Who Gets What:
The New Economics of Matchmaking and Market Design

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What are markets and marketplaces?

- What are they for?
- How do they work?
- How do they fail?
- How can we fix them when they’re broken?
Commodity markets

Fruit market

NY Stock Exchange
Commodity markets can be arms-length and anonymous

• When buying 100 shares of AT&T on the New York Stock Exchange, you don’t need to worry about whether the seller will pick you—you don’t have to submit an application or engage in any kind of courtship. Likewise, the seller doesn’t have to pitch himself to you.

• The price does all the work, bringing the two of you together at the price at which supply equals demand. On the NYSE, the price decides who gets what.

• The market helps do “price discovery” to find prices that work.
But in many markets prices don’t do all the work

• Harvard and Stanford don’t raise tuition until just enough applicants remain to fill the freshman class.

• Selective colleges in the U.S. try to keep the tuition low enough so that many students would like to attend, and then they admit a fraction of those who apply.

• Colleges don’t rely on prices alone to equate supply and demand

• Labor markets and college admissions are more than a little like courtship and marriage: each is a two-sided matching market that involves searching and wooing on both sides.
Matching markets

• Matching is economist-speak for how we get the many things that we choose in life that also must choose us.

• You can't just inform Harvard that you’re enrolling, or Google that you are showing up for work. You also have to be admitted or hired. Neither can Google or Harvard simply choose who will come to them, any more than one spouse can simply choose another: each also has to be chosen.

• Matchmaking, broadly speaking—the institutions that influence who gets which jobs, which school slots, which mates—helps shape lives and careers.
Matching is important throughout our lives

1. Nursery School, Kindergarten and Schools

2. College: getting in, and after (College is a nexus of matching markets...)
   1. Graduate schools
   2. Transition to jobs: summer internships, on campus recruiting of undergrads and MBA’s, unraveling, exploding offers...

3. Job markets

4. Dating and marriage markets

5. Medical care: Allocation of organs for transplant
Market design:

• **Medical labor markets**
  – *Medical Residents: in the U.S.: NRMP in 1995*
  – *Gastroenterology in 2006, and other Fellowship markets*

• **American labor market for new Ph.D. economists**
  – *Scramble March 2006*
  – *Signaling December 2007*

• **School choice systems:**
  – *New York City since Sept. 2004 (high schools only)*
  – *Boston since Sept. 2006*
  – *Denver, D.C., New Orleans—presently underway for Sept. 2012*
  – In discussion with Chicago, Newark

• **Kidney exchange**
  – *New England and Ohio (2004)*
  – *National US (2010–?)*
Some of these things are also of current concern in England

- Medical interns
- School choice
- Kidney exchange
A general market design framework

• To achieve efficient outcomes, marketplaces need make markets sufficiently
  – **Thick**
    • Enough potential transactions available at one time
  – **Uncongested**
    • Enough time for offers to be made, accepted, rejected, transactions carried out...
  – **Safe**
    • Safe to participate, and to reveal relevant preferences
• Some kinds of transactions are **repugnant**...and this can constrain market design.
Matching can start early

• “LONDON – To get her son into [pre-]school at age 4, Emma Pliner signed him up at birth. When she went into labor, she took the application forms with her to the hospital...

• The early effort paid off: Little Charlie was accepted at several schools, including Wetherby, the school Prince William attended...

• At Wetherby... head teacher Jenny Aviss advises women scheduling Caesarean sections to have them early in the month in order to secure one of five places that the school allots to newborns each month. ‘If you have the option, don't wait until the 31st, have it on the first and call on the second,’ she says.” (WSJ 2/12/07.)
School Choice

• New York City high schools, 2003
• **Boston public schools, in 2006**
• 2012: Denver, Washington DC, New Orleans Recovery School District, Newark (limited set of schools)
The old **Boston** school match:

• **An immediate acceptance system**

• Students have priorities at schools set by central school system
  – Priorities: sibling, walk zone, random tie-breaker
  – There are lots of people in each priority class (non-strict preferences)

• Students entering grades K, 6, and 9 submit (strict) preferences over schools.

• **In priority order, everyone who can be assigned to his first choice is. Then 2nd choices, etc.**
It wasn’t safe for families to list their true preferences

• If you fail to get the school you ranked first, the school you ranked second might already be filled with people who had ranked it first.

• You wouldn’t get in, even if you had the highest priority.
Advice from Boston Public Schools

• BPS School Brochure (2004, p3)
  – “For a better chance of your `first choice’ school... consider choosing less popular schools.”
Advice from the West Zone Parent’s Group: Introductory meeting minutes, 10/27/03

“One school choice strategy is to find a school you like that is undersubscribed and put it as a top choice, OR, find a school that you like that is popular and put it as a first choice and find a school that is less popular for a “safe” second choice.”
The system also harmed the unsophisticated

• A school is **overdemanded** if the number of students who rank that school as their first choice is greater than the number of seats at the school.

• In the Boston mechanism, no one who lists an overdemanded school as a second choice will be assigned to it by the Boston mechanism, and listing an overdemanded school as a second choice can only reduce the probability of receiving schools ranked lower.
But not everyone knows

- Of the 15,135 students on whom we concentrate our analysis, 19% (2910) listed two over-demanded schools as their top two choices, and about 27% (782) of these ended up unassigned.
## Unsophisticated play

What happens when you rank two overdemanded choices and get neither of them?

<table>
<thead>
<tr>
<th>Outcome</th>
<th>number</th>
<th>percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Third choice</td>
<td>98</td>
<td>27.5%</td>
</tr>
<tr>
<td>Fourth choice</td>
<td>55</td>
<td>15.4%</td>
</tr>
<tr>
<td>Fifth choice</td>
<td>29</td>
<td>8.2%</td>
</tr>
<tr>
<td>Unassigned</td>
<td>174</td>
<td>48.9%</td>
</tr>
</tbody>
</table>

- **Mistake:** 1/3 of unassigned 9th graders could receive their 3rd choice school by not ranking their overdemanded second choice.

- **Worth the risk?:** More than 40% of all unassigned students could have been assigned had they not ranked an overdemanded school first.
Costs of incentive problems:

• Many preferences are “gamed,” and hence we don’t have the information needed to produce efficient allocations (and don’t know how many are really getting their first choice, etc.)
  – There were real costs to strategic behavior borne by parents—e.g. West Zone Parents group
  – BPS couldn’t do effective planning for changes.

• Those who don’t play strategically get hurt.
In Britain: School Admissions Code, Department for Education, 1 Feb 2012

• “1.9 It is for admission authorities to formulate their admission arrangements, but they must not: ...
• c) “give extra priority to children whose parents rank preferred schools in a particular order, including ‘first preference first’ arrangements”*
• *First Preference First: Oversubscription criterion that giving priority to children according to the order of other schools named as a preference by their parents, or only considering applications stated as a first preference. The First preference First oversubscription criterion is prohibited by this Code.

https://www.education.gov.uk/publications/eOrderingDownload/DFE-00013-2012.pdf (pp9, 35)
Deferred Acceptance

• Step 0.0: students and schools privately submit preferences
• Step 0.1: arbitrarily break all ties in (school) preferences
• Step 1: Each student “applies” to her first choice. Each school tentatively assigns its seats to its applicants one at a time in their priority order. Any remaining applicants are rejected.

... 

• Step k: Each student who was rejected in the previous step applies to her next choice if one remains. Each school considers the students it has been holding together with its new applicants and tentatively assigns its seats to these students one at a time in priority order*. Any remaining applicants are rejected.
• The algorithm terminates when no student application is rejected, and each student is assigned her final tentative assignment.

• *note that schools take no account of in what step a student applied.

• Theorem (Roth, 1982): DA with students proposing makes it safe for students to state their true preferences (a dominant strategy)

• Deferred acceptance algorithm with students proposing also used in NYC, Denver, DC.
• A different algorithm used in New Orleans
Some differences in behavior since the change

• People are more expressive with their choices
  – Under the old system only 30% of families ranked 4 or more schools, now 68% do (at grade 6)

• Some highly desirable schools are achieved as other than first choices
  – ...Half day kindergarten at Lyndon school

• West Zone parents now more concerned with school quality

• And, anyone who ranks two over-demanded schools first and doesn’t get them still has just as good a chance to get their third choice as if they’d ranked it first...no one is hurt by revealing their true preferences.
New York City:

• Strategic behavior by schools as well as families: schools have preferences over students.
• Schools used to withhold places, so that they would be able to match later with students they preferred.
• The deferred acceptance algorithm fixed that: no student who a school prefers would prefer that school to the one he matched to through the centralized system. (David Gale and Lloyd Shapley 1962)
Organ transplantation
Kidney exchange--background

• There are more than **90,000 patients on the waiting list for cadaver kidneys in the U.S.** today, and **over 6,000 in the UK**

• In 2011 33,581 patients were added to the kidney waiting list, and 28,625 patients were removed from the list.

• In 2011 there were 11,043 transplants of cadaver kidneys performed in the U.S.

• In the same year, 4,697 patients died while on the waiting list (and 2,466 others were removed from the list as “Too Sick to Transplant”).

• In 2011 there were also 5,771 transplants of kidneys from *living* donors in the US.

• Sometimes donors are incompatible with their intended recipient.

• This opens the possibility of *exchange*. 
Two Pair Kidney Exchange

Donor 1
Blood type A

Recipient 1
Blood type B

Donor 2
Blood type B

Recipient 2
Blood type A
Section 301 of the National Organ Transplant Act (NOTA), 42 U.S.C. 274e 1984 states:

“it shall be unlawful for any person to knowingly acquire, receive or otherwise transfer any human organ for valuable consideration for use in human transplantation”.
Charlie W. Norwood Living Organ Donation Act

Public Law 110-144, 110th Congress, Dec. 21, 2007

• Section 301 of the National Organ Transplant Act (42 U.S.C. 274e) is amended--in subsection (a), by adding at the end the following:

• “The preceding sentence does not apply with respect to human organ paired donation.”
“Kidney exchange” is an *in-kind* exchange. A 2-way exchange involves 4 *simultaneous* surgeries.
3-pair exchange (6 simultaneous surgeries)
Three-way kidney transplant success

By Graham Satchell

BBC News Breakfast reporter

Step back to nine in the morning on 4 December 2009.

Six patients are ready for surgery at three different hospitals across the UK.
Non-directed donors: cycles plus chains
Non-directed donor chains

• Non-directed donors
The graph theory representation doesn’t capture the whole story

Rare 6-Way Transplant Performed
*Donors Meet Recipients*

March 22, 2007

**BOSTON** -- A rare six-way surgical transplant was a success in Boston.

NewsCenter 5's Heather Unruh reported Wednesday that three people donated their kidneys to three people they did not know. The transplants happened one month ago at Massachusetts General Hospital and Beth Israel Deaconess.

The donors and the recipients met Wednesday for the first time.

Why are there only 6 people in this picture?
Simultaneity congestion: 3 transplants + 3 nephrectomies = 6 operating rooms, 6 surgical teams...
‘Never ending’ altruistic donor chains (non-simultaneous, reduced risk from a broken link)

A. Conventional 2-way Matching

B. NEAD Chain Matching

Since NEAD chains don’t need to be simultaneous, they can be long...if the ‘bridge donors’ are properly identified.
A Nonsimultaneous, Extended, Altruistic-Donor Chain


SUMMARY

We report a chain of 10 kidney transplantations, initiated in July 2007 by a single altruistic donor (i.e., a donor without a designated recipient) and coordinated over a period of 8 months by two large paired-donation registries. These transplantations involved six transplantation centers in five states. In the case of five of the transplantations, the donors and their coregistered recipients underwent surgery simultaneously. In the other five cases, “bridge donors” continued the chain as many as 5 months after the coregistered recipients in their own pairs had received transplants. This report of a chain of paired kidney donations, in which the transplantations were not necessarily performed simultaneously, illustrates the potential of this strategy.
The First NEAD Chain (Rees, APD)

* This recipient required desensitization to Blood Group (AHG Titer of 1/8).

# This recipient required desensitization to HLA DSA by T and B cell flow cytometry.
THE KIDNEY CHAIN
How a single organ donation changed 20 lives and created the longest-running transplant chain

REYNALDO ESPINOZA, 59
Germantown, Md.

CLAUDIA ALAS, 32
Germantown, Md.

JEAN STAYLOR, 53
Charleston, S.C.

RAYMOND STAYLOR, 53
Charleston, S.C.

AYA ROBY, 54
Marysville, Ohio

GEORGE LEONIER, 51
Chillicothe, Ohio

LINDA JANISIEK, 42
Miamisburg, Ohio

CECILIA JANISIEK, 71
Huber Heights, Ohio

MATT JONES, 30
Peoria, Ill.

First donor

BARBARA BUNNELL, 54
Phoenix

RON BUNNELL, 54
Phoenix

ANGELA HOFFMAN, 54
Toledo, Ohio

LAURIE SEEBO, 54
Toledo, Ohio

REYNALDO ESPINOZA, 59
Germantown, Md.

CLAUDIA ALAS, 32
Germantown, Md.

JEAN STAYLOR, 53
Charleston, S.C.

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CECILIA JANISIEK, 71
Huber Heights, Ohio

MATT JONES, 30
Peoria, Ill.

First donor

ANONYMOUS DONOR

BILL COBHAM, 55
Lincolnton, N.C.

TIM SHADE, 35
Lincolnton, N.C.

LINLEY BLEKENHORN, 51
Patchogue, N.Y.

KURT BLEKENHORN, 41
Patchogue, N.Y.

KATHERINE MCKINNEY, 52
Toledo, Ohio

HELENE MCKINNEY, 29
Cincinnati

Donor-in-waiting

Dr. Mike Rees (center, left) and his team perform a kidney transplant.
Chains become more important as patient pools become more “highly sensitized”
Feb 2012: a NEAD chain of length 60 (30 transplants)
Why do we have laws against simply buying and selling kidneys?

• I sure don’t know the answer to this one, but I think it’s a subject that social scientists need to study...

• Making markets illegal doesn’t stop illegal markets
A quick search for “kidney AND illegal” on the Guardian website:

**World news**

**Illegal kidney trade booms as new organ is 'sold every hour'**
The Guardian, 27 May 2012
Denis Campbell and Nicola Davison in Shanghai

World Health Organisation estimates 10,000 black market operations involving human organs take place each year

...Illegal kidney trade booms as new organ is 'sold every hour' ... The illegal trade in kidneys has risen to such a level that an estimated 10,000 black market operations involving purchased human organs now take place annually, or more than one an hour, World Health Organisation experts have revealed...

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**World news**

**Two Britons held in Delhi over illegal kidney transplant racket**
The Guardian, 1 Feb 2008
Randeep Ramesh in Delhi

The passports of two Britons alleged to have travelled to India to buy kidneys in an organ transplant racket have been confiscated by police in the Indian capital, investigators confirmed yesterday

...Two Britons held in Delhi over illegal kidney transplant racket ... The passports of two Britons alleged to have travelled to India to buy kidneys in an organ transplant racket have been confiscated by police in the Indian capital, investigators confirmed yesterday. Police said "two British people have not been..."
Repugnance

• Let’s call a transaction *repugnant* if some people want to engage in it, and others don’t think they should be allowed to.
Repugnant transactions

• some historically important repugnances
  – Sex (outside of marriage, incest, homosexuality, pornography, prostitution…)

  • Same-sex marriage
  – Servitude: Slavery and serfdom and indentured servitude
  – Worship (Inquisitions, expulsions, heresy, religious wars, blasphemy)
  – Interest on loans (was repugnant, no longer so much)

• Note that the arrow of time points both ways
Surrogacy?
Surrogacy Arrangements Act 1985

1985 CHAPTER 49

An Act to regulate certain activities in connection with arrangements made with a view to women carrying children as surrogate mothers.

[16th July 1985]

Be it enacted by the Queen's most Excellent Majesty, by and with the advice and consent of the Lords Spiritual and Temporal, and Commons, in this present Parliament assembled, and by the authority of the same, as follows:—

2 Negotiating surrogacy arrangements on a commercial basis, etc.

(1) No person shall on a commercial basis do any of the following acts in the United Kingdom, that is—

(a) initiate or take part in any negotiations with a view to the making of a surrogacy arrangement,

(b) offer or agree to negotiate the making of a surrogacy arrangement, or

(c) compile any information with a view to its use in making, or negotiating the making of, surrogacy arrangements;

and no person shall in the United Kingdom knowingly cause another to do any of those acts on a commercial basis.
Revealed: how more and more Britons are paying Indian women to become surrogate mothers

The full scale of the surrogacy industry in India being used by Britons to become parents can be revealed.
Why can’t you eat horse meat in California?

Why can’t dwarves earn their living in certain ways in Canada or France?
Dwarf tossing

The longest midget toss on record that we could find was made during the British Dwarf Tossing championships of 2002 when Jimmy Leonard of England tossed all 4'4" and 98 pounds of Lenny the Giant a giant 11 feet 5 inches.
Ontario *Dwarf Tossing Ban Act, 2003*

- **Bill 97 2003 An Act to ban dwarf tossing**
- Her Majesty, by and with the advice and consent of the Legislative Assembly of the Province of Ontario, enacts as follows:

**Dwarf tossing banned**

1. (1) No person shall organize a dwarf tossing event or engage in dwarf tossing.

**Offence**

2. A person who contravenes subsection (1) is guilty of an offence and on conviction is liable to a fine of not more than $5,000 or to imprisonment for a term of not more than six months, or to both.

**Commencement**

2. This Act comes into force on the day it receives Royal Assent.

**Short title**

3. The short title of this Act is the *Dwarf Tossing Ban Act, 2003*.
France and the UN Human Rights Committee


Manuel Wackenheim began his fight in 1995 after dwarf tossing bans were upheld in France.

• The U.N. case report quotes Wackenheim to the effect that “there is no work for dwarves in France and that his job does not constitute an affront to human dignity since dignity consists in having a job.”

• The UN committee found for France, saying "the ban on dwarf-tossing was not abusive but necessary in order to protect public order, including considerations of human dignity. “
Repugnance can be hard to predict

- Why is dwarf tossing widely regarded as repugnant?
- It’s not just the small size of the dwarfs
  - E.g. jockeys are small
Wife Carrying—Not Repugnant?

Boston champs 2005--traditional

World champs—Estonian position
Money and repugnance

• Often $x+$ is repugnant, even when $x$ alone isn’t.
  – E.g. interest on loans,
  – payments to birth mothers in adoption,
  – prostitution
“We didn’t have time to pick up a bottle of wine, but this is what we would have spent.”

(New Yorker)
Money and repugnance

• There seem to be three principal lines of argument about how adding money makes a non-repugnant transaction repugnant:
  – Objectification
  – Coercion ("exploitation")
  – Slippery Slope
Transactions between consenting adults

- Test yourself for repugnance: are you willing to contemplate carefully regulated, sales of live:
  - Kidneys?
  - Hearts?
Kidney Exchange...

...achieves some of the benefits of a market, without using money, and thus without running into the barrier raised by the repugnance that kidney sales arouse.
What is a “free” market?

• Not central planning, but not no-rules laissez-faire...