpreted as contracts between parents and centers. However, two aspects must be considered: first, contracts may not be substitutes, which makes a straightforward transfer of the COP's properties between the original market and the child care market impossible. Second, the child care market may be large, making it impossible for parents to form preferences over all centers and durations. Consider, for example, the dataset provided by a municipality in Germany with 92 centers and 4 durations, which we study in Chapter 3.5. Parents would have to compare in total 368 options. Several municipalities in Germany have, therefore, implemented a version of the DA to find an allocation that requires less detailed preference information. To do so, parents are asked to order preferences over centers and durations separately. We compare different adaptations to examine whether the properties of the original DA carry over. Our analysis shows that preferences need to satisfy different assumptions to ensure that the mechanisms are strategy-proof and yield a stable outcome. However, the assumptions required for the *2DA* and a second mechanism are quite strong and do not seem realistic. Thus, the third mechanisms, the so-called DA-lexi, produces the best results. We support our theoretical results with simulations based on real data. Overall, our analysis highlights the demand for adapting existing models to account for care durations and incomplete preference formation.

The challenge of changing the way preferences are taken into account arises not only in the child care allocation problem. The neighborhood help market also faces the difficulty that existing theoretical frameworks do not readily carry over. Thus, in Chapter 4, coauthored by Nadja Stroh-Maraun, we present an explicit model of a neighborhood help market. It is titled **"Community Costs in Neighborhood Help Problems"**. Suppose there are neighbors in a community who wish to support one another. Neighbors may support one another by activities such as mowing the lawn, tutoring children or grocery shopping. While some neighbors provide help altruistically, others may seek assistance with or without offering help in return. To connect those seeking help with those willing to provide it, we model a neighborhood help market. By that, one agent can be present on both sides of the market, seeking at helping at the same time. However, not all agents need to be on both sides. This is different to most other matching markets where agents are restricted to one side of the market (compare Andersson et al., 2021; Roth et al., 2004). We fill this gap in the literature by providing a model and mechanism that are applicable to a broader range of settings and allow for more types of agents. As discussed earlier, it extents the kidney exchange model by Roth et al. (2004) as in their setting patients always have to enter the market together with a donor.

On neighborhood help markets, the help offered needs to be compatible with one's needs. Hence, not everybody can help everybody. For example, consider tutoring: not every neighbor is able to provide this kind of help, since it requires subject knowledge and teaching ability. This illustrates that the set of potential matches is constrained by the compatibility between the help required and the help available. By that, it may occur that not all neighbors can be matched with a helper, in which case they must rely on costly outside options. In these cases, neighbors who seek help but stay unmatched, have no incentive to also provide help on the market.

The potential impact of those who remain unmatched is often not considered further in the literature. Incorporating outside opportunities into the model provides a more realistic representation of help-based markets and allows us to analyze how such considerations influence allocation outcomes and market efficiency. We address this gap in the literature by explicitly incorporating an outside option, which we interpret as the community's effort to assist all unmatched neighbors. We call this the pool option. Thereby, the community incentivizes seekers who provide help in return to stay in the market. We could interpret this community's effort as a community fund that finds and pays the cost of unmatched neighbors. Therefore, the community aims to prioritize helping one another and to reduce the costs faced by unmatched neighbors, so as to provide for as many members as possible within the market. At first glance, matching neighbors to services may resemble the standard housing market introduced by Shapley & Scarf (1974), where a matching can be found via the TTC. However, by introducing the pool, costs can be reduced further when applying our new mechanism, the Neighborhood Top Trading Cycles and Chains mechanism (NTTCC). As the name suggests, the mechanism considers not only cycles but also chains that end in the pool. It relates to the TTCC by Roth et al. (2004) for kidney exchange. However, the TTCC is restricted to a certain market structure, making it a special case of the NTTCC. This extension allows for weakly more exchanges and weakly less community costs than under the TTC. Additionally, we show that the NTTCC yields a Pareto-constrained cost-minimal allocation, i.e., there is no allocation that further minimizes costs without harming any seeker when constrained by Pareto efficiency. Hence, our mechanism provides a robust new approach to match seeking to helping neighbors while keeping costs low.

As a concluding remark, it should be noted that the chapters that follow were written as independent research papers. As a result, they may display minor differences in terminology and notation. Some overlaps, particularly in the introductions and literature reviews, are therefore unavoidable.

CHAPTER 2

Non-induced Preferences in Matching Experiments

Sarah Kühn, Papatya Duman, Britta Hoyer, Thomas Streck and Nadja Stroh-Maraun

Working Paper of an earlier version can be found in:
Kühn, S., Duman, P., Hoyer, B., Streck, T., & Stroh-Maraun, N. (2025). *Non-induced Preferences in Matching Experiments.* Working Papers Dissertations 159, Paderborn University, Faculty of Business Administration and Economics

CHAPTER 3

Child Care Allocation Mechanisms: Navigating Incomplete Preference Elicitation

Sarah Kühn

Working Paper of an earlier version can be found in:
Kühn, S. (2025). *Child Care Allocation Mechanisms: Navigating Incomplete Preference Elicitation*. Working Papers Dissertations 162, Paderborn University, Faculty of Business Administration and Economics

CHAPTER 4

Community Costs in Neighborhood Help Problems

Sarah Kühn and Nadja Stroh-Maraun

Working Paper of an earlier version can be found in:
Kühn, S. & Stroh-Maraun, N. (2025). *Community Costs in Neighborhood Help Problems.* Working Papers Dissertations 158, Paderborn University, Faculty of Business Administration and Economics

CHAPTER 5 Conclusion

In summary, this thesis examines matching markets to investigate whether and how modifications to established models, designs, and mechanisms affect their performance and theoretical properties. In doing so, we effectively put matching mechanisms on the test bench. Simply assuming that standard mechanisms can be applied across a variety of settings without verification is problematic, as seemingly minor adjustments can have substantial consequences. Outcomes often deviate from theoretical expectations: experimental designs frequently rely on standard mechanisms without questioning their suitability; children may be allocated to unacceptable durations or have justified envy toward others; and neighbors may leave the market unmatched, losing substantial potential. These examples highlight the importance of recognizing that real-world applications present challenges that differ from previously studied theoretical settings.

This thesis addresses the question of how modifications to established matching models, designs, and mechanisms influence their performance and theoretical properties. To achieve this, it combines theoretical, experimental, and empirical analyses, allowing matching theory to become a practical tool for understanding and improving real allocation processes. The experiment presented in Chapter 2 investigates the role of preference induction versus non-induction in standard school choice experiments. Our results show that preference induction affects truthful reporting and comprehension of mechanisms. This highlights how experimental design choices affect the reliability of behavioral findings and have direct implications for policy evaluation. The subsequent theoretical analyses introduce new models tailored to specific contexts: Chapter 3 focuses on a child care allocation problem with care durations.

While variants of the DA, originally designed for school choice problems (Abdulkadiroğlu & Sönmez, 2003), allow these durations to be incorporated in various ways, they may lead to different outcomes. We conduct a comparative analysis to contrast mechanisms used in practice with the COP, which was originally designed for matching with contracts (Hatfield & Milgrom, 2005). In doing so, we show that eliciting preferences in large markets can be handled in different ways, with one mechanism used in practice offering a distinct advantage over the others.

Chapter 4 examines a neighborhood help market. We introduce a Pareto-constrained cost-minimal mechanism, the NTTCC, to allocate help among neighbors. In contrast to previous studies, we allow for different types of neighbors and explicitly model the outside option. By incorporating the outside option, our model becomes applicable to a broader range of settings and increases the number of agents that can be matched compared to the TTC proposed by Shapley & Scarf (1974).

Even though all chapters were written independently and address their own research questions, they share a common objective: to put matching designs to the test. Preferences play a central role throughout these analyses. We relax several assumptions found in previous studies, particularly those concerning the induction of preferences in experiments, the simplification of preference formation in large markets, and the treatment of outside options. Across all chapters, we demonstrate that adaptations to existing models and mechanisms are not only possible but also necessary to achieve outcomes that are both theoretically sound and practically effective.

Our findings indicate that the existing literature on matching markets is far from complete. Consequently, our analysis also points to several promising directions for future research. It would be interesting to examine how experimental results change once preferences are no longer induced. In Chapter 3, we simulated parts of the empirical analysis for mechanisms used in child care allocations; conducting a corresponding field study would enhance our understanding of the given mechanisms. In the context of the neighborhood help market, it would be interesting to explore how the model could be applied to organ exchange markets.

Bibliography

Abdulkadiroğlu, A., Pathak, P. A., & Roth, A. E. (2005). The new york city high school match. *The American Economic Review*, 95(2), 364–367.

Abdulkadiroğlu, A. & Sönmez, T. (1998). Random serial dictatorship and the core from random endowments in house allocation problems. *Econometrica*, 66(3), 689.

Abdulkadiroğlu, A. & Sönmez, T. (1999). House allocation with existing tenants. *Journal of Economic Theory*, 88(2), 233–260.

Abdulkadiroğlu, A. & Sönmez, T. (2003). School choice: A mechanism design approach. *The American Economic Review*, 93(3), 729–747.

Abdulkadiroğlu, A. & Andersson, T. (2023). Chapter 3 - school choice. volume 6 of *Handbook of the Economics of Education* (pp. 135–185). Elsevier.

Abdulkadiroğlu, A., Che, Y.-K., Pathak, P. A., Roth, A. E., & Tercieux, O. (2020a). Efficiency, justified envy, and incentives in priority-based matching. *American Economic Review: Insights*, 2(4), 425–42.

Abdulkadiroğlu, A., Che, Y.-K., Pathak, P. A., Roth, A. E., & Tercieux, O. (2020b). Efficiency, justified envy, and incentives in priority-based matching. *American Economic Review: Insights*, 2(4), 425–42.

Abdulkadiroğlu, A., Pathak, P. A., & Roth, A. E. (2005a). The new york city high school match. *American Economic Review*, 95(2), 364–367.

Abdulkadiroğlu, A., Pathak, P. A., Roth, A. E., & Sönmez, T. (2005b). The boston public school match. *American Economic Review*, 95(2), 368–371.

Abdulkadiroğlu, A. & Sönmez, T. (1998). Random serial dictatorship and the core from random endowments in house allocation problems. *Econometrica*, 66(3), 689–701.

Afacan, M. O., Hu, G., & Li, J. (2024). Housing markets since shapley and scarf. *Journal of Mathematical Economics*, 111, 102967.

Alcalde, J. & Barbera, S. (1994). Top dominance and the possibility of strategy-proof stable solutions to matching problems. *Economic theory*, 4(3), 417–435.

Alva, S. & Manjunath, V. (2019). Strategy-proof pareto-improvement. *Journal of Economic Theory*, 181, 121–142.

Andersson, T., Cseh, A., Ehlers, L., & Erlanson, A. (2021). Organizing time exchanges: Lessons from matching markets. *American Economic Journal: Microeconomics*, 13(1), 338–73.

Ashlagi, I., Gilchrist, D. S., Roth, A. E., & Rees, M. A. (2011a). Nead chains in transplantation. *American Journal of transplantation*, 11(12), 2780–2781.

Ashlagi, I., Gilchrist, D. S., Roth, A. E., & Rees, M. A. (2011b). Nonsimultaneous chains and dominos in kidney-paired donation—revisited. *American Journal of transplantation*, 11(5), 984–994.

Aygun, O. & Sönmez, T. (2012). *Matching with Contracts: The Critical Role of Irrelevance of Rejected Contracts*. Boston College Working Papers in Economics 804, Boston College Department of Economics.

Aygün, O. & Sönmez, T. (2013). Matching with contracts: Comment. *American Economic Review*, 103(5), 2050–51.

Azevedo, E. M. & Budish, E. (2019). Strategy-proofness in the large. *The Review of Economic Studies*, 86(1), 81–116.

Aziz, H. (2018). Mechanisms for house allocation with existing tenants under dichotomous preferences. *Journal of Mechanism and Institution Design*, 3(1), 97–110.

Aziz, H., Biró, P., Lang, J., Lesca, J., & Monnot, J. (2019). Efficient reallocation under additive and responsive preferences. *Theoretical Computer Science*, 790, 1–15.

Biró, P., Haase-Kromwijk, B., Andersson, T., Ásgeirsson, E. I., Baltesová, T., Boletis, I., Bolotinha, C., Bond, G., Böhmig, G., Burnapp, L., et al. (2019). Building kidney exchange programmes in europe—an overview of exchange practice and activities. *Transplantation*, 103(7), 1514–1522.

Biró, P., Manlove, D. F., & McBride, I. (2014). The hospitals / residents problem with couples: Complexity and integer programming models. In J. Gudmundsson & J. Katajainen (Eds.), *Experimental Algorithms*, volume 164 (pp. 10–21). Cham: Springer International Publishing. Combinatorial Optimization.

Biró, P., Manlove, D. F., & Rizzi, R. (2009). Maximum weight cycle packing in directed graphs, with application to kidney exchange programs. *Discrete Mathematics, Algorithms and Applications*, 01(04), 499–517.

Blum, Y. & Rothblum, U. G. (2002). "timing is everything" and marital bliss. *Journal of Economic Theory*, 103(2), 429–443.

Bó, I. & Hakimov, R. (2020). Iterative versus standard deferred acceptance: Experimental evidence. *The Economic Journal*, 130(626), 356–392.

Bogomolnaia, A. & Moulin, H. (2004). Random matching under dichotomous preferences. *Econometrica*, 72(1), 257–279.

Boyle, D. & Bird, S. (2014). *Give and Take: How timebanking is transforming healthcare*. Gloucester: Timebanking UK.

Calsamiglia, C., Haeringer, G., & Klijn, F. (2011). A comment on "school choice: An experimental study" [j. econ. theory 127 (1) (2006) 202–231]. *Journal of Economic Theory*, 146(1), 392–396.

Carlsson, S. & Thomsen, S. L. (2015). Improving the allocation of spots in child care facilities for toddlers in germany: A mechanism design approach. *IZA Discussion Paper*.

Chen, Y. & Kesten, O. (2019). Chinese college admissions and school choice reforms: An experimental study. *Games and Economic Behavior*, 115, 83–100.

Chen, Y., Liang, Y., & Sönmez, T. (2016). School choice under complete information: An experimental study. *The Journal of Mechanism and Institution Design*, 1(1), 45–82.

Chen, Y. & Sönmez, T. (2006). School choice: an experimental study. *Journal of Economic theory*, 127(1), 202–231.

Collom, E. (2007). The motivations, engagement, satisfaction, outcomes, and demographics of time bank participants: survey findings from a us system. *international Journal of Community Currency research*, 11(1), 36–83.

Combe, J. (2022). Matching with ownership. *Journal of Mathematical Economics*, 98, 102563.

Crawford, V. P. (1991). Comparative statics in matching markets. *Journal of Economic Theory*, 54(2), 389–400.

Crawford, V. P. & Knoer, E. M. (1981). Job matching with heterogeneous firms and workers. *Econometrica: Journal of the Econometric Society*, (pp. 437–450).

Davidson, R. R. & Farquhar, P. H. (1976). A bibliography on the method of paired comparisons. *Biometrics*, 32(2), 241–252.

De Haan, M., Gautier, P. A., Oosterbeek, H., & Van der Klaauw, B. (2023). The performance of school assignment mechanisms in practice. *Journal of Political Economy*, 131(2), 388–455.

Duch, M. L., Grossmann, M. R., & Lauer, T. (2020). z-tree unleashed: A novel client-integrating architecture for conducting z-tree experiments over the internet. *Journal of Behavioral and Experimental Finance*, 28, 100400.

Erdil, A. & Ergin, H. (2008). What's the matter with tie-breaking? improving efficiency in school choice. *American Economic Review*, 98(3), 669–89.

Ergin, H. & Sönmez, T. (2006). Games of school choice under the boston mechanism. *Journal of Public Economics*, 90(1), 215–237.

Ergin, H., Sönmez, T., & Ünver, M. U. (2017). Dual-donor organ exchange. *Econometrica*, 85(5), 1645–1671.

Fischbacher, U. (2007). z-tree: Zurich toolbox for ready-made economic experiments. *Experimental economics*, 10, 171–178.

Gale, D. & Shapley, L. S. (1962). College admissions and the stability of marriage. *The American Mathematical Monthly*, 69(1), 9–15.

Greiner, B. (2015). Subject pool recruitment procedures: organizing experiments with orsee. *Journal of the Economic Science Association*, 1(1), 114–125.

Gridgeman, N. (1959). Pair comparison, with and without ties. *Biometrics*, (pp. 382–388).

Guillen, P. & Hakimov, R. (2017). Not quite the best response: truth-telling, strategy-proof matching, and the manipulation of others. *Experimental Economics*, 20, 670–686.

Guillen, P. & Hakimov, R. (2018). The effectiveness of top-down advice in strategy-proof mechanisms: A field experiment. *European Economic Review*, 101, 505–511.

Guillen, P. & Veszteg, R. F. (2021). Strategy-proofness in experimental matching markets. *Experimental Economics*, 24, 650–668.

Hafalir, I. E., Yenmez, M. B., & Yildirim, M. A. (2013). Effective affirmative action in school choice. *Theoretical Economics*, 8(2), 325–363.

Hakimov, R. & Kübler, D. (2021). Experiments on centralized school choice and college admissions: a survey. *Experimental Economics*, 24(2), 434–488.

Hatfield, J. W. & Kojima, F. (2008). Matching with contracts: Comment. *American Economic Review*, 98(3), 1189–94.

Hatfield, J. W. & Kojima, F. (2010). Substitutes and stability for matching with contracts. *Journal of Economic Theory*, 145(5), 1704–1723.

Hatfield, J. W. & Milgrom, P. R. (2005). Matching with contracts. *American Economic Review*, 95(4), 913–935.

He, Y. & Magnac, T. (2018). *A pigouvian approach to congestion in matching markets*. Technical report, IZA Discussion Papers.

Hirata, D. & Kasuya, Y. (2014). Cumulative offer process is order-independent. *Economics Letters*, 124(1), 37–40.

Hoyer, B. & Stroh-Maraun, N. (2020). Matching strategies of heterogeneous agents under incomplete information in a university clearinghouse. *Games and Economic Behavior*, 121, 453–481.

Kelso, A. S. & Crawford, V. P. (1982). Job matching, coalition formation, and gross substitutes. *Econometrica*, 50(6), 1483–1504.

Klijn, F., Pais, J., & Vorsatz, M. (2019). Static versus dynamic deferred acceptance in school choice: Theory and experiment. *Games and Economic Behavior*, 113, 147–163.

Kojima, F. (2012). School choice: Impossibilities for affirmative action. *Games and Economic Behavior*, 75(2), 685–693.

Kominers, S. D. & Sönmez, T. (2016). Matching with slot-specific priorities: Theory. *Theoretical Economics*, 11(2), 683–710.

Koutout, K., Dustan, A., Van der Linden, M., & Wooders, M. (2021). Mechanism performance under strategy advice and sub-optimal play: A school choice experiment. *Journal of Behavioral and Experimental Economics*, 94, 101755.

Krishna, A. & Wang, Y. (2007). The relationship between top trading cycles mechanism and top trading cycles and chains mechanism. *Journal of Economic Theory*, 132(1), 539–547.

Kühn, S. (2025). *Child Care Allocation Mechanisms: Navigating Incomplete Preference Elicitation*. Working Papers Dissertations 162, Paderborn University, Faculty of Business Administration and Economics.

Kühn, S., Duman, P., Hoyer, B., Streck, T., & Stroh-Maraun, N. (2025). *Non-induced Preferences in Matching Experiments*. Working Papers Dissertations 159, Paderborn University, Faculty of Business Administration and Economics.

Kühn, S. & Stroh-Maraun, N. (2025). *Community Costs in Neighborhood Help Problems*. Working Papers Dissertations 158, Paderborn University, Faculty of Business Administration and Economics.

Ma, J. (1994). Strategy-proofness and the strict core in a market with indivisibilities. *International Journal of Game Theory*, 23(1), 75–83.

Manjunath, V. & Westkamp, A. (2021). Strategy-proof exchange under trichotomous preferences. *Journal of Economic Theory*, 193, 105197.

Morrill, T. & Roth, A. E. (2024). Top trading cycles. *Journal of Mathematical Economics*, 112, 102984.

Mullin, C. H. & Reiley, D. H. (2006). Recombinant estimation for normal-form games, with applications to auctions and bargaining. *Games and Economic Behavior*, 54(1), 159–182.

NobelPrize.org (2012). The prize in economic sciences. https://www.nobelprize.org/prizes/economic-sciences/2012/summary/ [Accessed: 2025-08-12].

Pais, J. & Pintér, Á. (2008). School choice and information: An experimental study on matching mechanisms. *Games and Economic Behavior*, 64(1), 303–328.

Pápai, S. (2000). Strategyproof assignment by hierarchical exchange. *Econometrica*, 68(6), 1403–1433.

Pathak, P. A. & Sönmez, T. (2013). School admissions reform in chicago and england: Comparing mechanisms by their vulnerability to manipulation. *The American Economic Review*, 103(1), 80–106.

Rees, M. A., Kopke, J. E., Pelletier, R. P., Segev, D. L., Rutter, M. E., Fabrega, A. J., Rogers, J., Pankewycz, O. G., Hiller, J., Roth, A. E., et al. (2009). A nonsimultaneous, extended, altruistic-donor chain. *New England Journal of Medicine*, 360(11), 1096–1101.

Reischmann, T., Klein, T., & Giegerich, S. (2021). A deferred acceptance mechanism for decentralized, fast, and fair childcare assignment. *Journal of Mechanism and Institution Design Volume 6, Issue*, 6(1), 59.

Romm, A., Roth, A. E., & Shorrer, R. I. (2024). Stability vs. no justified envy. *Games and Economic Behavior*, 148, 357–366.

Roth, A. (2012). Alvin E. Roth – prize lecture. https://www.nobelprize.org/prizes/economic-sciences/2012/roth/lecture/ [Accessed: 2025-08-12].

Roth, A. E. (1982). The economics of matching: Stability and incentives. *Mathematics of Operations Research*, 7(4), 617–628.

Roth, A. E. (1984). The evolution of the labor market for medical interns and residents: a case study in game theory. *Journal of political Economy*, 92(6), 991–1016.

Roth, A. E. (1985). The college admissions problem is not equivalent to the marriage problem. *Journal of Economic Theory*, 36(2), 277–288.

Roth, A. E. (2008). Deferred acceptance algorithms: history, theory, practice, and open questions. *International Journal of Game Theory*, 36(3-4), 537–569.

Roth, A. E. & Postlewaite, A. (1977). Weak versus strong domination in a market with indivisible goods. *Journal of Mathematical Economics*, 4(2), 131–137.

Roth, A. E. & Rothblum, U. G. (1999). Truncation strategies in matching markets - in search of advice for participants. *Econometrica*, 67(1), 21–43.

Roth, A. E., Sönmez, T., & Ünver, M. U. (2004). Kidney exchange. *The Quarterly journal of economics*, 119(2), 457–488.

Roth, A. E., Sönmez, T., & Ünver, M. U. (2005). Pairwise kidney exchange. *Journal of Economic Theory*, 125(2), 151–188.

Roth, A. E., Sönmez, T., Ünver, M. U., Delmonico, F. L., & Saidman, S. L. (2006). Utilizing list exchange and nondirected donation through 'chain'paired kidney donations. *American Journal of transplantation*, 6(11), 2694–2705.

Roth, A. E. & Sotomayor, M. A. (1990). *Two-Sided Matching: A Study in Game-Theoretic Modeling and Analysis*, volume 1 of *Econometric Society Monographs*. Cambridge University Press.

Seyfang, G. (2003). 'with a little help from my friends.'evaluating time banks as a tool for community self-help. *Local Economy*, 18(3), 257–264.

Shapley, L. & Scarf, H. (1974). On cores and indivisibility. *Journal of Mathematical Economics*, 1(1), 23–37.

Sönmez, T. & Switzer, T. B. (2013). Matching with (branch-of-choice) contracts at the united states military academy. *Econometrica*, 81(2), 451–488.

Sönmez, T. & Ünver, M. U. (2010). House allocation with existing tenants: A characterization. *Games and Economic Behavior*, 69(2), 425–445.

Stroh-Maraun, N. (2024). Weighted school choice problems and the weighted top trading cycles mechanism. *Mathematical Social Sciences*, 132, 49–56.

Sönmez, T. (2013). Bidding for army career specialties: Improving the rotc branching mechanism. *Journal of Political Economy*, 121(1), 186–219.

Sönmez, T. & Ünver, M. U. (2005). House allocation with existing tenants: an equivalence. *Games and Economic Behavior*, 52(1), 153–185.

Thurstone, L. (1927). A law of comparative judgment. *Psychological Review*, 34(4), 273–286.

Wang, Y. & Krishna, A. (2006). Timeshare exchange mechanisms. *Management Science*, 52(8), 1223–1237.

Wu, Q. & Roth, A. E. (2018). The lattice of envy-free matchings. *Games and Economic Behavior*, 109, 201–211.

Zenios, S., Woodle, E. S., & Ross, L. F. (2001). Primum non nocere: Avoiding harm to vulnerable wait list candidates in an indirect kidney exchange. *Transplantation*, 72(4), 648–654.