Influencing Policy and Transforming Institutions: Lessons from Kidney/Liver Exchange

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Abstract

Kidney exchange emerged as a pioneering application in the early stages of market design. Unlike most other successful applications in the field, where design economists primarily serve as consultants to decision-makers, in the context of kidney exchange, they assumed the role of outsider critics, ultimately succeeding in shaping real-life practices and institutions. This paper explores the strategies that facilitated this influential role. Drawing on our two decades of involvement in shaping kidney and liver exchange clearinghouses in the United States and Turkey, we provide insights into factors pivotal for the effectiveness of market design research in shaping policy. Building upon these experiences and incorporating lessons from school choice reforms in the 2000s, Sönmez (2023) introduces "minimalist market design" as a novel institutional design paradigm. Recent years have witnessed tangible outcomes from holistic research and policy efforts using this framework, notably contributing to the 2021 reform of the US Army's cadet branching system and the establishment of reserve systems during the COVID-19 pandemic for vaccine and therapy allocation across multiple states.

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1 Introduction

In 1984, the U.S. Congress passed the *National Organ Transplant Act* (NOTA) to address the shortage of transplant organs and improve the organ allocation process. This landmark legislation led to the establishment of the *Organ Procurement and Transplantation Network* (OPTN), entrusted with maintaining a national transplantation registry. NOTA specified that a private organization should operate this network under a federal contract. Since 1986, the *United Network for Organ Sharing* (UNOS), a non-profit organization, has been fulfilling this important role.

In 2000, the U.S. Department of Health and Human Services (HHS) implemented a *Final Rule*, outlining comprehensive regulations governing OPTN's structure and operations.[1] According to this Final Rule, OPTN is required to form a Board of Directors consisting of:

(i) Approximately 50 percent transplant surgeons or transplant physicians.

(ii) At least 25 percent transplant candidates, transplant recipients, organ donors, and their family members.

(iii) Representatives of Organ Procurement Organizations, transplant hospitals, voluntary health associations, transplant coordinators, histocompatibility experts, non-physician transplant professionals, and the general public.

Despite OPTN's primary mission of ensuring efficient and equitable organ procurement and allocation, the current composition of the OPTN Board of Directors, guided by the Final Rule, lacks representation from fields such as market design, operations research, or computer science—areas where researchers possess the expertise to design complex allocation systems. In our view, recognizing this crucial expertise gap is essential, given OPTN's mission. At the same time, policy recommendations from experts in these formal disciplines must align with the institution's overarching goals to receive serious consideration from decision-makers.

Many initiatives in U.S. transplantation policy could significantly benefit from expertise in market design. Before exploring how persuasion strategies can be incorporated into market design research to enhance its potential influence on real-life policies, let's briefly discuss three of these initiatives.

[1] The Final Rule is available at `https://www.ecfr.gov/current/title-42/chapter-I/subchapter-K/part-121`, last accessed on 08/26/2024.

Liver Exchange in the US: Living-donor organ exchange, utilized for kidneys and livers, involves a process where a group of patients, some or all of whom have medically incompatible donors, engage in a donor swap to ensure that each recipient receives a compatible transplant. In the U.S., kidney exchange programs have thrived since the mid-2000s, but liver exchange is a more recent development.[2] In a significant move, UNOS, in collaboration with 15 top-tier transplant centers in the U.S., initiated the first national liver exchange pilot program on January 13, 2023.[3] Unfortunately, after failing to generate any transplants, the pilot program was discontinued on November 30, 2023.[4]

This setback faced by UNOS is in an area where market designers have a lot of experience. In the case of kidney transplantation, while the practice of donor exchange existed in the U.S. before market designers took an interest, it thrived globally with their contributions. In Section 2, we explore the strategies that helped achieve this policy impact. Furthermore, as discussed in Section 2.8, the results from the first two years of a single-center liver exchange program in Turkey, which quickly established global leadership, emphasize the potential importance of input from market design experts. This suggests that such expertise could have been equally vital for the UNOS liver exchange pilot program.

A New System for Allocating Deceased Donor Organs: To enhance the fairness of the current system for allocating deceased donor (DD) organs, OPTN has been developing a new system called "continuous distribution." The multifaceted objectives of this system, as outlined by OPTN, are as follows:[5]

- Prioritize the sickest candidates first to reduce waitlist deaths.
- Improve long-term survival after transplant.
- Increase transplant opportunities for patients who are medically harder to match.
- Expand transplant opportunities for candidates with distinct characteristics, such as those under the age of 18 or prior living donors.
- Promote the efficient management of organ placement.

[2]According to a *UT Health* story published on February 4, 2020, titled "Called 1st in U.S.: Living liver donors kindly swap to save 2 recipients," the first liver exchange in the U.S. took place in April 2019.

[3]Refer to the *UNOS News* story titled "UNOS launches first national liver paired donation pilot program", dated January 13, 2023, last accessed on 08/29/2024.

[4]See the blogpost "UNOS ends its liver exchange pilot program" by Alvin Roth, dated November 30, 2023, last accessed on 08/29/2023.

[5]For more details, visit `https://optn.transplant.hrsa.gov/policies-bylaws/a-closer-look/continuous-distribution/`, last accessed on 11/19/2023.

The new system is structured as a *priority point system*, with the aim of simultaneously considering multiple factors crucial for a successful transplant within the organ offer process. The objective is to establish a system that not only prioritizes urgency but also incorporates various medical and demographic factors, ensuring a comprehensive and equitable allocation of organs.

While OPTN promotes the new system as more equitable than the current one, it has raised concerns among specific groups. Living donors, currently enjoying the highest priority under the existing system, express anxiety that their status may now become just one of several factors determining priority under the new system.[6] This potential shift also raises concerns about the negative impact on the supply of living-donor transplant organs. In an open letter dated March 13, 2023, the President of the American Society of Nephrology, Michelle A. Josephson, issued an important warning to officials in OPTN:[7]

> "It would be a massive violation of trust to living donors to alter the prioritization they were promised and would almost certainly be a substantial deterrent to anyone considering living donation today and in the future."

In the design of such allocation systems, there is often an oversight of *incentive considerations* when not guided by experts in market design. This is another setting where expertise from market design can be very valuable.

OPTN Modernization Initiative: In March 2023, a significant shift in transplantation policy occurred with the introduction of the OPTN Modernization Initiative by the White House. This landmark initiative signaled the government's commitment to breaking UNOS's monopoly in U.S. transplantation policy.[8]

The drive behind this initiative to revamp the current system stems from several concerns related to UNOS, including:

- Too many organs being discarded, damaged, or not collected.
- Issues with faulty technology risking transplant procedures.
- Lack of accountability for underperforming entities.

[6]Refer, for instance, to the *STAT News* opinion piece by Martha Gershu titled "Living kidney donors rely on a promise to protect our future health. We're scared it will go away," published on 03/22/2023, last accessed on 08/29/2024.

[7]The open letter is available in `https://www.asn-online.org/policy/webdocs/23.3.13ASNOPTNLKD.pdf`, last accessed on 11/18/2023.

[8]For detailed information, see the press release from the Health Resources and Services Administration (HRSA), dated 03/22/2023, last accessed on 08/29/2024.

An article in *The Washington Post* on March 22, 2023, titled "Troubled U.S. Organ System Targeted for Overhaul," sheds light on the proposed federal reform (Bernstein, 2023). One of the main objectives in the proposed reform is to increase transparency in the complex process of patient and organ matching. Bernstein (2023) outlines another noteworthy feature as follows:

> "HRSA [Health Resources and Services Administration], however, is proposing a 'modular' system of improvements that could be tested independently of one another and gradually integrated into a new structure while the old one is still running. This setup would also enable each component to be improved individually, without having to rewrite the entire program."

This transformative initiative also presents numerous opportunities for market designers. However, to impact policy, these ideas must not only be innovative but also transparent and seamlessly harmonize with the broader system.

In our experience, market designers are more likely to succeed in influencing policy and transforming institutions if their policy recommendations, supported by research, strongly align with the mission of the institution. In Section 2, we discuss how we benefited from this approach for over two decades in designing living-donor organ exchange clearinghouses. We then conclude in Section 3 by discussing how these experiences helped shape a broader institution design framework, *minimalist market design* (Sönmez, 2023), which we used to persuade decision-makers to enhance their institutions in various settings.

2 Policy Relevance of Research in Market Design: Lessons from Living-Donor Organ Exchange

What factors contribute to the potential success of market design research in this field? Drawing on insights from our extensive collaborations with policymakers and experts across various disciplines since the late 1990s, we focus on the area of living-donor organ exchange. In this section, we articulate our perspective on the factors that are pivotal to the effectiveness of market design research in shaping policy.

One of the most unexpected applications of market design, which has significantly elevated the visibility and success of the field, is *kidney exchange* (Roth, Sönmez, and Ünver, 2004, 2005b, 2007). Within a few years after its introduction as a market design applica-

tion, our formal approach transformed living donor kidney donation in many countries (Purtill, 2018). Within a decade, it started saving more than a thousand lives annually (Rose, 2019). This success was "unexpected" not only because kidney transplantation was far beyond the traditional scope of economics but also because assistance from economists came from "outsiders" rather than being actively sought.

How did three economists manage to develop the tools for and helped to establish the infrastructure which regularly touches so many lives? In our view, the key was convincing stakeholders (e.g., policymakers, system operators) that we could assist them in enhancing their institution

1. in aspects they care about,
2. by using the tools with which they are familiar (or at the very least they are comfortable to use), and
3. without creating any new issues.

To have a realistic chance of influencing policy, an aspiring market designer must possess a deep understanding of the mission of the institution. In this regard, the history of the institution can often provide valuable insights. For an outsider aspiring design economist, another crucial prerequisite for enhancing an institution is to have a *practical* and *transparent* plan for its improvement. Policy aspirations often carry substantial implications for viable designs, thereby shaping the underlying research program.

2.1 Paired Kidney Exchange and List Exchange

To provide practice guidelines for transplant physicians, primary care providers, and health care planners, a *Consensus Statement on the Live Organ Donor* was issued in 2000 by representatives of several professional transplantation societies (Abecassis et al., 2000). Two instruments aimed at overcoming medical incompatibilities between kidney patients and their willing living donors, namely a *paired kidney exchange* and a *list exchange*, were prominently discussed in the Consensus Statement.

Paired Kidney Exchange (PKE): A donor who is medically incompatible with their patient can often be compatible with another patient. Similarly, a patient who is incompatible with their donor may be compatible with another patient's donor. In such cases, patients can find a medically compatible donor by exchanging their donors. The process by which two patients mutually exchange their donors, ensuring a medically compatible transplant for each, is referred to as *paired kidney exchange* or *2-way exchange*.

The concept of PKE was initially proposed in 1986 by Dr. Felix Rapaport, a renowned transplant surgeon who served as the editor of *Transplantation Proceedings* for over three decades (Rapaport, 1986). Globally, it was first implemented in South Korea in 1991 (Park et al., 1999). In the U.S., the first PKE took place in Rhode Island in 2000 (Anderson et al., 2015).

List Exchange (LE): The second kidney exchange mechanism entails an indirect exchange between an incompatible pair and the deceased-donor (DD) list. In this scenario, a donor, incompatible with their intended recipient, contributes a kidney to a patient on the DD list. As a reciprocal arrangement, the incompatible patient gains priority in the DD list, facilitating a mutually beneficial exchange.

Initially discussed in Ross and Woodle (2000), LE stands out for its organizational simplicity. While orchestrating a PKE necessitates the coordination of two mutually compatible patient-donor pairs, LE can be arranged whenever an incompatible pair expresses interest in this kidney exchange form. However, as thoroughly explored in Ross and Woodle (2000), a significant ethical concern surrounds LE: it has the potential to be detrimental to blood type O patients on the DD list.

To comprehend this concern, it is essential to recall the principles of blood type compatibility. There are four blood types: A, B, AB, and O. Blood type AB patients can receive a kidney of any blood type. Blood type A or B patients can accept a kidney of their own blood type or one from blood type O. On the other hand, blood type O patients can only receive a kidney from blood type O donors. This natural limitation places blood type O patients at a disadvantage.

As Ross and Woodle (2000) pointed out, the disadvantage for blood type O patients without willing donors may be exacerbated by LE. This is because blood type O patients, who are already at a disadvantage due to their limited compatibility, may be further disadvantaged by participating in LE. Specifically, blood type O patients who are blood type incompatible with their potential donors are particularly likely to benefit from this form of kidney exchange, highlighting the intricate ethical considerations inherent in the use of LE.

Among these two forms of kidney exchange, PKE garnered widespread approval in the Consensus Statement, being deemed "ethically acceptable." To forestall scenarios wherein a donor contributes a kidney to another patient through PKE, only for their own intended donor to face potential transplant challenges later on due to the other donor reneging or becoming unavailable, the Consensus Statement urged for the simultaneous execution of all four operations. In contrast, the Consensus Statement underscored the ethical apprehensions associated with LE (Abecassis et al., 2000).

2.2 Early Phases of Kidney Exchange in New England

Approved by the UNOS Board of Trustees in Fall 2000, the first kidney exchange program in the US was established in New England (UNOS Region 1) in February 2001 (Delmonico et al., 2004). In addition to PKE, which received broad support from the transplantation community, New England also included LE in its program despite the ethical concerns. This decision was defended by its leadership as follows:

> "This exchange program has a clear utilitarian goal: to have more recipients undergo successful transplantation by expanding the pool of compatible live donors." Delmonico et al. (2004)

However, Delmonico et al. (2004) centered much of its discussion on the ethical concerns, particularly focusing on the precautions implemented to mitigate the adverse impact of LE on blood type O patients listed for transplantation. Consequently, the New England kidney exchange program operated under the guidance of two fundamental ethical principles: *utilitarianism* and *equity*.[9]

In its initial phases, despite being the less favored type of kidney exchange, the majority of transplants facilitated by the New England program were through LE. Between February 2001 and December 2003, the program orchestrated 17 LE transplants, in contrast to only 8 transplants coordinated across four PKEs during the same period. One significant factor directly contributing to the limited number of transplants from PKE was the absence of a patient-donor database accessible by all 14 participating centers, a shortcoming rectified through our initiatives in the Fall of 2004.

While arranging a LE does not necessitate a patient-donor database, the organization of such exchanges also presented operational challenges in New England. A prerequisite for LE eligibility was to ensure that no PKE was feasible between the patient and any other patient registered in all 14 transplant centers in the system.

> "[...] The duration that the RTOC [Renal Transplant Oversight Committee] will wait for a live donor exchange pair to come forward from another center has not been regulated, although the general practice has been to ask such pairs to wait a minimum of one month, in order to avoid

[9] Health equity, as defined by the *Centers for Disease Control and Prevention*, is the state in which everyone has a fair and just opportunity to attain their highest level of health. Achieving this necessitates societal efforts to address historical and contemporary injustices, overcome economic and social obstacles to health and healthcare, and eliminate preventable health disparities. (Source: `https://www.cdc.gov/nchhstp/healthequity/index.html`, last accessed 11/11/2023.)

> flooding the system with 'unnecessary' list exchanges. If no such pair is identified, the center can proceed with the live donor list exchange process."
>
> Delmonico et al. (2004)

Amidst the challenges faced by New England's kidney exchange program, we presented Roth, Sönmez, and Ünver (2003) to Dr. Francis Delmonico in the Fall of 2003, who served as the Medical Director of the New England Organ Bank.[10] During this encounter, we expressed our interest in collaborating to enhance their kidney exchange program. Surprisingly, Delmonico exhibited a keen interest in our initiative. As we will discuss in more detail in Section 2.6, his strong opposition to the *Global Kidney Exchange* initiative, led by Mike Rees from Alliance for Paired Donation and Alvin Roth in the following years, suggests that our meticulous attention to medical ethics considerations in Roth, Sönmez, and Ünver (2003) may have been pivotal in shaping his openness to our proposal.

2.3 Early Market Design Research on Kidney Exchange

While we were faculty members at Koç University in İstanbul, Ünver visited Alvin Roth at Harvard University for the academic year 2002-2003. During his visit, Roth pointed out to him that the model for *house allocation with existing tenants*, initially introduced in Abdulkadiroğlu and Sönmez (1999) and further explored in Sönmez and Ünver (2005), has an unconventional application in kidney transplantation.

Motivated by the efficient and incentive-compatible allocation of campus housing units, Abdulkadiroğlu and Sönmez (1999) introduced a mechanism known as *You Request My House - I Get Your Turn (YRMH-IGYT)* which allocates two types of houses to two types of individuals. One type of individuals, termed existing tenants, had the option to retain their current houses if they chose to do so. The other type of individuals, referred to as newcomers, did not have any claim to specific houses. The two types of houses included the occupied houses of existing tenants and the vacant houses that did not belong to any specific individuals.

In the context of kidney transplantation,

- patients with living donors correspond to existing tenants,
- living-donor kidneys correspond to occupied houses,

[10] A shorter version of Roth, Sönmez, and Ünver (2003) is later published as Roth, Sönmez, and Ünver (2004).

- patients on the deceased-donor (DD) list correspond to newcomers, and
- DD kidneys correspond to vacant houses.

Existing tenants can retain their current houses in Abdulkadiroğlu and Sönmez (1999), and similarly, patients with living donors can hold onto their donors. Just as newcomers have no claim on any specific house, patients on the DD list also do not have any claim on any specific kidney. Finally, as in the case where all individuals collectively own all vacant houses in house allocation, all patients collectively own all deceased donor kidneys.

Drawing on these analogies, the YRMH-IGYT mechanism finds direct application in kidney exchange. By overseeing claims for "unattached" houses, which could be either vacant or vacated during the procedure, through an exogenous priority list, the YRMH-IGYT mechanism organizes two distinct types of transactions: *cycles* and *chains*. In a cycle, existing tenants exchange their occupied houses, with PKE corresponding to a cycle involving only two patients with living donors. In a chain, an individual exchanges their priority for an "unattached" house, and the remaining individuals trade their currently occupied houses. LE corresponds to a chain involving one patient with a living donor and the highest-priority patient on the DD list.

While employing exogenous priority lists, such as in YRMH-IGYT, was a viable approach for regulating chains in kidney exchange, we observed that alternative *chain selection rules* might alleviate, and even eliminate, the adverse impact of LE on blood type O patients on the DD list. Leveraging this insight, we addressed both goals of the transplantation community in Roth, Sönmez, and Ünver (2003, 2004) through a generalization of the YRMH-IGYT mechanism, rather than merely framing kidney exchange as a direct application of Abdulkadiroğlu and Sönmez (1999).

2.4 The Birth of a Partnership Between Economists & Medical Doctors

Our informed and cautious approach resonated with Delmonico, who subsequently made the following requests as prerequisites for a potential collaboration:

1. Considering the scale of simulated welfare gains from our system, we should eliminate the more controversial LE altogether.
2. Due to logistical constraints, we should restrict the kidney exchange to PKE, i.e. 2-way exchanges.
3. To prevent a situation where patients and hospitals might compete for donors with specific characteristics, we must assume that patients are indifferent between all

compatible donors.[11]

We accommodated all requests in Roth, Sönmez, and Ünver (2005b) which formed the basis of the New England Program for Kidney Exchange (NEPKE). Approved by the Renal Transplant Oversight Committee of New England in September 2004, NEPKE became the first kidney exchange system that adapted analytical techniques from market design and optimization (Roth, Sönmez, and Ünver, 2005a).

Our team coded and ran NEPKE's software for several years. Our partnership resulted in a number of additional breakthroughs.

Larger Cycles: Analyzing New England data, it became evident early on that the incorporation of 3-way exchanges is particularly crucial from a utilitarian standpoint (Roth, Sönmez, and Ünver, 2007). We successfully persuaded our medical partners to integrate 3-way exchanges into the NEPKE software and jointly advocated for it within the broader transplantation community Saidman et al. (2006).

Non-Directed Donor Chains: In collaboration with our NEPKE partners, we introduced and advocated for the non-simultaneous implementation of chains, particularly when initiated with a non-directed living donor kidney (Roth et al., 2006). Although NEPKE did not incorporate non-directed donor chains, a second kidney exchange program we supported during its early years, Alliance for Paired Donation (APD), did (Anderson et al., 2015). Today, a sizable part of the welfare gains from kidney exchange in the US are due to non-directed donor chains (Agarwal et al., 2019).

2.5 The Role of Compatible Pairs in Living-Donor Organ Exchange

Currently, the majority of kidney exchange programs worldwide restrict participation to incompatible patient-donor pairs. This limitation results in a significant welfare loss worldwide, particularly posing a challenge for blood type O patients with donors of blood types A, B, or AB. The challenge arises because, unless there is tissue-type incompatibility with their patients, blood type O donors are medically compatible with their designated patients.

Importantly, our initial paper on kidney exchange successfully navigated this challenge. In Roth, Sönmez, and Ünver (2003, 2004), preferences, assumed to depend on blood-type compatibility, tissue-type compatibility, and donor age, were considered strict.

[11]Strictly speaking, rather than suggesting a formal structure on patient preferences, Delmonico indicated that he is not in favor of a system where patients rank compatible donors. In his view, compatibility information should be sufficient to effectively run a kidney exchange system.

Consequently, Roth, Sönmez, and Ünver (2003, 2004) incorporated a built-in mechanism for compatible pairs to participate in kidney exchange.

In contrast, Roth, Sönmez, and Ünver (2005b), developed at the request of Delmonico, and enabling our collaboration, imposed a limitation by restricting participation to incompatible pairs. As a result, the intrinsic mechanism in Roth, Sönmez, and Ünver (2003, 2004) for compatible pairs to engage in kidney exchange was forfeited in Roth, Sönmez, and Ünver (2005b). Since NEPKE served as a blueprint for kidney exchange programs subsequently launched in the US and many other countries, the end result was a substantial efficiency loss. Sönmez, Ünver, and Yenmez (2020) estimates that the number of kidney exchange transplants in the US could increase by as much as 160% if blood-type-compatible pairs were included in kidney exchange.

Various policies have been proposed in academic literature and the field to incorporate blood-type-compatible pairs into living-donor organ exchange.

2.6 Global Kidney Exchange

One direct approach to incorporating blood-type-compatible pairs into kidney exchange pools in high-income countries, such as the U.S., is proposed and implemented, albeit with limited success, through a program called *Global Kidney Exchange* (GKE) (Rees et al., 2017). GKE offers funding for a kidney transplant procedure to recipients from low and middle-income countries in exchange for a living donor who facilitates a cycle or NDD-chain of transplants in the high-income country. As depicted in Figures 1A and 1B of Rees et al. (2017), the main idea involves including blood type-compatible pairs who cannot afford transplantation in a low and middle-income country into the kidney exchange pool for the high-income country.[12]

Despite strong promotion by Michael Rees from APD and Alvin Roth, GKE has led to a relatively modest number of transplants. Between January 2015 and February 2022, 17 international patients facing financial barriers to direct transplantation facilitated kidney transplants for 35 US patients through GKE, resulting in a total of 52 kidney transplantations (Rees et al., 2022). In contrast, the number of kidney exchange transplants in the US during the same time frame exceeded 6000.[13]

[12]In Figure 1A of Rees et al. (2017), a blood-type A patient with a blood type O donor, facing financial barriers for direct transplantation, engages in a 2-way exchange with a blood-type O patient from a high-income country who has a blood type A donor. In Figure 1B of Rees et al. (2017), a blood-type B patient with a blood type O donor, confronting financial barriers for direct transplantation, participates in a 5-way exchange with four blood type-incompatible pairs from a high-income country.

[13]Data available at `https://optn.transplant.hrsa.gov/data/view-data-reports/national-data/`, last accessed 08/29/2024.

Why did GKE account for only about 0.5% of kidney exchange transplants in the U.S. from January 2015 to February 2022? The answer lies in the strong opposition to GKE within the transplantation community.[14]

Many contend that GKE undermines various ethical norms in transplantation. The persuasion strategies employed during the initial interactions between our team of market designers and members of the broader transplantation community are either bypassed under GKE or have shown limited effectiveness. Delmonico, a pivotal figure in the initial collaboration between market designers and medical professionals, played a central role in the opposition against GKE. He not only co-authored a comment titled "Opposition to Irresponsible Global Kidney Exchange" in the *American Journal of Transplantation* (Delmonico and Ascher, 2017), but also spearheaded an ethical objection to GKE through his position as the Executive Director of the *Declaration of Istanbul Custodian Group* (DICG).[15]

According to DISG,

1. GKE is deceptive,
2. GKE program exploits poor countries and individuals,
3. helping poor patients in exchange for "donated" organs constitutes organ trafficking, and
4. GKE increases the risk that organs will come from paid sources.

Based on similar ethical concerns, GKE has also faced criticism and opposition from other key groups, such as the *Council of Europe Committee on Organ Transplantation*[16] and the *European Union's National Competent Authorities on Organ Donation and Transplantation*[17].

We abstain from taking a position on whether the sharp criticisms of GKE by these groups are justified or not, as many of these objections fall beyond our expertise. What is relevant for our purposes is that GKE faced substantial criticism from various organizations, indicating a level of ineffectiveness in achieving the intended welfare gains from kidney exchange. The contrast between the early success in kidney exchange and the

[14]Refer to Ambagtsheer et al. (2020) for an extensive analysis of the opposition to GKE, involving organizations and professional groups such as the *Council of Europe Committee on Organ Transplantation*, the *European Union's National Competent Authorities on Organ Donation and Transplantation*, and the *Declaration of Istanbul Custodian Group*.

[15]See the "Statement of the Declaration of Istanbul Custodian Group Concerning the Ethical Objections to the Proposed Global Kidney Exchange Program", last accessed 08/26/2024.

[16]See the "CD-P-TO Position Statement on Global Kidney Exchange Concept", last accessed 08/26/2024.

[17]See the "Statement on a Proposed Concept of Global Kidney Exchange", last accessed 08/26/2024.

opposition to GKE underscores the importance of adopting a cautious approach when establishing partnerships with experts in other disciplines and policymakers.

2.7 Incentivized Kidney Exchange

In contrast to GKE, where certain blood-type compatible patient-donor pairs are compelled to join kidney exchange through direct means, *Incentivized Kidney Exchange* (IKE) (Sönmez and Ünver, 2015; Sönmez, Ünver, and Yenmez, 2020) adopts a more nuanced strategy to achieve the same objective. The primary idea involves incentivizing such pairs to participate in kidney exchange by offering the patient a priority increase in the DD list in the event of another renal failure in the future. This incentive is valuable as a kidney from a living donor typically lasts about 15 to 20 years on average.

In recent years, approximately 1,100 patients in the US have annually received transplants through kidney exchange. According to Sönmez, Ünver, and Yenmez (2020), for every 10% of incentivized pairs in the U.S., the number of kidney exchange transplants can be increased by about 180. Therefore, the number of kidney exchange transplants in the US could potentially double if 60% of compatible pairs can be incentivized.

The ethical aspects of this policy have been favorably discussed by several members of the Canadian transplantation community in Gill et al. (2017). In principle, IKE could be considered for potential implementation as part of the ongoing reform of the UNOS-DD allocation system discussed in Section 1. However, since the allocation of living donor kidneys and deceased donor kidneys is managed separately in the US, the adoption of a policy that links the management of these two sources of transplant kidneys requires a broader consensus at the national level.

For another solid organ, the liver, recent efforts have been more effective at incentivizing blood-type-compatible pairs to participate in donor exchange through localized policies.

2.8 Developing and Implementing Best Practices in Liver Exchange

The key challenge in encouraging blood-type-compatible pairs to participate in kidney exchange is the absence of a widely accepted and ethically sound "biological" incentive mechanism to motivate these pairs to swap their donors.

In contrast, liver exchange presents several "biological" incentive mechanisms, primarily due to size compatibility requirements (Ergin, Sönmez, and Ünver, 2020; Yilmaz et al., 2024). One such mechanism relates to the varying donor risks associated with left-lobe versus right-lobe donation.

In living-donor kidney transplants, an entire kidney is transplanted. In contrast, living-donor liver transplants involve dissecting the liver and using only a portion—typically the right lobe, left lobe, or segments 2-3 of the left lobe. To ensure patient safety, the standard practice is to transplant a liver graft that comprises at least 40% of the patient's original liver volume. Since the right lobe usually accounts for 60-70% of the liver's volume, it is often the only viable option for most patients with blood-type-compatible living donors and is, therefore, commonly chosen.

However, historically, donor mortality and morbidity rates have been three to five times higher for right-lobe donations compared to left-lobe donations. Ergin, Sönmez, and Ünver (2020) argue that this substantial difference in donor risk could serve as the basis for a "biological" incentive mechanism, encouraging a significant number of compatible patient-donor pairs to consider joining a liver exchange pool. By participating in an exchange with another pair that includes a relatively smaller patient, a donor may secure a transplant for their co-registered patient while opting to donate the less risky left lobe (or segments 2-3 of the left lobe) instead of the higher-risk right lobe.

Expanding on this intrinsic biological incentive, Ergin, Sönmez, and Ünver (2020) introduced both an additional ethical argument in favor of liver exchange and formulated an efficient and incentive-compatible liver exchange mechanism.

Building on the ideas presented in Ergin, Sönmez, and Ünver (2020) and refining them further using best practices learned from our kidney exchange experience, we reached an agreement with the leadership of the Liver Transplantation Institute at İnönü University (Malatya, Turkey) in September 2019 to establish and run a single-center liver exchange system.[18]

Our collaboration brought to light that, there are other, and likely more significant, "biological" incentives for blood-type-compatible pairs to participate in liver exchange. For example, the anatomical structure of the smaller left lobe of many potential donors are often unsuitable for transplantation, whereas pediatric patients frequently need a transplant involving all or part of the left lobe. Hence, the existence of patient-specific size compatibility requirements has provided us with several avenues to encourage the inclusion of blood-type-compatible pairs in the system.

After a three-year delay caused by bureaucracy and the Covid-19 pandemic, the pilot phase of the *Banu Bedestenci Sönmez Liver Paired Exchange (BBS-LPE) System* was launched

[18]The Liver Transplantation Institute at İnönü University, located in Malatya, Turkey, is the highest-volume liver transplant center in Europe and one of the largest worldwide, performing about 250 to 300 living-donor liver transplants annually. For comparison, the annual number of living-donor liver transplants in the U.S. reached a record high of 658 in 2023.

in June 2022.[19] The pilot continued until August 2023. Despite a magnitude 7.8 earthquake that struck the region in February 2023, 15 liver exchange transplants, including the world's first 4-way liver exchange, were successfully completed during this phase (Yilmaz et al., 2023).

The BBS-LPE system was publicly announced in late July 2023, marking the end of its pilot phase and significantly boosting its visibility and effectiveness. By the end of August 2024, the system had facilitated an additional 129 liver exchange transplants, bringing the total to 144. During this time, the BBS-LPE system achieved several world-first milestones, including a 5-way liver exchange in October 2023, a 6-way exchange in January 2024, and most recently, a 7-way exchange in July 2024 (Yilmaz et al., 2024). In March 2024, it became the first liver exchange program to surpass 100 transplants.

For context, fewer than 250 liver exchange transplants had been reported worldwide in the two decades before the BBS-LPE system's implementation, from 2002 to 2022. Although the first liver exchange was performed over 20 years ago at South Korea's ASAN Medical Center in 2003 (Hwang et al., 2010) to increase the supply of liver grafts, no program before the BBS-LPE accounted for more than 2% of liver transplants at participating centers.[20]

In stark contrast, the BBS-LPE system was responsible for 27.7% of the 231 living-donor liver transplants at the Liver Transplantation Institute at İnönü University in 2023 (Yilmaz et al., 2024) and 40% of the 170 living-donor liver transplants in the first eight months of 2024. The system enabled transplants for 45 patients with incompatible donors in 2023, resulting in a 24.2% increase in the number of living-donor liver transplants that year. In the first eight months of 2024, it facilitated transplants for 52 patients with incompatible donors, leading to a 44.1% increase in living-donor liver transplants.[21]

These statistics highlight that the BBS-LPE system became the leading liver exchange program worldwide within just two years, driven by the adoption of several best prac-

[19]The system is named in memory of Banu Bedestenci Sönmez, the late wife of the first author, who passed away in August 2016. More information about the system, including the latest statistics on liver exchange transplants it has facilitated, can be found at `https://caprazkaracigernakli.inonu.edu.tr/en`, last accessed on 08/26/2024.

[20]Despite the first liver exchange taking place at South Korea's ASAN Medical Center in 2003, the number of liver exchange transplants in South Korea remained at 52 from 2002 to 2018, representing only 0.4% of all living donor liver transplants performed in the country during that period (Kim, 2022). We are aware of only two other liver exchange programs globally that have reported more than 10 liver exchange transplants to date. The highest number is reported from Medanta Hospital in India, with 91 transplants conducted from 2009 to 2022 (Soin et al., 2023). Another program in India reported by Agrawal et al. (2022) conducted 34 liver exchange transplants between 2012 and 2021, accounting for 1.45% of the living donor liver transplants in that program.

[21]Nineteen patients in 2023 and sixteen in the first eight months of 2024 participated in liver exchange either to receive a more favorable transplant or altruistically to benefit patients with incompatible donors.

tices developed over time. The system's success can be attributed to incorporating multiple "biological" incentive mechanisms that encouraged participation from compatible pairs, as well as its capability to perform up to seven simultaneous liver transplants. Currently, the BBS-LPE system is responsible for all reported liver exchanges worldwide involving more than three pairs, including seven 4-way, three 5-way, two 6-way, and one 7-way exchanges. Moreover, it has conducted fourteen of the sixteen 3-way liver exchanges reported to date.[22]

3 Conclusion: Integrating Persuasion Strategies into Market Design

Over the past three decades, the field of *market design* has come to the forefront, witnessing active engagement from researchers in auction theory and matching theory. Their involvement has been pivotal in shaping and reshaping economic and social institutions.

Two of the earliest success stories in market design are commonly recognized as the first *spectrum auction* conducted by the Federal Communication Commission (FCC) in 1994,[23] and the subsequent redesign of the entry-level matching system for medical doctors in the U.S., led by Alvin Roth in 1995 (Roth and Peranson, 1999). These instances exemplify "commissioned" market design, where the imperative for change is acknowledged, and experts are specifically enlisted to drive the transformation. In contrast, "aspired" market design, as exemplified by *kidney exchange* and *liver exchange*, involves offering unsolicited reform advice as external critics.

Below we outline some essential distinctions between commissioned versus aspired market design.

Commissioned Market Design:

1. The imperative for change is already established, minimizing (if not entirely eliminating) the need for a persuasion strategy.

2. Market designers are selected based on their track record of success, affording them significant autonomy in various facets of the design.

[22]Outside of the BBS-LPE system, only two other 3-way exchanges have been reported in academic literature or media: the world's first 3-way exchange from Pakistan (Salman et al., 2023) and another from India (Soin et al., 2023).

[23]Prominent contributors to the design of the Federal Communication Commission's (FCC) spectrum auction encompass renowned auction theorists. Notable among them are John McMillan, who served as a consultant directly for the FCC, along with Paul Milgrom and Robert Wilson, who provided their expertise as consultants for Pacific Telesis (McMillan, 1994).

3. Custom-made theory is not obligatory; a convincing case can be built through experimental, empirical, or computational methods.

Aspired Market Design:

1. The need for change is not established, facing resistance and skepticism.
2. A compelling persuasion strategy is crucial, as past success may not sway stakeholders with vested interests.
3. Custom-made theory aligning with stakeholders' goals becomes pivotal in the persuasion stage.

Since the late 1990s, the distinctions between commissioned and aspired market design have significantly shaped our research and policy strategies. Our engagements in *kidney exchange* and *school choice* (Balinski and Sönmez, 1999; Abdulkadiroğlu and Sönmez, 2003) during this period culminated in the development of the *minimalist market design* paradigm (Sönmez, 2023). In our experience, this paradigm uniquely benefits *aspiring* market designers contributing insights as external critics.

Essentially, *minimalist market design* ingrains a persuasion strategy into its core. Three pivotal tasks define this paradigm:

1. **Identify the *mission* of the institution:** Uncover the fundamental objectives of policymakers, system operators, and other stakeholders. Notably, these goals may diverge from the primary objectives of mainstream economics research. Historical insights into the institution's evolution can prove instructive.
2. **Evaluate the existing institution against these objectives:** Assess whether the current institution aligns with the identified objectives. If not, the potential for impactful policy changes arises. To realize this potential in a successful redesign, pinpoint the *root causes* of the shortcomings.
3. **Address failures through minimal interference:** Intervene *only* in the flawed aspects of the deficient institution, akin to a surgeon's "minimally invasive" procedure. This focused approach aligns with the medical principle of "first do no harm," ensuring precise adjustments that optimize the chances of a successful and influential transformation.

Building upon the success of our methodology in kidney exchange (outlined in this chapter) and in school choice during the early 2000s, we systematically applied this

paradigm across diverse contexts, consistently achieving success in influencing policy and enhancing real-life institutions. A compelling testament to the effectiveness of our approach is also evident in our experience with liver exchange, as discussed in Section 2.8.

In a similar vein, Pathak et al. (2024) and Greenberg et al. (2024) present case studies on the *pandemic allocation of scarce medical resources* and the *branching process of U.S. Army cadets*, illustrating the efficacy of minimalist market design for policy success in these applications. Additional instances that underscore the informativeness and relevance of this paradigm include school choice implementations in Chicago and England (Pathak and Sönmez, 2013) and the implementation of court-mandated affirmative action policies in India (Sönmez and Yenmez, 2022).

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