

Minimalist Market Design: A Framework for Economists with Policy Aspirations

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Minimalist Market Design [▶ LINK TO PDF](#)

- Consider an economic, political, or social institution that is deployed to fulfill a number of objectives.
 - Typically it has many components, each serving its own purposes, and interacting with each other in various ways.

Example (Auction Design): A component collects private information from the participants, a second component processes this information, a third component is used to determine the pricing of outcomes, and a fourth component is used to ensure a fair outcome.

- Now suppose that the institution fails in some of its objectives. Maybe some of its components are broken, or maybe there is an issue with the interface between various components.
- How can a design economist be helpful in addressing these failures?

Minimalist Market Design

- How would experts in other areas would respond to similar challenges?
 - How would a surgeon address an analogous failure on a human body?
 - What about a mechanic on a broken car?
- These experts would first identify the **root cause** of the failure, whether it has to do with a component itself or an interface between various components, and directly address the failure.
 - A surgeon would remove diseased tissue or organs, repair body systems, or replace diseased organs with transplants.
 - A mechanic would repair or replace the worn part of the broken car.

Minimalist Market Design

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 - A surgeon would remove diseased tissue or organs, repair body systems, or replace diseased organs with transplants.
 - A mechanic would repair or replace the worn part of the broken car.
- **Minimalist market design** (Sönmez, 2023) is a paradigm under which a design economist operates in a similar way.

Three Main Tasks under Minimalist Market Design

1. Identify the **mission** of the institution: What are the primary objectives of policymakers, system operators and other stakeholders?
 - The history of the institution may be instructive.
2. Determine whether the institution in place satisfies these primary objectives or not.
 - If it doesn't, then there is potential for policy impact with a compelling alternative design.
 - To materialize this potential into a successful redesign, the **root causes** of the failures should be identified.
3. Address the failures of the deficient institution by interfering **only** with its flawed components and interfaces.
 - Akin to a surgeon performing a "**minimally invasive**" procedure.

Three Main Tasks under Minimalist Market Design

- In some cases, the discord between the mission of the institution and its practical implementation can be eliminated by a unique minimalist intervention.
 - Straightforward resolution via the three main steps of minimalist market design.
- In other cases, however, some of the primary objectives of the stakeholders may be incompatible with others.
 - E.g. The incompatibility between **Pareto efficiency** and **no justified envy** in school choice (Balinski & Sönmez, 1999)
 - In these cases, a design economist may need to formulate compelling compromises between these objectives.

A Supplemental Task under Minimalist Market Design

- Finally, in some cases, multiple minimalist interventions may eliminate the discord between the objectives and practical implementation. In these applications, there is one additional task.
- 4. If there are multiple “minimally invasive” designs through tasks 1-3, present a comprehensive analysis of these competing institutions.
 - May be especially valuable in applications with important social, racial and distributive justice considerations.
 - Depending on policy objectives, **axiomatic characterizations** may be one way to pursue such analyses.
- The role of the fourth step is to maintain **informed neutrality** between reasonable normative principles in design proposals (Li, 2017).

Outline of the Lecture Series

- Today, in **Lecture 1**, I present the philosophy of minimalist market design and its evolution through my integrated research and policy efforts from late 1990s to mid 2000s with a range of collaborators (Abdulkadiroğlu, Chen, Ergin, Pathak, Roth, Ünver).
 - How an **aspiring** design economist can overcome various barriers to inform policy when she is an **outsider**?
 - How does theoretical research in house allocation (Abdulkadiroğlu & Sönmez, 1999) relate to minimalist market design?
 - How did the unsuccessful policy efforts to reform the centralized college admission mechanism in Turkey (Balinski & Sönmez, 1999) guided the subsequent successful efforts to reform the school choice mechanism at Boston Public Schools (Abdulkadiroğlu & Sönmez, 2003)?
 - How did a team of design economists convince transplant surgeons to set up a kidney exchange clearinghouse which uses a range of analytical tools from economic design (Roth, Sönmez & Ünver, 2004, 2005)?

Outline of the Lecture Series

- Since minimalist market design strives to **imitate** the natural evolution of real-life institutions, my efforts in school choice and kidney exchange were largely instinctive.
- Only after observing the strong parallels between the **engineered** reform in Boston and the subsequent **natural** reforms in England and Chicago (Pathak & Sönmez, 2013), it occurred to me that my approach may be the basis of a broader institution design framework.
- As such, starting with early 2010s, I religiously followed minimalist market design in several new applications of market design.
- In **Lecture 2**, I present the first direct application and subsequent proof-of-concept of minimalist market design in the US Army's branching process of cadets to military specialties (Sönmez & Switzer, 2013; Sönmez, 2013, Greenberg, Pathak & Sönmez, 2021).

Outline of the Lecture Series

- The **external validity** for minimalist market design through the school choice reforms of England (2007) and Chicago (2009) was one of the reasons I systematically followed this paradigm since early 2010s.
 - Both of these natural school choice reforms
 1. were triggered by the same reasons as the 2005 engineered school choice reform at Boston,
 2. ended up with the removal the same flawed mechanism in Boston, and
 3. resulted in adoption of the same mechanism adopted in Boston.
- In **Lecture 3**, I present another application which provided minimalist market design with external validity: Affirmative Action in India.
 - In March 2019, the first draft of Sönmez & Yenmez (2022) formulated the root causes of thousands of litigations in India due to a flawed 1995 Supreme Court judgment, and suggested a minimalist reform.
 - During the scholarly review of this paper, the root causes it identified triggered a reform in December 2020, where the Supreme Court revoked the flawed judgment and endorsed its minimalist alternative!

Outline of the Lecture Series

- Tasks 1-3 of minimalist market design prescribe a unique minimalist reform in the applications presented in Lectures 1 and 2.
 - Straightforward resolution.
- In **Lecture 4**, I present a more controversial aspect of the Indian Affirmative Action system, where there are multiple resolutions suggested by minimalist market design (Sönmez & Ünver, 2022).
 - Illustrates the importance of maintaining **informed neutrality** between reasonable normative principles.

My Training at Rochester

- In early 1990s, I pursued my Economics Ph.D. at the University of Rochester under the guidance of **William Thomson**.



My coursework from him included:

- **Mechanism Design**
- **Axiomatic Approach to Resource Allocation**
- **Two-Sided Matching Theory** during his **Sabbatical** year!
- In addition to positive economics, thanks to William's strong emphasis on equity, I formed a solid foundation on **normative economics**.
- In 1995, I defended my theoretical thesis on "Strategy-Proofness and Implementation on Matching Markets."

The Birth of Market Design

- 1990s witnessed the emergence of **market design** where researchers in auction theory and matching theory started playing active roles in design or reform of economic and social institutions.
- Early success stories were the design of the **FCC Spectrum Auction** in 1994 and the redesign of the **US Medical Residency Match** in 1997.
 - **FCC's Spectrum Auction:** Key figures includes many auction theorists including **John McMillan** as consultant for the FCC, **Paul Milgrom** and **Robert Wilson** as consultants for Pacific Telesis and **Preston McAfee** as a consultant for AirTouch Communications (McMillan, 1994).
 - **US Residency Match:** The redesign was commissioned by NRMP Board of Directors to matching theorist **Alvin Roth** in 1995 and approved in 1997 (Roth & Peranson, 1999).

My Early Aspirations to Design Real-Life Institutions

- Inspired by these success stories, I aspired to improve real-life institutions with my research. As a fresh Ph.D., I pondered on
 - On-Campus Housing at University of Rochester
 - College Admissions in Turkey
- There was, however, one major issue with my aspirations. Who would commission a fresh Ph.D. to design or reform a real-life institution? Moreover, any unsolicited initiative would likely irritate authorities...
 - Success stories of the Spectrum Auction and the US Medical Match offered little guidance for an **outsider** who aspires to guide a design.
 - How would I convince system operators for a costly reform when they have vested interests to maintain the system?
- **My Plan:** Developing **custom-made theories** which can make it possible to improve existing systems with minimal interference.
 - I could make compelling **normative** points.
 - Perhaps, I could pitch my ideas as a slight improvements of their ideas.

Beginnings of Minimalist Market Design

- Balinski & Sönmez (1999) and Abdulkadiroğlu & Sönmez (1999) mark the beginnings of minimalist market design.
 - They both start with a flawed real-life mechanism.
 - Guided by earlier pure theory, they both develop custom-made theory.
 - Only addressing the root causes of the flawed mechanisms, they both prescribe a “minimally invasive” alternative.
- The flawed mechanisms they study and my vision of a viable path to reform them are reflected in the modeling choice in both papers.
- Starting with Abdulkadiroğlu & Sönmez (1999), I next discuss the roles of these two papers in my vision of institution design.

Serial Dictatorship with Squatting Rights

- There are two types of agents (existing tenants and newcomers) and two types of houses (occupied and vacant).
 - Agents have strict preferences over all houses.
 - Each occupied house is owned by an existing tenant.
 - Vacant houses are collectively owned by all agents.
- In a preliminary phase of the allocation process, each existing tenant is given two options: Keeping her current house or giving it up and entering the centralized process.

A Flawed Real-Life Procedure: SD with Squatting Rights

- Once the participants are determined, the final allocation is carried out in the main phase by the following mechanism, first discussed in Satterthwaite & Sonnenschein (1981):

Simple Serial Dictatorship (SSD)

1. Participants are ordered in a line with some criteria (possibly a lottery).
 2. They submit their strict preferences over houses.
 3. The first agent in line is assigned her first choice; the second agent is assigned her first choice among the remaining houses, etc.
- Since there are **no guarantees** to receive a better house, keeping their occupied houses may be optimal for some existing tenants, potentially compromising gains from trade.
 - In addition, although SSD used in the main phase is strategy-proof, the preliminary phase of the mechanism is strategically complex.

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 - In addition, although SSD used in the main phase is strategy-proof, the preliminary phase of the mechanism is strategically complex.
 - **Root Cause of the Failures:** Lack of individual rationality

A “Minimally Invasive” Intervention

- Here is a resolution in Abdulkadiroğlu & Sönmez (1999) that directly addresses the root cause of the failure.

You Request My House – I Get Your Turn (YRMH-IGYT)

1. Agents are ordered in a line with some criteria (possibly a lottery).
2. They submit their strict preferences over houses.
3. The first agent in line is assigned her first choice; the second agent is assigned her first choice among the remaining houses, etc., **until someone demands the occupied house of an existing tenant.**
4.
 - a. Do not disturb the process if the existing tenant is already served.
 - b. Otherwise, promote her to the top of the line, and proceed.
5. Similarly, promote any existing tenant still in the line to the top of the queue when her house is demanded.
6. If a **cycle** forms, then assign each agent in the cycle the house she demands, and proceed with the procedure.

Example: Mechanics of YRMH-IGYT

Existing Tenants: $a_1, a_2, a_3, a_4, a_5, a_6, a_7, a_8, a_9$

Occupied Houses: $h_1, h_2, h_3, h_4, h_5, h_6, h_7, h_8, h_9$

Newcomers: $a_{10}, a_{11}, a_{12}, a_{13}, a_{14}, a_{15}, a_{16}$

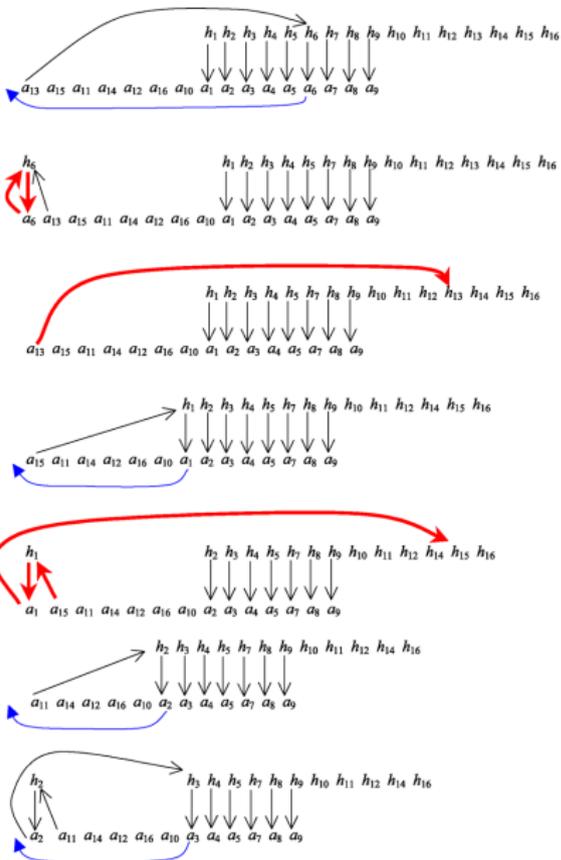
Vacant Houses: $h_{10}, h_{11}, h_{12}, h_{13}, h_{14}, h_{15}, h_{16}$

Preferences:

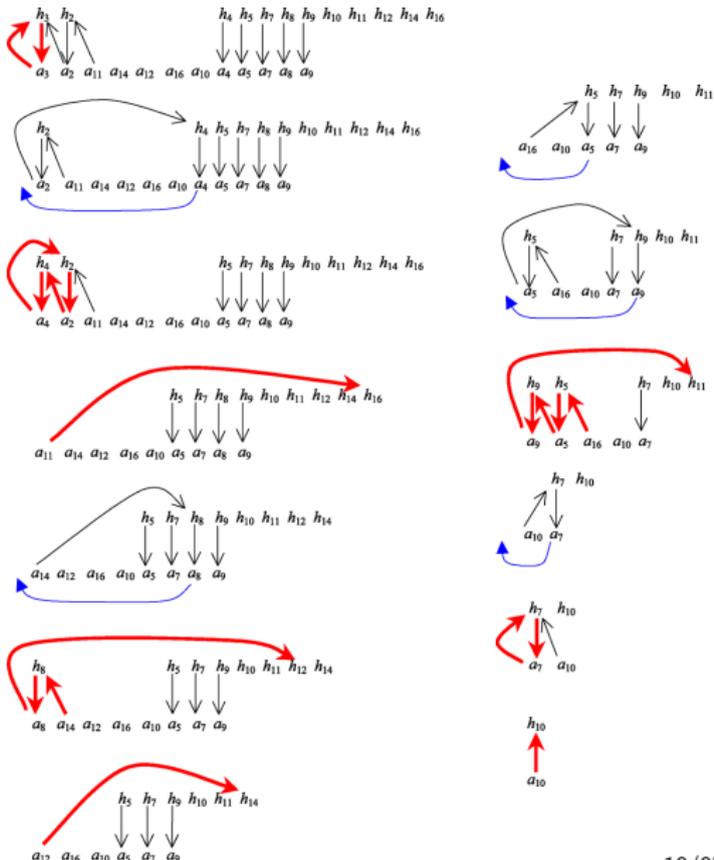
A_E									A_N						
a_1	a_2	a_3	a_4	a_5	a_6	a_7	a_8	a_9	a_{10}	a_{11}	a_{12}	a_{13}	a_{14}	a_{15}	a_{16}
h_{15}	h_3	h_1	h_2	h_9	h_6	h_6	h_6	h_{11}	h_7	h_2	h_4	h_6	h_8	h_1	h_5
\vdots	h_4	h_3	\vdots	\vdots	\vdots	h_7	h_{12}	\vdots	h_3	h_4	h_{14}	h_{13}	\vdots	\vdots	\vdots
	\vdots	\vdots				\vdots	\vdots		h_{12}	h_{16}	\vdots	\vdots			
									h_{10}	\vdots					
									\vdots						

Lottery Order: $a_{13} a_{15} a_{11} a_{14} a_{12} a_{16} a_{10} a_1 a_2 a_3 a_4 a_5 a_6 a_7 a_8 a_9$

Red Arrows: Finalized Assignments



Blue Arrows: Priority Upgrade



What is Special About YRMH-IGYT?

- YRMH-IGYT integrates allocation of unit-demand indivisible goods when **property rights** come in the following two forms:
 1. **Private ownership** via free trade
 2. **Public ownership** via priority allocation and trade of priority
- YRMH-IGYT reduces to **SSD** for the case of house allocation (Hylland & Zeckhauser, 1977) and to **Gale's top trading cycles** procedure for the case of housing markets (Shapley & Scarf, 1974).
 - **House allocation**: No existing tenants or occupied houses
 - **Housing markets**: No newcomers or vacant houses
- YRMH-IGYT inherits plausible properties of its predecessors: It is **individually rational**, **Pareto efficient** and **strategy-proof**.
 - Corrects all flaws of the **Serial Dictatorship with Squatting Rights** with minimal interference.

Why Bother with a “Minimally Invasive” Alternative?

- Assuming that there is no excess of houses, a theorist is more like to come up with the following simpler mechanism.

A Technocratic Solution to House Allocation with Existing Tenants

1. Create an **initial endowment** by
 - a. assigning each existing tenant her occupied house, and
 - b. randomly assigning vacant house to the newcomers.
 2. Find the final assignment with Gale's top trading cycles procedure.
- Not only this mechanism also satisfies individual rationality, Pareto efficiency and strategy-proofness, the proofs of these results directly follow from earlier literature.

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 - However, there is a very subtle bias in this mechanism!

Why Bother with a “Minimally Invasive” Alternative?

Theorem (Sönmez & Ünver, 2005)

The technocratic solution to house allocation with existing tenants is equivalent to a special case of YRMH-IGYT mechanism where

- 1. each newcomer is priority listed higher than each existing tenant, and*
- 2. the newcomers are priority listed among themselves randomly with uniform distribution.*

- Not only the technocratic solution favors the newcomers considerably, it does so in a **hidden** way!
 - This happens because of the first step of its procedure where the existing tenants **forfeit** their property rights on vacant houses when an initial endowment is artificially constructed.
 - A form of an **algorithmic bias**.

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 - A form of an **algorithmic bias**.
- **Moral of the story:** Custom-made theory is important!

A Normative Approach to Centralized Admissions

- Although YRMH-IGYT was developed as a minimally invasive alternative to a real-life house allocation mechanism, it was never pursued (at least by me) for practical implementation.
 - My first policy interactions took place in 1997 with Turkish officials on centralized assignment of high school graduates to colleges.

A Normative Approach to Centralized Admissions

- Although YRMH-IGYT was developed as a minimally invasive alternative to a real-life house allocation mechanism, it was never pursued (at least by me) for practical implementation.
 - My first policy interactions took place in 1997 with Turkish officials on centralized assignment of high school graduates to colleges.
- Balinski & Sönmez (1999) plays an important role in my career.
 - It was my first research project where I paid close attention to institutional details, and interacted with authorities upon completion for possible policy impact.
 - It is my first integrated effort in research and policy which relied on **normative economics** to pursue a reform of a major real-life institution.
 - It was also my first failure in my policy efforts, the earliest one of many to come, but not without teaching me several valuable lessons that influenced the evolution of my minimalist approach to market design.

Priority Admission and SSD

- Allocation of school seats centrally based on a performance metric is a widespread practice worldwide.
 - Today, we will consider a setting with no distributional objectives.
- The solution of this problem is straightforward when all seats are identical at a single institution.
 - **Priority Admission:** Simply admit the highest score students up to capacity.
- Priority admission also has a straightforward generalization when there are multiple institutions, provided that they all priority list applicants with the same performance metric.
 - **Simple Serial Dictatorship (SSD):** The first-ranked student receives her top choice, the second-ranked student receives her top choice among remaining seats, etc.

No Justified Envy

- Overcoming favoritism and corruption is one of the main reasons why so many countries or local authorities allocate school seats centrally, using an objective performance metric.
 - Assuming that the assignment rule **respects** the performance metric, i.e., each school has a minimum **cutoff** score uniformly applied for all students, this practice increases legitimacy of the process.
- **No Justified Envy (Balinski & Sönmez, 1999)**: No student ever loses a seat to another student who has a strictly lower performance score.
 - Technically related to **stability** in two-sided matching, but very different conceptually. Unlike stability which is a **positive** criterion, no justified envy is mainly a **normative** criterion.
- **Proposition (Balinski & Sönmez, 1999)**: An outcome can be supported by minimum cutoff scores if and only if it satisfies no justified envy.

Normative Justification for Priority Admission and SSD

- **Proposition (Balinski & Sönmez, 1999):** When all institutions use the same performance metric, SSD is the only direct mechanism that satisfies Pareto efficiency and no justified envy.
- **Proposition (Svensson, 1999):** SSD is strategy-proof.
- Therefore, not only is SSD (or its simpler version priority admission) an intuitive mechanism which is easy to discover by policymakers and system operators, but also one that has compelling normative basis.

More Complex Versions of Centralized Admissions

- In many applications of centralized school admissions, however, the problem is more complex.
 - Heterogeneity on school priorities
 - Distributional constraints
 - Means to improve priority with a costly action (e.g. via higher tuition)
- Policymakers and system operators often tend to rely on some basic (and often rudimentary) modifications of SSD or priority admission to solve these more complex versions of the problem.
 - Possible loss of normative appeal

Example with Heterogeneity on School Priorities

- Processing higher-ranked choices before lower-ranked ones is a compelling idea for the layman. This idea reflects itself by repeated use of the priority admission in the following popular mechanism:

Boston Mechanism

1. Considering the first choice of each student, allocate seats with priority admissions.
 2. Considering the second choice of any student who remains unassigned from Step 1, allocate all remaining seats with priority admissions.
 - \vdots
 - \vdots
 - l . Considering the l^{th} choice of any student who remains unassigned from earlier steps, allocate all remaining seats with priority admissions.
- Unlike its predecessor priority allocation, Boston mechanism neither satisfies no justified envy nor strategy-proofness.

Priority-Based Allocation with Heterogenous Priorities

- While a single standardized test is used to allocate all college seats in Turkey, by using different weights for its various sections, multiple performance rankings of students are constructed from this test.
 - Depending on the field, the central planner exogenously maps each college to one of these performance rankings.
 - The resulting heterogeneity in college priorities deem a one-shot application of SSD inapplicable.
- Just as the Boston mechanism is based on repeated application of priority admissions, the Turkish college admissions mechanism is based on repeated application of SSD.

Turkish College Admissions Mechanism

Multi-Category Serial Dictatorship (MCSD)

- 1a. For each performance ranking, tentatively assign seats of related colleges with SSD.
 - 1b. Construct a new preference relation for each student by removing choices ranked lower than the highest-ranked tentative assignment.
- ⋮
- ℓa. For each performance ranking, tentatively assign seats of related colleges with SSD using the preference profile from Step $(\ell - 1)$ b.
 - ℓb. Construct a new preference relation for each student by removing choices ranked lower than the highest-ranked tentative assignment under the preference relation constructed in Step $(\ell - 1)$ b.
- Finalize the assignments when no student receives more than one tentative assignment.

Example: Mechanics of MCSD

Students	=	{Alp, Banu, Can, Derin, Elif}
Colleges	=	{ c_1, c_2, c_3 }
College capacities	=	(2, 1, 1)
Score types	=	{purple, turquoise}
Score type for c_1	=	purple
Score type for c_2, c_3	=	turquoise

Student preferences and exam scores:

$\succ_A:$	$c_2 - c_1 - \emptyset$	$s^A = (450, 450)$
$\succ_B:$	$c_1 - c_2 - c_3 - \emptyset$	$s^B = (400, 300)$
$\succ_C:$	$c_1 - c_3 - c_2 - \emptyset$	$s^C = (350, 350)$
$\succ_D:$	$c_1 - c_2 - \emptyset$	$s^D = (300, 400)$
$\succ_E:$	$c_2 - c_3 - c_1 - \emptyset$	$s^E = (250, 250)$

The resulting performance rankings:

$$\pi_p : A B C D E$$

$$\pi_t : A D C B E$$

Step 1: We first find SSD outcomes for both rankings under \succ

$$\pi_p : \begin{array}{ccccc} A & B & C & D & E \\ c_1 & c_1 & & & \end{array} \quad \pi_t : \begin{array}{ccccc} A & D & C & B & E \\ c_2 & - & c_3 & & \end{array}$$

Step 1 generates the following tentative assignments:

$$\nu^1 = \left(\begin{array}{ccccc} \text{Alp} & \text{Banu} & \text{Can} & \text{Derin} & \text{Elif} \\ c_1, c_2 & c_1 & c_3 & \emptyset & \emptyset \end{array} \right)$$

Having received at least one tentative assignment, preferences of Alp, Banu, Can are truncated:

$$\begin{aligned} \gamma'_A &: c_2 - \emptyset \\ \gamma'_B &: c_1 - \emptyset \\ \gamma'_C &: c_1 - c_3 - \emptyset \end{aligned}$$

For other students: $\gamma'_D = \gamma_D$ and $\gamma'_E = \gamma_E$.

Step 2: We first find SSD outcomes for both rankings under γ'

$$\pi_p : \begin{array}{ccccc} A & B & C & D & E \\ - & c_1 & c_1 & & \end{array} \quad \pi_t : \begin{array}{ccccc} A & D & C & B & E \\ c_2 & - & c_3 & & \end{array}$$

Step 2 generates the following tentative assignments:

$$\nu^2 = \left(\begin{array}{ccccc} \text{Alp} & \text{Banu} & \text{Can} & \text{Derin} & \text{Elif} \\ c_2 & c_1 & c_1, c_3 & \emptyset & \emptyset \end{array} \right)$$

Having received two tentative assignments, preferences of Can is further truncated:

$$\gamma''_C : c_1 - \emptyset$$

For other students: $\gamma''_A = \gamma'_A$, $\gamma''_B = \gamma'_B$, $\gamma''_D = \gamma'_D$ and $\gamma''_E = \gamma'_E$.

Step 3: We first find SSD outcomes for both rankings under \succ''

$$\pi_p : \begin{array}{ccccc} A & B & C & D & E \\ - & c_1 & c_1 & & \end{array} \quad \pi_t : \begin{array}{ccccc} A & D & C & B & E \\ c_2 & - & - & - & c_3 \end{array}$$

Step 3 generates the following tentative assignments:

$$\nu^3 = \left(\begin{array}{ccccc} \text{Alp} & \text{Banu} & \text{Can} & \text{Derin} & \text{Elif} \\ c_2 & c_1 & c_1 & \emptyset & c_3 \end{array} \right)$$

Since no student received more than one tentative assignment in ν^3 , mechanism MCSD finalizes the outcome as ν^3 .

Strengths and Limitations of MCSD

- At first glance, MCSD seems to be a compelling mechanism. For example, it satisfies no justified envy.
 - If it didn't, the outcome would be regularly challenged at court.
- However, it has several limitations:
 - Its outcome can be Pareto dominated by an outcome which also satisfies no justified envy.
 - It is not strategy-proof.
 - It does not **respect improvements** in performance scores, i.e., an increase in a score may sometimes result in a lower-ranked assignment.
- A close inspection reveals the source of these limitations.

Proposition (Balinski & Sönmez, 1999): MCSD is equivalent to

- (i) interpreting each performance ranking of students as the uniform preference relation of colleges which are mapped to this ranking, and
- (ii) selecting the **college-optimal stable matching** (Gale & Shapley, 1962) of the induced **two-sided matching problem**.

How MCSD Relates to Two-Sided Matching Theory?

- For anyone familiar with the seminal work of Gale & Shapley (1962), a natural question follows: Why would authorities use this procedure in a setting where colleges are not agents whose welfare matter, but rather public goods to be fairly rationed?
- This line of reasoning also comes with an alternative mechanism.
Student optimal stable mechanism (SOSM): Construct the same “sister” two-sided matching problem, but instead select its student optimal stable matching.
 - Often called **deferred acceptance (DA)** mechanism these days.

The Case for SOSM

In a setting where no justified envy is indispensable, the case for SOSM is very strong.

Theorem (Balinski & Sönmez, 1999)

SOSM Pareto dominates any other mechanism that satisfies no justified envy.

Theorem (Alcaldé & Barberà, 1994; Balinski & Sönmez, 1999)

SOSM is the only mechanism that satisfies no justified envy, individual rationality, non-wastefulness and strategy-proofness.

Theorem (Balinski & Sönmez, 1999)

SOSM is the only mechanism that satisfies no justified envy, individual rationality, non-wastefulness and respect for improvements.

Failed Policy Attempt in Turkey

- As a fresh Ph.D., I was exhilarated upon these discoveries.
 - My model was exact, and, at least in my mind, the superiority of my proposed mechanism was clear cut.
 - Surely authorities would welcome my discovery and correct their flawed mechanism, or so I thought...
- In 1997, even before the paper was submitted for scholarly review, I reached out to authorities in the hopes of guiding a reform.
- After several correspondences via physical mail and a meeting with the head of the centralized clearinghouse ÖSYM,¹ I received a formal letter from Ankara that kindly turned down my proposal.

¹ÖSYM is the acronym for Öğrenci Seçme ve Yerleştirme Merkezi, which translates to English as Student Selection and Placement Center.

T.C.
YÜKSEKÖĞRETİM KURULU
ÖĞRENCİ SEÇME VE YERLEŐTİRME MERKEZİ

Başkanlık
Sayı: B.30.1.ÖSM.0.00.10.00/909-51606

26 Kasım 1997

Sayın Y. Doç. Dr. Tayfun Sönmez,
Department of Economics
University of Michigan
Ann Arbor, Michigan 48109-1220
USA

Öğrenci Seçme ve Yerleştirme Sınavı (ÖSYM) Sisteminde kimi aksaklıklar bulunduğu görüşüyle bu aksaklıkları çözmeye yönelik öneriler getiren "A Tale of Two Mechanisms in Student Placement Problems" adlı makaleniz Merkezimizce incelenmiştir. Bu incelemede,

1. Makalenizde önerilen modelin bilimsel olarak tutarlı olduğu ve akademik değer taşıdığı,
2. Bir yerleştirme problemi için kuramsal olarak minimum puan koşulunu sağlayan birden çok çözüm bulunabileceği, ÖSYM sisteminin bunlardan birini, makalede önerilen algoritmanın ise bir diğeri çözdüğü ve teorik olarak bu iki çözüm dışında başka çözümlerin de bulunabileceğinin olduğu,
3. Uygulama açısından bakıldığında, makalede önerilen algoritmanın ÖSYM'de kullanılması sonucunda kuramsal olarak çok uç noktalarda farklı bir sonuç verebileceği, ancak bu olasılığın son derece az olduğu,
4. Merkezimizde, makalede önerilen algoritma, simülasyon çalışmasıyla 1997 ÖSYM tım aday kitilesi üzerinde uygulanarak yerleştirme yapıldığı, bu çalışmada elde edilen sonuç ile 1997 ÖSYM gerçek yerleştirme sonucu arasında herhangi bir fark bulunmadığı,
5. Bu bulgular ışığında, ÖSYM'de algoritma değişikliğine gidilmesinin uygun olmayacağı sonucuna varılmıştır.

Yukarıda belirtildiği gibi, çalışmanızın kuramsal olarak tutarlı olduğunu ve bu tip çalışmalarda her zaman işbirliği yapmaya açık olduğumuzu bildirir, başarılarınızın devamını dilerim.


Dr. Fethi Tokar
Başkan

After analyzing my proposal, the leadership at ÖSYM reached the following conclusions:

1. The model is scientifically consistent and it carries academic value.
2. There can be multiple solutions that respect the cut-off score condition, ÖSYM system gives one of them, SOSM gives another, and there can be others.
3. While in theory the two mechanisms could generate very different outcomes, from a practical perspective this is a very low probability event.
4. With the 1997 data (which includes more than a million students and thousands of colleges), the two mechanisms generated the same outcome.
5. In light of their findings, it is not adequate to reform the mechanism.

My Take on the Failed Policy Attempt in Turkey

- While I failed in my ultimate objective of making policy impact with my research, my proposal received serious consideration.
 - The diligence of the leadership at ÖSYM gave me the hope that, perhaps, next time I might succeed with some more careful planning.
- Given their emphasis on solutions that respect cut-off scores, I was correct in my hypothesis that, at least in the Turkish context **no justified envy** was the most important desideratum.
- On the other hand, the authorities did not even comment about the lack of **strategy-proofness, respect for priority improvements**, or even the potential **Pareto inferiority** of their mechanism.
- While they acknowledged that the two mechanisms can generate different outcomes, due to their simulations with 1997 data, they concluded that this must correspond to a low probability event.

Lessons from the Failed Policy Attempt in Turkey

- In retrospect, my failure made complete sense.
 - I was an **outsider** who arrived with bad news. I found fault in a mechanism which had been working without issues for years.
 - How would they justify a reform to their superiors or the public?
 - Why admit an issue when the system was working just fine?
- I had two important lessons from this experience:
 1. No matter how accurate my model and clean my analysis might be, theoretical analysis alone will not cut it for my policy ambitions. I had to present more concrete value to the stakeholders.
 2. How good the mechanism I advocate is unlikely to be important for the authorities, unless I also show that their current mechanism is really bad. I had to support my normative analysis with positive economics.

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 2. How good the mechanism I advocate is unlikely to be important for the authorities, unless I also show that their current mechanism is really bad. I had to support my normative analysis with positive economics.
- Seven years later, these two lessons guided my interactions with the authorities at Boston Public Schools (BPS).

School Choice vs. Student Placement in Turkey

- Shortly after my policy failure in Turkey, it became clear that the relevance of Balinski & Sönmez (1999) goes well beyond Turkish college admissions.
- Most notably, as part of a policy called **school choice** in the US, K-12 admissions at public schools were carried out with similar centralized clearinghouses in many large school districts.
 - School choice was advocated by various groups as a more equitable alternative to neighborhood assignment.
- At first, school choice seemed fully isomorphic to Balinski & Sönmez (1999). The only difference was, rather than standardized tests, in most school districts other criteria determined student priorities.
 - So, perhaps there was no need for formal analysis. After all, we already declared SOSM as the unambiguous winner!

Is No Justified Envy Indispensable in School Choice?

For at least three reasons, however, it was valuable to explore mechanisms which fail to satisfy no justified envy.

1. While full enforcement of priorities is compelling no matter how priorities are obtained, it was less clear how essential it is when they are not “earned” through effort.
2. Of all school choice mechanisms in the US we documented in the late 1990s, there wasn't a single one that satisfied no justified envy!
 - Field evidence strongly suggested that no justified envy is dispensable.
3. In settings with heterogenous school priorities, no justified envy is no longer compatible with Pareto efficiency (Balinski & Sönmez, 1999).
 - Full enforcement of priorities is not free.

Example: Efficiency Cost of No Justified Envy

There are 3 students i_1, i_2, i_3 and 3 schools c_1, c_2, c_3 with one seat each.

Preferences

$$\gamma_{i_1}: c_2 - c_1 - c_3 - \emptyset$$

$$\gamma_{i_2}: c_1 - c_2 - c_3 - \emptyset$$

$$\gamma_{i_3}: c_1 - c_2 - c_3 - \emptyset$$

School Priorities

$$\pi_{c_1}: i_1 - i_3 - i_2$$

$$\pi_{c_2}: i_2 - i_1 - i_3$$

$$\pi_{c_3}: i_2 - i_1 - i_3$$

Only μ satisfies no justified envy but it is Pareto dominated by ν :

$$\mu = \begin{pmatrix} i_1 & i_2 & i_3 \\ c_1 & c_2 & c_3 \end{pmatrix}$$

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- While SOSM Pareto dominates any mechanism that satisfies no justified envy, it is **not** Pareto efficient!

A Pareto Efficient Mechanism for School Choice

- **Source of the Efficiency Loss from No Justified Envy:** Even though the priority of student i_3 at college c_1 is not high enough to secure a seat, it is high enough to “block” its assignment to student i_2 .
- This efficiency loss can be avoided by allowing individuals to trade their priorities, leading to the **Top Trading Cycles (TTC)** mechanism.
 - **Gale's TTC (Shapley & Scarf, 1974)** Trade of privately owned houses.
 - **YRMH-IGYT (Abdulkadiroğlu & Sönmez, 1999)** Trade of privately owned houses and priorities for available houses.
 - **TTC (Abdulkadiroğlu & Sönmez, 2003)** Trade of priorities for school seats.
- **Proposition (Abdulkadiroğlu & Sönmez, 2003)** TTC satisfies Pareto efficiency, individual rationality, strategy-proofness and respect for improvements.

Policy Recommendations for School Choice

- In Abdulkadiroğlu & Sönmez (2003), we proposed two mechanisms for school choice:
 - SOSM if no justified envy is indispensable.
 - TTC if Pareto efficiency is more important than no justified envy.
- My experience with Turkish officials, however, suggested that merely proposing good mechanisms is not likely to compel policymakers to adopt these mechanisms.
 - We had to establish that their current mechanism is really bad.
- One mechanism of interest was the **Boston** mechanism.
 - Harbors strong incentives for preference manipulation.
 - By far the most popular mechanism in the late 1990s.

Anecdotal Evidence Against the Boston Mechanism

- Unlike the Turkish college admissions mechanism, subtle aspects of the Boston mechanism created some anxiety in the field.
- The following is a representative quote from a newspaper story entitled “Yep, it’s complicated. If you care where your kid ends up, you have to be savvy and alert.”

“Make a realistic, informed selection on the school you list as your first choice. It’s the cleanest shot you will get at a school, but if you aim too high you might miss. Here’s why: If the random computer selection rejects your first choice, your chances of getting your second choice school are greatly diminished. That’s because you then fall in line behind everyone who wanted your second choice school as their first choice. You can fall even farther back in line as you get bumped down to your third, fourth and fifth choices.”

Thomas Tobin, St. Petersburg Times, September 14, 2003

How Efficient is Boston Mechanism?

- These discoveries suggested that, authorities who rely on the Boston mechanism could be more receptive to my reform efforts than their Turkish counterparts.
- Before making any move, however, this time I decided to build a much stronger case against this widespread mechanism.
 - One theoretical strength of the Boston mechanism is its Pareto efficiency under truthful preference revelation.
 - Laboratory experiment in Chen & Sönmez (2005) revealed that, strategic manipulation is notable under the Boston mechanism, resulting in a lower efficiency than both SOSM and TTC.
 - Complete information equilibrium analysis in Ergin & Sönmez (2006) revealed that, SOSM outperforms the Boston mechanism in efficiency.

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 - Complete information equilibrium analysis in Ergin & Sönmez (2006) revealed that, SOSM outperforms the Boston mechanism in efficiency.
- Finally, a timely development in September 2003 created a golden opportunity to approach the leadership at BPS.

FRIDAY, SEPTEMBER 12, 2003

THE BOSTON GLOBE

School assignment flaws detailed

Two economists study problem, offer relief

By Gareth Cook

Boston sees a deeply flawed system for assigning students to its public schools, pushing more students out of their top-choice schools than necessary and giving parents a reason to be about which schools they want, according to a pair of researchers who recently published their findings in a leading economics journal.

A new system, they say, could greatly reduce the anxiety in the city's annual school-choice process, in which thousands of parents submit lists of their top choices and await the computer-generated decision that will affect their next year to five years of their child's education.

The researchers found that once the parents submit their lists, they are subject to a poorly designed method of allocating spots in the top schools. By using a different technique, they say, the city could get more students into one of their top-choice schools while also making the system fairer. The alternative

technique, which the researchers outline in the paper, could be put in place with relatively simple, inexpensive changes and would not require the city to change any of its broader policies, according to the researchers and other economists who have seen the paper.

"Once all this is known, I don't see how they can keep the Boston mechanism," said Turkish economist Dursun Sinir, one of the researchers who studied Boston's system.

For more than two decades, policymakers have devoted enormous amounts of attention to various ways to assign students to schools, examining

philosophical debates, charges of racial and economic discrimination, and tangled court battles — all of which have played out with particular drama in Boston. But the authors say their work, which also examined districts in Columbus, Minneapolis, and Seattle, is the first rigorous examination of how best to do the actual matching once the policy is decided.

The research has broader implications as well. If more parents were happier with their school assignments, it would help keep them from fleeing for the suburbs and bolster the fortunes of

► SCHOOLS

Continued from Page B7

the school district — and the city. Officials with the Boston public schools and the Boston School Committee readily acknowledge that parents are frustrated with the current system, and officials said at a School Committee meeting this week that they would make changing the system a priority. They have not yet considered the method suggested by the economists.

"For every parent who feels frustrated about a policy, there is always a parent who will feel frustrated about an alternative," said Christopher M. Horan, chief of staff for the Boston public schools.

Horan said he was intrigued by the economists' work and considered their suggestion a serious alternative.

In Boston, most students have to apply to get into kindergarten, first grade, sixth grade, and ninth grade. All students are given a priority ranking at each school, based on whether they have a sibling there, whether they live within walking distance, and a lottery number. And all parents rank the schools they would like their children to attend.

To begin, each school considers all the students who ranked it number one, and gives out seats in order of the student's priority at that school. Then, each school that still has room considers all the students who ranked it number one, and again gives out seats in order of student priority. This process continues until all the students are assigned a spot or no more schools are left on a student's list — in which case the student is "unassigned" and ends up at a school that still has an empty spot.

The problem, as parents quickly figure out, is that many of the best schools fill up in the first round, so students who don't get into their first choice can find themselves crowded out of all their top choices.

"It is crazy," said Kathy Bear, a 7-year-old daughter, Kaitlyn, didn't get any of her top choices for kindergarten, and was assigned to a distant, troubled school in Dor-

A better method for school choice

The system used to place students in Boston public schools sends thousands of students to low-choice schools although they have priority at better schools, according to a new analysis. Researchers say that adopting a system like the one used to place students in medical residencies nationwide would better match students with schools they want to attend.

STUDENT & SCHOOL PRIORITIES

Parents make lists of schools — at least three, and often five to 10 — ranking them by preference.

Each school makes a list of all students, ranking them with specific criteria.



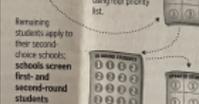
THE PRESENT SYSTEM
Each school takes the list of students who have ranked it as their top school.

Schools choose students in order of priority until the school is full, or to top of first-round students is exhausted.



In the second round, schools with remaining space take the list of unplaced students who have ranked it as their second choice, picking them as before.

The problem: Student placements are final in each round. If a school fills in the first round, students higher on the priority list — but who ranked it as their second choice — won't get a seat. The given students incentive to inflate the ranks of schools to which they have a high priority to avoid being frozen out in early rounds.



THE ADVANTAGES
Truthful lists are the best strategy, because students with high priority can't lose seats to lower-priority students in early rounds.

"Inflatable envy" is avoided: No student who prefers School A is frozen out of that school by someone with a lower priority than theirs.



SOURCE: ANALYSIS BY GARETH COOK AND DURSUN SINIR FOR THE BOSTON GLOBE. ART BY GABRIELLE BOWEN

This happens because as soon as a school fills up, no longer considering any more applicants, no matter how high the student might be on the priority list.

A better alternative, said the researchers in the June issue of the American Economic Review, is a system similar to the national

then considers these students, along with all the students temporarily assigned to it, and gives out all of its seats in order of the applicants' priority. This process repeats, with any unassigned students applying to the next school on their list, and getting in if there

is more space. The method is likely to make more students happier with their assignment. In the experiment, which used 96 students vying for seven schools, most students wound up at a school that was slightly higher on their list than their preference.

- Soon after it appeared in print, *Boston Globe* published a story on Abdulkadiroğlu & Sönmez (2003).

- The story included interviews with frustrated parents, BPS officials and members of the Boston School Committee.

Select Excerpts from the *Boston Globe* Story

“Officials with the Boston public schools and the Boston School Committee readily acknowledge that parents are frustrated with the current system, and officials said at a School Committee meeting this week that they would make changing the system a priority.”

“Horan [Chief of staff for the BPS] said he was intrigued by the economists’ work and considered their suggestion a serious alternative.”

“Of course, no new system can create more seats at the most sought-after schools. But all parents interviewed by the Globe said that it would be a huge relief simply to write a truthful answer to the question: What school do you want?”

‘A lot of the alienation some parents have toward the choice system is solely attributable to the alienation of not making your first choice your first choice,’ said Neil Sullivan, the father of four children who have attended Boston public schools.”

Preliminary Communications with BPS Authorities

- Emboldened with the *Boston Globe* story, I expressed Superintendent Thomas Payzant my desire to collaborate with BPS for a potential reform of their school choice mechanism.
 - In addition to the *Boston Globe* story, my e-mail message included a detailed justification of my proposed reform and its supporting research (i.e., Balinski & Sönmez, 1999; Abdulkadiroğlu & Sönmez, 2003; Chen & Sönmez, 2005 and Ergin & Sönmez, 2006).
- Following a reply message from Valerie Edwards, the Strategic Planning Manager at BPS, I had a phone call with her discussing my proposal and explaining my underlying motives.
 - At the beginning, the officials at BPS were upset about the mayhem caused with the *Boston Globe* story. They also alerted me that they have no funding for me for any potential interaction.
 - I explained that my efforts are meant to be on a pro bono basis.

Meeting with BPS Authorities

- My assurances facilitated an invitation to BPS to present the details of the proposed reform and its expected benefits to the city.
 - With the approval of the BPS leadership, I invited Atila Abdulkadiroğlu and (then) Boston-based Alvin Roth to the meeting.
- In October 2003, I gave a presentation to BPS officials on the merits of the proposed reform.
 - Roth joined the meeting with Parag Pathak, who was then a first year graduate student at Harvard University.
- In my presentation, it became clear that it was mainly the incentive compatibility considerations that secured this important meeting.
 - Though I mainly pitched SOSM for a possible reform, Valerie Edwards explicitly inquired about our thoughts on TTC.

Results of the BPS Meeting

- Authorities were convinced that the Boston mechanism does not serve the city well and it likely alters the submitted preferences.
 - Relying on preference data to assess school popularity, they were wary of a possible disconnect between submitted and true preferences.
- Authorities were convinced that a strategy-proof mechanism will increase **transparency** and **parental satisfaction**.
- Authorities decided to form a Student Assignment Task Force to evaluate the city's assignment process including our proposed reform.
 - September 2004 Task Force Recommendation: **TTC**
- Providing us with student preference data, authorities requested an empirical analysis of strategic behavior under the Boston mechanism.
 - Presence of strategic behavior is empirically verified in Abdulkadiroğlu, Pathak, Roth & Sönmez (2006).

BPS Recommendation: Boston Mechanism

- In a May 2005 public meeting of the School Committee, BPS officials announced their recommendation to discard the Boston mechanism.



The Problems With the BPS System

- The current process forces families to STRATEGIZE.
- Strategizing is imperfect because families don't know:
 - what their random number will be.
 - what schools other families are choosing.
 - how many others they're competing with.
- Assignment becomes a **high-stakes gamble** for families.
- Undermines families' trust in the BPS system.
- Families should not have to sacrifice their true preferences.
- Families should be able to be forthright about their choices.
- The system, not families, should compensate for mismatches between preferences and priorities.

BPS Recommendation: The Role of Incentives

- BPS officials emphasized the appeal of adopting a strategy-proof mechanism in promoting **transparency** and **leveling the playing field**.
 - These **normative** justifications for strategy-proofness, a first in a public debate, are later formalized in Pathak & Sönmez (2008).



Conclusion

- The current BPS assignment algorithm makes it risky for parents to rank an over-demanded school first, unless they have a high priority at that school.
- A Strategy-Proof Algorithm:
 - Removes the risk from ranking schools in order of true preference.
 - Eliminates the need for strategizing.
 - **Adds “transparency”** and clarity to the assignment process, by allowing for clear and straight forward advice to parents regarding how to rank schools.
 - **“Levels the playing field”** by diminishing the harm done to parents who do not strategize or do not strategize well.

BPS Recommendation: SOSM

- Despite the Task Force recommendation, BPS supported SOSM.
 - Recommendation driven by **no justified envy** and **strategy-proofness**



IV. Recommendation: Gale-Shapley

- The Gale-Shapley *Deferred Acceptance Algorithm* will **best serve Boston families**, as a centralized procedure by which seats are assigned to students based on both student preferences and their sibling, walk zone and random number priorities.
- Students will receive their highest choice among their school choices for which they have **high enough priority** to be assigned. The final assignment has the property that a student is not assigned to a school that he would prefer **only** if every student who is assigned to that school has a higher priority at that school.
- Regardless of what other students do, this assignment procedure allows all students to rank schools in their true order of preference, without risk that this will give them a worse assignment than they might otherwise get.

BPS Recommendation: TTC

- Despite its Pareto efficiency, strategy-proofness and support from the Task Force, authorities were hesitant to recommend TTC.
 - Main Reasons: Failure of no justified envy and **perceptions**



Why Not Top Trading Cycles?

- The Top Trading Cycles Algorithm allows **students to trade their priority** for a seat at a school with another student. This trading shifts the emphasis onto the priorities and away from the goals BPS is trying to achieve by granting these priorities in the first place.
- This trading of priorities could lead families to believe they can still benefit from strategizing, as they may be encouraged to rank schools to which they have priority, even if they would not have put it on the form if the opportunity for trading did not exist.
- The behind the scenes mechanized trading makes the student assignment process less transparent.

BPS School Choice Reform

- In June 2005, the Boston School Committee voted to replace the Boston mechanism with SOSM.
- The city adopted SOSM starting the next school year and has been using it for allocation of K-12 public school seats since then.
 - Along with a “similar” reform in New York City (NYC), the BPS school choice reform triggered a series of similar reforms worldwide.
- The strong role of various axioms in both the successful policy efforts in Boston and the earlier unsuccessful ones in Turkey played an instrumental role in evolution of minimalist market design.
 - **Key Lesson:** What really matters for various stakeholders is the underlying **principles** and not specific mechanisms.
 - Not all similar reforms that followed were guided by design economists. Some evolved naturally, giving **external validity** to the joint research and policy framework which I now call minimalist market design.

Incentive Compatibility: Constraint or Design Objective?

- Following the school choice reform at BPS and two similar reforms in Chicago and England, we made the following point:

“The Boston episode challenges a paradigm in traditional mechanism design that treats incentive compatibility only as a constraint and not as a direct design objective, at least for the specific context of school choice. Given economists’ advocacy efforts, one might think that this incident is isolated, and the Boston events do not adequately represent the desirability of non-consequentialist objectives as design goals. To demonstrate otherwise, we provide further, and perhaps more striking, evidence that excessive vulnerability to ‘gaming’ is considered highly undesirable in the context of school choice. Officials in England and Chicago have taken drastic measures to attempt to reduce it, and remarkably the Boston mechanism plays a central role in both incidents.”

Pathak & Sönmez (2013)

What is the Driving Force of Reforms?

- A signature feature of minimalist market design is that it is driven more by underlying principles than procedural details.
- **Persuasion Stage of Reform Advocacy:** Establishment of Necessity
 1. Identification of desiderata that really matter for the stakeholders.
 2. Verification of visible and consequential failures of the existing institution based on desiderata that matter.
- **Thesis:** In the absence of a well-executed persuasion stage of the reform advocacy, stakeholders ignore any efforts for a policy change.
 - Persuasion stage is bypassed under **commissioned** market design.
 - Persuasion stage was missing in my failed attempt to reform the Turkish college admissions mechanism.
- **Enhancement Stage of Reform Advocacy** is the formulation of a “better” institution, but it can receive attention from policymakers or other stakeholders only if the persuasion stage is already established.

Imitating Natural Evolution of Institutions

- Example: BPS School Choice Reform
 - **Persuasion Stage of Reform Advocacy:** Identification of incentive compatibility as a key desiderata and verification of the excessive vulnerability of the Boston mechanism to preference manipulation.
 - **Enhancement Stage of Reform Advocacy:** Exploration of incentive compatible mechanisms subject to broader mission of the institution.
- Ideally, the two-stage process of reform advocacy under minimalist market design **imitates** the natural evolution of an institution.
 - Lack of formalism or technical limitations often result in mistakes when an institution is designed by laymen. The main objective under minimalist market design is to formulate the **intended** institution.
 - If minimalist market design works sufficiently well in imitating the natural evolution of an institution, it may receive **external validity** through similar but natural reforms when the starting point is a mechanism with the same failures.

External Validity: School Admissions Reforms in England

- Nationwide 2003 School Admissions Code mandated that local authorities, an operating body similar to a US school district, should coordinate student admissions through a centralized mechanism.
- Two classes of mechanisms were recommended with the code.
 1. SOSM (called **equal preference** system) and its capped versions.
 2. A generalization of the Boston mechanism called a **first preference first (FPF)** system and its capped versions.
- Of more than 150 local authorities, many adopted the FPF system.
 - Pathak & Sönmez (2013) documents 59 local authorities which adopted FPF, including 5 which adopted the Boston mechanism.
- All versions of the FPF system including the Boston mechanism were **banned** throughout England with the 2007 School Admissions Code.
 - All local authorities in England was using variants of SOSM by 2007.

External Validity: School Admissions Reforms in England

- Official Justification for the Ban:

“the ‘first preference first’ criterion made the system unnecessarily complex to parents”

School Code 2007, Foreword, p. 7

“[The first preference first system] forces many parents to play an ‘admissions game’ with their children’s future.”

Education Secretary Alan Johnson

- Comparison with 2005 School Choice Reform at BPS:

- Members of the **same class of mechanisms** are discarded,
- due to **same reasons**,
- resulting in the **same resolution**.

- More so than its own virtues, SOSM emerged as the primary mechanism in England because of the failures of its main competitor.

External Validity: 2009 School Choice Reform in Chicago

- For allocation of seats at selective high schools, Chicago Public Schools (CPS) abandoned a version of the Boston mechanism in the middle of the 2009 allocation process (Pathak & Sönmez, 2013).
 - A few months after the preferences were submitted under the capped Boston mechanism, CPS officials asked the students to resubmit their preferences under a capped version of SOSM.
- This incidence was reported in a November 8th, 2009 *Chicago Sun-Times* story:

"Poring over data about eighth-graders who applied to the city's elite college preps, Chicago Public Schools officials discovered an alarming pattern.

High-scoring kids were being rejected simply because of the order in which they listed their college prep preferences.

'I couldn't believe it,' schools CEO Ron Huberman said. 'It's terrible.'

CPS officials said Wednesday they have decided to let any eighth-grader who applied to a college prep for fall 2010 admission re-rank their preferences to better conform with a new selection system."

External Validity: 2009 School Choice Reform in Chicago

- In addition to the manipulability of the capped version of the Boston mechanism, its failure of no justified envy was also a major concern.
 - Entrance exams and middle school grades play strong role in priorities.
 - These failures must have been so unacceptable that, the officials could not even wait for the next academic year to correct their mechanism.
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- **Comparison with 2005 School Choice Reform at BPS:**
 - Members of the **same class of mechanisms** are discarded,
 - due to **similar reasons**,
 - resulting in the **same resolution**.
- **External Validity for Minimalist Market Design:** Strong parallels between the natural Chicago and England reforms and the engineered BPS reform suggest that, minimalist market design (at least in some cases) succeeds in creating the intended mechanisms.

Contrast with 2003 NYC School Choice Reform

- Another successful application of market design in mid 2000s was the economist-guided adoption of SOSM for allocation of public high schools in NYC (Abdulkadiroğlu, Pathak & Roth, 2005).
 - Since both BPS and NYC adopted versions of SOSM, the success of these applications were attributed to **similar** reasons.
- Bundling these two applications, however, shifted the focus too much into technical aspects of these designs (e.g., merits of the deferred acceptance algorithm) and away from **political economy** of a reform.
- Focusing on their underlying political economy, I next discuss the fundamental differences between the two school choice reforms.

Background of the 2003 NYC School Choice Reform

- In 2002, NYC Department of Education (NYCDOE) faced the following three issues with the assignment of rising high school students to more than 500 programs:
 1. Of nearly 100,000 students, approximately 30% had been assigned to a school that was not included in their submitted preference lists.
 2. The system was vulnerable to strategic preference manipulation by the students in a way similar to the Boston mechanism.
 3. A number of schools were able to conceal capacity from the central administration and preserve seats for allocation outside the system.
- In May 2003, an official at NYC DOE consulted to Alvin Roth whether the matching process of the US Medical Match could be modified to design a new high-school matching process.
 - Just as the SOSM, the procedure used for the US Medical Match (Roth & Peranson, 1999) is also based on the Gale and Shapley's celebrated individual-proposing deferred acceptance algorithm.

Background of the 2003 NYC School Choice Reform

- By the time design economists were involved in the redesign of NYC high school assignment process, the need for a reform was already established and the authorities were in search of expert opinion.
 - A leading expert in matching market design was **commissioned** for a redesign of the system.
 - Authorities were leaning towards adopting a version of the SOSM.
- As it is the case in other applications of **commissioned market design**, the persuasion stage of reform advocacy is bypassed under the NYC high school assignment reform.
 - Applications of commissioned market design offer little guidance for an **outsider** design economist on political economy of an **aspired** design.
- The enhancement stage of reform advocacy also had a head start for NYC reform since authorities were leaning towards SOSM.
 - Due to the bankrupt situation with the existing system, SOSM was adopted a few months after authorities contacted a design economist.

Kidney Exchange

- One of the most unexpected applications of market design which contributed to visibility and success of the field is **kidney exchange (KE)** (Roth, Sönmez & Ünver, 2004, 2005, 2007).
 - Within a few years after its introduction as a market design application, our formal approach transformed living donor kidney donation in many countries.
 - Within a decade, it started saving more than a thousand lives annually.
- Why unexpected?
 - Way outside the traditional domain of economics.
 - As in the case of the school choice reform at BPS, help from economists was volunteered as **outsiders** and it was not solicited.

Outreach Efforts in Kidney Exchange

- How did three economists manage to develop the tools for and helped to establish the infrastructure which regularly touches so many lives?

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- They key was convincing stakeholders (e.g. policymakers, system operators) that we can help them to improve their institution
 - in aspects they care about,
 - by using the tools they are familiar with (or at least they are comfortable to use), and
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 - in aspects they care about,
 - by using the tools they are familiar with (or at least they are comfortable to use), and
 - without creating any issues.
- To have a realistic chance to influence policy, an aspiring market designer needs to have an in depth understanding of the mission of the institution along with a **practical** and **transparent** plan to improve it.
 - Often the **history** of the institution can be instructive.
 - Policy aspirations usually have strong implications on viable designs, and therefore also on the research program.

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 order to overcome barriers to living donation due to biological incompatibilities, the program made two types of arrangements:
 1. **Paired Kidney Exchange (PKE):** A direct exchange of donors between two patients with incompatible donors.
 2. **List Exchange (LE):** An indirect exchange between an incompatible pair and the deceased-donor (DD) list. (Elevated priority in the list in exchange for a kidney of the co-registered donor).

Paired Kidney Exchange (PKE)

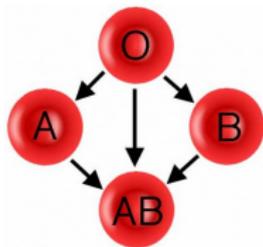
- Originally proposed by a transplant surgeon in Rapaport (1986).
- First carried out in South Korea in 1991 (Park et al., 1999).
- Transplantation community issued a **consensus statement** in 2000 declaring it as **ethically acceptable** (Abecassis et al., 2000).
 - Considered as a high praise in medical community.
 - The consensus statement urged all four operations to be carried out simultaneously.
- The first PKE in the US was carried out in Rhode Island in 2000.

List Exchange (LE)

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- There are four blood types A, B, AB and O.



- Type AB patients can receive a kidney of any type
 - Type A patients can receive a kidney of types A or O
 - Type B patients can receive a kidney of types B or O
 - Type O patients can only receive a kidney of type O
 - Type O patients are disadvantaged because of this **“natural injustice.”**
- The consensus statement (Abecassis et al., 2000) highlighted the ethical concerns that involve type O patients.

Early Phases of Kidney Exchange in New England

- Despite the ethical concerns, New England included LE in its program. 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)

- Reflecting the concerns, however, much of the discussion in Delmonico et al. (2004) involves the precautions taken to mitigate the adverse impact of LE on type O patients on the DD waiting list.

Early Phases of Kidney Exchange in New England

- Despite being the less preferred type of KE, most transplants arranged by the New England's program in its early phases were from LE.
 - # of LE Transplants (Feb. 2001– Dec. 2003): 17
 - # of PKE Transplants (Feb. 2001– Dec. 2003): 8 in 4 PKEs
- **No Database:** Prior to our involvement in Fall 2004, the program did not have a unified database where participating centers could access information on patient-donor pairs co-registered in other centers.
 - Explains the small number of transplants from PKE in early years of the program.

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 - Explains the small number of transplants from PKE in early years of the program.
- While arranging a LE does not require a patient-donor database, organizing them also involved operational challenges in New England.

Early Phases of Kidney Exchange in New England

- A prerequisite for eligibility for LE was to assure that no PKE is feasible between the patient and any other patient registered in all 14 transplant centers in the system.

“[...] the general practice has been to ask such pairs to wait a minimum of one month, in order to avoid 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)

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Delmonico et al. (2004)

- **Timing is Everything!** Under these circumstances, we shared the first draft of RSÜ (2004) with Dr. Francis Delmonico in Fall 2003, and conveyed our interest to support them to improve their KE program.

Early Market Design Research in Kidney Exchange

- While we were both faculty members at Koç University-İstanbul, my colleague Utku Ünver visited Alvin Roth at Harvard University for the academic year 2002-2003.
- During his visit, Roth alerted him that Abdulkadiroğlu & Sönmez (1999) has an unusual application in kidney transplantation.
 - Patients with living donors are analogous to existing tenants
 - Paired-donor kidneys are analogous to occupied houses
 - Patients on DD list are analogous to newcomers
 - DD kidneys are analogous to vacant houses
- As such, YRMH-IGYT mechanism also had a potential application.

Early Market Design Research in Kidney Exchange

- Regulating the claims for “unattached” houses (either vacant or vacated during the procedure) with an **exogenous priority list**, YRMH-IGYT mechanism organizes two types of transactions:
 1. **Cycle**: Existing tenants trade their occupied houses
 - PKE corresponds to a cycle with two individuals
 2. **Chain**: One individual trade her priority for an “unattached” house and the remaining individuals trade their occupied houses
 - LE corresponds to a chain with two individuals
- While regulating chains through an exogenous priority list (as in YRMH-IGYT) is also a viable policy for KE, we observed that other **chain selection rules** may mitigate (and even eliminate) the adverse impact of LE on type O patients on the DD list.
- **RSÜ (2004)**: Addressed both goals of the transplantation community with this generalization of the YRMH-IGYT mechanism.

The Birth of a Partnership Between Economists & Doctors

- Our **informed** and **cautious** approach resonated with Dr. Delmonico, the Chief Medical Officer at New England Organ Bank.
Subsequently, he made the following requests:
 1. Given the scale of simulated welfare gains from our system, we should drop the more controversial LE altogether.
 2. Due to logistical constraints, we should only allow for two-way KE.
 3. To avoid a situation where patients and hospitals may compete for donors with certain characteristics, we must assume that patients are indifferent between all compatible donors.
- We accommodated all requests in **RSÜ (2005)**, 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 KE system that adapted analytical techniques from market design and optimization.

Subsequent Policy Influence

- Our team coded and ran NEPKE's software for several years. Our partnership resulted in a number of additional breakthroughs.
- **Larger Exchanges:** With New England data, early on it became clear that inclusion of 3-way KE is especially important from a utilitarian perspective (RSÜ, 2007).
 - We convinced our medical partners to include 3-way KE to NEPKE software, and together advocated for it to the broader transplantation community in Saidman et al. (2006).
- **NDD-chains:** Together with our NEPKE partners, we introduced and advocated for non-simultaneous implementation of chains, when they initiate with a non-directed living donor kidney (Roth et al., 2007).
 - While NEPKE did not adopt NDD-chains, a second KE program we supported in its early years, **Alliance for Paired Donation (APD)**, did.
 - Today, a sizable part of the welfare gains from KE are due to NDD-chains (Agarwal et al., 2019).

Limited Progress: Compatible Pairs

- Since preferences are assumed to be strict, compatible pairs participate KE in RSÜ (2004).
- RSÜ (2005) made our collaboration possible, but it restricted participation to compatible pairs.
 - **Major Welfare Loss:** non-O patients with O donors rarely join KE.
 - **Implication:** A large majority remain unmatched among O patients with non-O donors.

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 - **Implication:** A large majority remain unmatched among O patients with non-O donors.
- **What can be done to include these harder-to-match pairs in KE?**

Global Kidney Exchange and Its Challenges

- One possibility is **Global Kidney Exchange (GKE)** (Rees et al., 2017): Match harder-to-match pairs with patient-donor pairs from countries where there is no possibility for living donor transplantation.
- While GKE has been heavily promoted by Michael Rees from APD and Alvin Roth, it lead to relatively modest number of transplants.
 - # of GKE transplants (01/2015 – 02/2022): **52** (17 Intl. & 35 US) (Rees et al., 2022)
Reference: # of KE transplants US (01/2015 – 02/2022): **6000+**
- A big challenge for GKE is the **mixed reaction** in the transplantation community.
 - Many argue GKE undermines various ethical norms in transplantation.
 - Persuasion stage of reform advocacy is either bypassed under GKE or it has shown limited effectivity.

Importance of Ethical Norms

- Dr. Delmonico—key for initial collaboration between economists and medical doctors—is a leading figure in the opposition against GKE.

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on ORGAN TRAFFICKING and TRANSPLANT TOURISM



**STATEMENT OF THE DECLARATION OF ISTANBUL CUSTODIAN GROUP
CONCERNING ETHICAL OBJECTIONS TO THE PROPOSED GLOBAL KIDNEY EXCHANGE PROGRAM**

- According to the Opposition on GKE:
 - The program exploits poor countries and individuals
 - Helping poor patients in exchange for “donated” organs constitutes organ trafficking
 - GKE increases the risk that organs will come from paid sources

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 - Helping poor patients in exchange for “donated” organs constitutes organ trafficking
 - GKE increases the risk that organs will come from paid sources
- The contrast between the early success on KE and the opposition on GKE highlights the gravity of persuasion stage of reform advocacy.

Improving Welfare w/o Challenging Ethical Norms: Kidney

- **Incentivized Kidney Exchange** (Sönmez & Ünver, 2015, Sönmez, Ünver & Yenmez, 2020)
- For certain compatible patient-donor pairs, their participation in KE increases the total number of transplants.
 - Especially, non-O patients with O donors
- **Main Idea:** Incentivize such pairs to join KE by giving the patient some form of a priority increase in the DD list in the event of another renal failure in the future.
 - A living donor kidney functions, on average, 12 to 20 years.

Improving Welfare w/o Challenging Ethical Norms: Kidney

- In the last several years, about **1100** patients in the US received transplants via KE annually.
 - For **each 10%** of incentivized pairs, the number of transplants can be increased by about **180** (Sönmez, Ünver & Yenmez, 2020).
 - KE transplants can be doubled if 60% of compatible pairs can be incentivized.
- Ethics of this policy favorable discussed by several members of Canadian transplantation community in Gill et al. (2017).
- Can be considered as part of the on-going reform of the UNOS–DD allocation system for kidney.
- **Challenge:** Broader consensus needed to influence national policy.

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- Can be considered as part of the on-going reform of the UNOS–DD allocation system for kidney.
- **Challenge:** Broader consensus needed to influence national policy.
- For other organs, it may be possible to incentivize blood-type compatible pairs to join donor exchange through more local policies.

Improving Welfare w/o Challenging Ethical Norms: Liver

- **Key Idea for Liver Exchange:** Utilize **size-compatibility** requirements in living donor liver transplantation and the difference between donor risk from left vs. right-lobe donation (Ergin, Sönmez & Ünver, 2020).
- Living donors for liver typically donate (i) the larger right lobe (60-70% liver mass), (ii) the smaller left lobe (30-40% liver mass), or (iii) part of the left lobe (Segment 2/3) for small children.
 - Morbidity/Mortality risk to donor is several times higher under right lobe transplantation.
 - To survive the operation, the patient needs a graft of at least 40% of the volume of his dysfunctional liver.
- These aspects of liver transplantation result in a natural instrument to incentivize blood-type compatible pairs to join liver exchange:
 - **Reducing donor risk:** Instead of donating the right lobe to her intended patient, a donor can instead donate her left lobe to a smaller patient through liver exchange.

Liver Exchange at İnönü University (Malatya-Turkey)

- These ideas resulted in a partnership between our team of design economists and the liver transplant group at İnönü University (Malatya-Turkey) under the leadership of Prof. Dr. **Sezai Yilmaz**.
 - The second largest liver transplant group worldwide (250-300 living donor liver transplants annually)
Reference: In 2022, the US total was an all-time high of 603.
- Agreement for **Banu Bedestenci Sönmez Liver Paired Exchange (BBS-LPE)** system was approved in September 2019, but the system was launched in June 2022 due to Covid-19.
- Despite the magnitude 7.8 earthquake that hit the region in February 2023, **15** patients received transplants through BBS-LPE program in one 4-way, one 3-way and four 2-way liver exchanges in its first year.
 - The **4-way** liver exchange conducted in July 2022 is a **world first** and the largest liver exchange to date (Yilmaz et al., 2023).



Commissioned vs. Aspired Market Design

- Commissioned market design is fundamentally different than aspired market design by an outsider.
 - **Commissioned market design:**
 1. The need for a change is already established (i.e., no need for a persuasion stage in reform process).
 2. Commissioned design economist is chosen mostly based on past success and experience. She is given a lot of flexibility on various details.
 3. Custom-made theory is not expected. A strong case can be made through experimental, empirical or computational techniques.
 - **Aspired market design:**
 1. The need for a change is not established. There will be a lot of resistance for a reform. Motives will be questioned.
 2. A compelling persuasion strategy is absolutely necessary for a reform. Past success or merely providing intuition with previous research are not compelling factors to convince policymakers who have vested interests in maintaining the status quo.
 3. Custom-made theory which represents the true goals of the stakeholders may be an important part of the persuasion stage.

Minimalist Market Design for Persuasion

- Minimalist market design is an **integrated** paradigm for research and policy.
 - Policy objectives have strong implications on research questions.
- In terms of policy success, the most critical aspect of this paradigm is in its persuasion stage.
 - The starting point is not a very compelling design. It is rather a truly bad mechanism with respect to the true mission of the institution.
 - Against all odds, it may convince authorities that the uninvited design economist critical of their institution can actually be a valuable partner.

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 - Against all odds, it may convince authorities that the uninvited design economist critical of their institution can actually be a valuable partner.
- By now, there is strong evidence that the persuasion strategy baked into minimalist market design is working as intended in a wide variety of settings.

Policy Impact through Minimalist Market Design

- **School Choice:** 2005 reform at BPS (Abdulkadiroğlu & Sönmez, 2003)
- **Kidney Exchange:** NEPKE, APD, NDD-Chains etc. (RSÜ, 2004, 2005)
- **Liver Exchange:** İnönü University, Malatya/Turkey (Ergin, Sönmez & Ünver, 2020; Yilmaz et al., 2023)
- **US Army's Branching System (Lecture 2):** 2020 reform at West Point and ROTC (Sönmez & Switzer, 2013, Sönmez, 2013, Greenberg, Pathak & Sönmez, 2021)
- **Pandemic Rationing of Scarce Medical Resources:** (Pathak, Sönmez, Ünver & Yenmez, 2020)
 - **Vaccine Rollout (Covid-19)** 15+ states/jurisdictions (Schmidt et al., 2021)
 - **Therapeutic Agents (Covid-19)** Pennsylvania (White et al., 2022)
 - **Monoclonal Antibodies (Covid-19)** Massachusetts (Rubin et al., 2021)
 - **Crisis Care Guidance (Post-Pandemic)** Oregon (ORAAC, 2023).

External Validity for Minimalist Market Design

- **School Choice:**
 - 2007 reform of School Admissions Code in England (Pathak & Sönmez, 2013)
 - 2009 reform at Chicago Public Schools (Pathak & Sönmez, 2013)
- **Affirmative Action Laws in India (Lecture 3):** Prediction of the following decisions by the 2020 Supreme Court Judgment *Saurav Yadav vs. State of Uttar Pradesh* (Sönmez & Yenmez, 2022):
 1. Rescission of a mechanism mandated for allocation of all public jobs in India with the 1995 Supreme Court judgment *Anil Kumar Gupta vs. State of Uttar Pradesh* (the flawed mechanism),
 2. the mandates of its amendment (the root causes of its failures), and
 3. the endorsed mechanism as a replacement (the resolution).

Minimalist Market Design to Avoid Unintended Effects

- We have seen that minimalist market design can be useful to detect subtle biases in allocation rules.
- E.g. De-facto loss of the intended walk-zone priority at BPS in period 2006-2013 (Dur, Kominers, Pathak & Sönmez, 2018).

“Leaving the walk zone priority to continue as it currently operates is not a good option. We know from research that it does not make a significant difference the way it is applied today: although people may have thought that it did, the walk zone priority does not in fact actually help students attend schools closer to home. The External Advisory Committee suggested taking this important issue up in two years, but I believe we are ready to take this step now. We must ensure the Home-Based system works in an honest and transparent way from the very beginning.”

Superintendent Carol Johnson, March 2013

- Discovery resulted in formal elimination of walk-zone priority at BPS.
- E.g. Intended and accidental consequences of H1-B via allocation rule (Pathak, Rees-Jones & Sönmez, 2020).

Minimalist Market Design for Advancing Theory

- In his 2017 *Nature Human Behavior* perspective, Duncan Watts argues that

“social science has generated a tremendous number of theories on the topics of individual and collective human behaviour” but “it has been much less successful at reconciling the innumerable inconsistencies and contradictions among these competing explanations.”

According to Duncan Watts,

“this ‘incoherency problem’ has been perpetuated by an historical emphasis in social science on the advancement of theories over the solution of practical problems” and “one possible solution to the incoherency problem is to reject the traditional distinction between basic and applied science, and instead seek to advance theory specifically in the service of solving real-world problems.”

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- I agree with his perspective wholeheartedly!

Minimalist Market Design for Advancing Theory

- Duncan Watts suggests that a plausible way to **advance theory** is through crafting solution to real-life problems.
- While the main motive for developing minimalist market design has been **“solving real-life problems,”** this framework has indeed proved to be a valuable approach to **“advance theory.”**
 - House allocation
 - Normative theory on priority-based allocation of indivisible goods
 - School choice
 - Living-donor organ exchange (e.g., kidney exchange, liver exchange)
 - Matching with slot-specific priorities (e.g., cadet-branch matching)
 - Reserve systems
- The role of minimalist market design in policy and theory suggests a positive answer to the following important question posed in the title of Watts (2017):
“Should social science be more solution-oriented?”