Good Markets (Really Do) Make Good Neighbors

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This article gives a (very) brief exposition of what market design is, along with four examples of market design in action. Loosely themed after Robert Frost's poem "Mending Wall," the examples demonstrate ways in which market design can break barriers—physical, political, and/or metaphorical. Each example also illustrates one of four broader classes of ways that market design can create positive change: marketplace mechanism (re-)design, information provision, (re-)shaping the extensive margin, and market(place) creation.

Categories and Subject Descriptors: J.4 [**Computer Applications**]: Social and Behavioral Sciences—*Economics*; K.4.4 [**Computers and Society**]: Electronic Commerce

General Terms: Economics, Theory

Additional Key Words and Phrases: Market Design, Matching, Marketplaces, Refugee Resettlement, Labor Market Entry, College Admissions, Health Data Exchange

> [. . .] My apple trees will never get across
> And eat the cones under his pines, I tell him.
> He only says, "Good fences make good neighbours."
> Spring is the mischief in me, and I wonder
> If I could put a notion in his head:
> "*Why* do they make good neighbours? Isn't it
> Where there are cows? But here there are no cows.
> Before I built a wall I'd ask to know
> What I was walling in or walling out,
> And to whom I was like to give offence.
> Something there is that doesn't love a wall,
> That wants it down." [. . .]
>
> —Robert Frost, "Mending Wall"

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This article is an expanded version of a talk I gave at the First Workshop on Mechanism Design for Social Good (MD4SG) in 2017. The talk was presented on June 26—an auspicious day given the topic, as it coincided with the anniversary of the signing of the United Nations charter. Some of the material I include here has also featured into my lectures at the Human Capital and Economic Opportunity (HCEO) Working Group's Summer Schools on Socioeconomic Inequality.

I am deeply grateful to the MD4SG organizers, Rediet Abebe and Kira Goldner, for inviting me to share some thoughts on market design, and to the editor, Hu Fu, for his extraordinary advice and patience as I have been preparing this article. I also thank Zoe DeStories, Steven Durlauf, Tom Eisenmann, Abigail Fradkin, John Hatfield, Zoë Hitzig, Amanda Pallais, and especially Alex Teytelboym for comments, and thank Jean Eagleton for helping me understand Frost. I am grateful for the support of the National Science Foundation (grants SciSIP-1535813 and SES-1459912), the Ng Fund and the Mathematics in Economics Research Fund of the Harvard Center of Mathematical Sciences and Applications, the Oxford Martin School, and HCEO (which is sponsored by the Institute for New Economic Thinking).

1. INTRODUCTION

Robert Frost's "Mending Wall" tells of a neighbor who thinks that the key to a stable relationship is a robust barrier—a wall—that keeps everyone's property and ideas apart. Each year, the neighbor and Frost's narrator convene to repair the wall between them; ironically, this annual ritual is the only thing that brings them together, yet it just serves to ensure they will stay cut off. "Good fences make good neighbors," the neighbor admonishes, while Frost's narrator wonders—not quite aloud—why the wall cannot come down.

If we may mix our poetry metaphors with physics for a moment, we might say that *the market abhors a wall*: Exogenous barriers and constraints often stop markets from reaching their full potential. Consequently, much of market design's work in recent years has served to eliminate or lessen structural obstructions to market function.[1]

In this article, I give a (very) brief exposition of what market design is, along with four examples of market design in action. Loosely themed after Frost, my examples all demonstrate ways in which market design can break barriers—be they physical, political, or metaphorical. Each example also illustrates one of four broader classes of ways that market design can create positive change (or, as we should call it in the context of the MD4SG Workshop, *social good*):

—marketplace mechanism (re-)design,

—information provision,

—(re-)shaping the extensive margin, and

—market(place) creation.

My presentation here is not intended to be comprehensive; rather, I just hope to give readers a taste of market design's potential in social good contexts. As such, this article is highly complementary with a recent survey I co-authored [S. D. Kominers, Teytelboym, and Crawford, 2017], which has the same goal but a very different approach. For those who do want to explore market design further, there are many wonderful sources to start with, including those of A. E. Roth and Sotomayor [1990], A. E. Roth [2002, 2008], Klemperer [2004], Milgrom [2004, 2017], Cramton, Shoham, and Steinberg [2006], Nisan, Roughgarden, Tardos, and Vazirani [2007] Krishna [2009], Sönmez and Ünver [2011], Abdulkadiroğlu and Sönmez [2013], Leyton-Brown [2014], Y. Chen et al. [2016], Bichler [2017], Haeringer [2018], Parkes and Seuken [2018] and the Royal Swedish Academy of Sciences [2012].

2. WHAT IS MARKET DESIGN?

Markets are everywhere that incentives matter. And incentives—combined with underlying market features such as preference heterogeneity, transaction costs, or search frictions—frequently lead to *market failures*, in which markets fall short of social optima.

[1]It is worth remembering, of course, that we can only take our metaphors so far. Sometimes constraints are necessary to make markets work well from a social perspective—and indeed, some frictions can even be Pareto improving (e.g., partial congestion pricing on highways; see Hall [2018]).

Market design seeks to improve market outcomes: increasing allocative efficiency, for example, enhancing transaction liquidity, and/or promoting equity and fairness (see S. D. Kominers, Teytelboym, and Crawford [2017]). The field is fundamentally translational—it uses economic analysis to find solutions to market failures, and then seeks to implement those solutions in practice. Working in the real world requires careful attention to market details, and often calls for tools from a range of disciplines, including economics, computer science, and operations research.

Much of market design is concerned with the design of *marketplaces* [Eisenmann, Parker, and Van Alstyne, 2006; Eisenmann and S. D. Kominers, 2018], comprised of

—*rules* that govern which transactions occur (and when), along with

—*infrastructure* that aids market participants in choosing and completing transactions.

Rules innovations include, for example, changing market-clearing mechanisms (e.g., A. E. Roth and Peranson [1999]; Pathak and Sönmez [2008]; Goldman and Procaccia [2015]), as well as adjusting which sorts of transactions are permitted (e.g., Zhang, Y. Chen, and Parkes [2009]; Milgrom [2010]). Infrastructure innovations, meanwhile, often deal with providing and managing information (e.g., Athey [2014]), simplifying or promoting entry (e.g., Djankov, LaPorta, Lopez-de-Silanes, and Shleifer [2002]; B. N. Roth and Shorrer [2017]; Akbarpour and S. Li [2018]), or developing market architecture (e.g., Ng, Yan, and Lim [2000]; Milgrom [2009]; Fu et al. [2012]; Chawla, Goldner, Miller, and Pountourakis [2018]; Newman, Fréchette, and Leyton-Brown [2018]) and interfaces (e.g., Conen and Sandholm [2001]; Bhattacharya and B. N. Roth [2016]; Li [2018]).

Not every market design intervention must address all problems with a market at once; moreover, fixing first-order market failures frequently exposes (and can sometimes unintentionally create) second-order ones. Consequently, market design requires constant feedback between theory and practice.

3. MARKETPLACE MECHANISM (RE-)DESIGN

One of the most canonical forms of market(place) design is the development or adjustment of market-clearing *mechanisms*—say, systems for deciding who matches with whom, or how resources should be distributed. In such contexts, a marketplace exists, but that marketplace does not achieve policymakers' welfare goals. We act as engineers, identifying trade-offs between design objectives, while trying to develop solutions that achieve as many of those objectives as possible.

3.1 An Example: Refugee Resettlement Matching

In the worldwide migrant crisis, the number of forcibly displaced people has passed 65 million—resulting in over 16 million refugees, many of whom require permanent resettlement (see, e.g., United Nations High Commissioner for Refugees [2017]). On the way to resettlement, refugees must—quite literally—cross borders; moreover, they and their supporters must overcome political hurdles like negative sentiment and lack of resources. Yet there is substantial social value in resettlement: not only are lives saved (certainly on its own enough to motivate market design!), but there

is evidence that refugees on net contribute a tax surplus to their host countries (see, e.g., Evans and Fitzgerald [2017] and also Åslund and Rooth [2007]).

Refugee resettlement mechanisms can be improved at multiple geographic scales: Moraga and Rapoport [2014] have proposed a system of international matching, whereby countries could trade refugee admission capacity and refugees could express preferences over destination countries. Delacrétaz, S. D. Kominers, and Teytelboym [2016], Trapp and Teytelboym [2017], and Bansak et al. [2018], meanwhile, have developed systems for optimizing the assignment of refugees to localities and/or labor markets within countries (see also Jones and Teytelboym [2017a, forthcoming]). And Andersson and Ehlers [2016] have proposed a matching-based approach to finding housing for refugees within cities.

In the work on refugee matching, the goal is to incorporate refugees' and localities' preferences and constraints into the resettlement process. The hope is that finding refugees "better" match outcomes—areas with real labor market prospects, and perhaps existing linguistic communities—will help refugees integrate into their host countries. In addition to improving individual-level outcomes, integration could also improve refugees' neighbors' sentiments.

At the same time, there is no perfect mechanism for the resettlement problem. Indeed, refugees often have large families with specific service needs, while countries, regions, and cities may have complex resource constraints that affect which refugees they can host. Hence, refugee resettlement matching almost always has features (such as complementarity; see Aziz, J. Chen, Gaspers, and Sun [2017] and also Kelso and Crawford [1982]; Hatfield and Milgrom [2005]; Hatfield et al. [2013, 2017]; Fleiner, Jagadeesan, Jankó, and Teytelboym [2017]) that induces nontrivial design trade-offs. Even so, the theory literature on refugee resettlement has so far provided promising approaches (see Andersson [forthcoming]), some of which are now making their way into practice.

3.2 Further Examples and Synthesis

Marketplace mechanism design is, by nature, mostly concerned with selecting rules regarding which transactions occur. As we have just seen, much of the work on refugee resettlement has concerned the design of new allocation rules. In another, more classic, example, A. E. Roth and Peranson [1999] developed and implemented a new medical residency matching mechanism that for the first time enabled couples to submit joint preferences over potential residency assignments. Abdulkadiroğlu, Pathak, A. E. Roth, and Sönmez [2005], meanwhile, changed the mechanism used to assign students to public schools in Boston, replacing the prior mechanism (which could be gamed) with one that was strategy-proof. Adjusting assignment rules so as to remove the value of being strategically sophisticated gave students in Boston more "equal access" to the school choice program (see Abdulkadiroğlu, Pathak, A. E. Roth, and Sönmez [2006]; Pathak and Sönmez [2008]).

Nevertheless, marketplace mechanism designers sometimes face fundamental questions about infrastructure, as well. Translating refugee resettlement matching theory to practice requires the design of new data and preference formation infrastructure (see, e.g., Jones and Teytelboym [2017b]). Similarly, Budish, Cachon, Kessler, and Othman's [2016] redesign of the course allocation mechanism at Wharton, for example, required not only a new mechanism [Budish, 2011], but also new prefer-

ence submission languages [Budish and Kessler, 2016] and algorithms for finding (approximately) optimal outcomes [Othman, Sandholm, and Budish, 2010].

4. INFORMATION PROVISION

Some markets fail because *information* about participants or goods is too diffuse or asymmetric. Markets for antiques might fail to clear, for example, because prospective sellers cannot find or identify buyers. In markets for used cars, meanwhile, prospective buyers may be unwilling to transact because they have trouble determining which cars have hard-to-observe defects (that is, which cars are "lemons," in the language of Akerlof [1970]). Imperfect information can be a baseline market attribute (for any given antique, prospective buyers may be few and far between), or can be the result of incentives for obfuscation (used-car salespeople would of course prefer not to identify "lemons" upfront).

4.1 An Example: Entry-Level Labor Market Certification

Young and low-income workers face numerous barriers to labor market entry. As Pallais [2014] pointed out, however, there is at least one hurdle that might not be too hard to overcome with market design: inexperienced workers' lack of employment history. Working with the online labor market oDesk, Pallais [2014] conducted an experiment in giving new workers "trial" jobs and then providing those workers with reputation signals (see also Stanton and Thomas [2015]).

Pallais [2014] collected applications for low-level data entry jobs from a number of candidate workers, then hired two treatment groups' worth. Workers in the treatment groups conducted data-entry tasks, and then received either "coarse" or "detailed" performance ratings in oDesk's public evaluation system. The ratings received in the experiment were standardized and simple to provide; nevertheless, the information they conveyed raised workers' future employment and earnings on average (although, consistent with theory, workers who had done poorly—and thus received poor ratings—saw earnings decrease). Moreover, Pallais [2014] found evidence that her experiment's market-level benefits outweighed the overall costs (in terms of both monetary payments and externalities on other workers). And in principle, entry-level labor market certification could become even easier to provide with automated evaluation systems (although such systems would have to be built carefully to discourage strategic gaming).

4.2 Further Examples and Synthesis

In response to information-driven market failures, market design (naturally) seeks to change the flow and availability of information, so as to equalize or rebalance knowledge among participants. Market designers might also adjust marketplace features to improve participants' incentives to acquire information (see, e.g., Bergemann and Välimäki [2002]; Hatfield, Kojima, and S. D. Kominers [2017]; and also Rogerson [1992]).

The solution might be as simple as creating infrastructure for participants to record and publicize reputations (see, e.g., Luca [2016, 2017]); however, the market organizers may need to seed profiles (as in the Pallais [2014] example we just examined; see also, e.g., L. I. Li, Tadelis, and Zhou [2016]) or otherwise assemble or curate information themselves (see, e.g., Lindau et al. [2016]; Filippas, Horton, and

Golden [2018]). Almost paradoxically, the socially optimal design may sometimes require instituting rules or infrastructure that constrain the data available—as in the case of hiding participants' personal or demographic information to prevent market participants from using that information discriminatorily (e.g., Goldin and Rouse [2000]; Edelman, Luca, and Svirsky [2017]).

5. (RE-)SHAPING THE EXTENSIVE MARGIN

At times, a market or marketplace exists but some prospective participants do not take part—either by choice or because they wholly lack access. Individuals outside of a market cannot benefit from the transaction opportunities the market provides; quasi-conversely, if some prospective participants are absent, then the market is unlikely to reach its full potential. To improve participation, market designers need to actively reshape the *extensive margin*, that is, the point at which prospective participants decide that entry is valuable.

5.1 An Example: Improving College Access on the Application Margin

Hoxby and Avery [2013] have shown that high-achieving, low-income students often do not apply to selective colleges or universities, even though those schools offer generous financial aid and substantial return on investment (see also, e.g., Hoxby and Turner [2013, 2015]; Pallais [2015]). More generally, Hoxby and Avery [2013] find that "low-income high achievers' application behavior differs greatly from that of their high-income counterparts with similar achievement." It is as if an invisible obstruction at the pre-application stage keeps low-income high achievers out of the market for top colleges, as well as the adjoint market for the best financial aid packages. As Hoxby and Avery [2013] and Hoxby and Turner [2013, 2015] provide evidence to suggest, the barrier is likely in large part an informational one—most low-income students are not exposed to teachers or classmates who can provide information about college opportunities.

Barriers to participation call for innovation on the extensive margin. Caniglia and Porterfield [forthcoming] recently reported on one such response: a multi-year initiative they ran to give high-achieving, low-to-moderate income students access to Franklin & Marshall College (F&M). They partnered with organizations like The Posse Foundation, KIPP, and Cristo Rey Network to identify students who were on par with F&M's current students, but would not normally have applied. At the same time, F&M shifted away from merit-based financial aid, freeing up more funding for need-based aid. The results were striking: F&M almost tripled its enrollment of low-income Pell grant recipients, yet the new students performed just as well as their higher-income counterparts. In sum, F&M provided college opportunities to hundreds of students just by smoothing over a market access failure—while, if anything, *increasing* the average quality of its student cohorts.

5.2 Further Examples and Synthesis

Fixing problems at the extensive margin often starts with ethnography: The designer must figure out where and how sources of friction impede participation, and must then assess the proper scale of response (for some strategies, see Duflo [2017]; see also Abebe [2018]). Sometimes, as in Caniglia and Porterfield's [forthcoming] case, it may be optimal to collaborate with intermediaries who know the

non-participants well—institutions that we might call "infrastructure partners."

Common causes of participation failure include entry and/or transaction costs (e.g., Coase [1960]; Bleakley and Ferrie [2014]), historical exclusion (e.g., Cutler, Glaeser, and Vigdor [1999]; Akerlof and Kranton [2000]), or unawareness of market opportunities (e.g., Hoxby and Avery [2013]). Responses might include information campaigns (again as in the Caniglia and Porterfield [forthcoming] example), perhaps alongside subsidies (e.g., McKenzie [2017]) or affirmative action rules (e.g., Fryer and Loury [2013]). In some cases, fixing extensive margin failures might require restructuring market participation itself (see, e.g., Goldin [2014]; Dworczak ® S. D. Kominers ® Akbarpour [2018]).

6. MARKET(PLACE) CREATION

At times, markets or marketplaces are simply "missing"—prospective buyers have no interaction with sellers, or allocation is carried out in a way that does not respond to demand. Often, market(place) "nonexistence" results from coordination failures or regulatory barriers; in such circumstances, simply introducing a marketplace may be both the most difficult and the most first-order design response.

6.1 An Example: The Chicago HealthLNK

In recent years, healthcare institutions have increasingly switched over to electronic medical record (EMR) systems; the resulting data holds extraordinary potential for use in research. However, because of regulations such as the Health Insurance Portability and Accountability Act (HIPAA)—inspired by well-founded privacy concerns—the health data market is illiquid. It is extremely difficult to merge EMR data across hospital boundaries, much less link it with outside data sources. We could conduct city-wide studies by merging together statistics reported by individual hospitals (see, e.g., Behrman et al. [2011]); however, that approach is problematic if hospitals have overlapping patient populations, as then we would overweight patients who visit multiple hospitals. Thus, without infrastructure supporting privacy-preserving data sharing, research suffers.

Kho et al. [2015] developed a solution: HealthLNK, a data marketplace design that enables secure, privacy-preserving linkage of electronic health records. HealthLNK was implemented in Chicago, drawing upon data from six area medical centers. To incentivize sites to participate in the marketplace, all sites that shared their own data were able to use the aggregated data for research.

Each participating site collected internal health record data, then created up to seventeen 512-bit hashes for each patient, using a shared seed. The hash keys were based on combinations of patients' first and last names, dates' of birth, Social Security Numbers (SSN), and genders, using a secure HIPAA-compliant cryptographic hash function (for specific security and implementation details, see the Kho et al. [2015] paper). The hashed records were de-identified and then merged together at a central site; using a large number of hashes allowed the marketplace organizers to match records even when some sites had mistyped or omitted certain identifiers.[2] Once the records were merged, their hash keys were erased and replaced with indi-

[2]The matching process's effectiveness was validated using a subset of patients at the host site.

vidual patient IDs, completely disconnecting the merged records from the hashed identifiers. And so the bridge across sites was built.

In principle, the Kho et al. [2015] approach could be used in other geographic regions, as well as in contexts where health records are to be matched with outside data sources (so long as those data sources have identifiers that can be converted into hashes). And recent advances in privacy science offer even more exciting opportunities for data marketplace design (see, e.g., Dwork [2011]; A. Roth and Schoenebeck [2012]; Dwork and A. Roth [2014]; Ghosh, Ligett, A. Roth, and Schoenebeck [2014]; Ghosh and A. Roth [2015], as well as Madan et al. [2009]; Arrieta-Ibarra et al. [2018]; Posner and Weyl [2018]). In the meantime, a proof of concept with HealthLNK showed that de-duplicating patient records has real implications for research: estimates of Type II diabetes prevalence across Chicago, for example, would be biased upwards by over 20% if patients were counted across hospitals with multiplicity.

6.2 Further Examples and Synthesis

The optimal market(place) creation strategy is closely tied to the cause of nonexistence. In the case of health data and research marketplaces (as in the Kho et al. [2015] example), the key issue to work around is regulatory: the designer needs to develop technological infrastructure that enables data exchange while respecting privacy laws. Other times, market-based allocation has been avoided because of broad concerns about allocative fairness; a marketplace designed with attention to fairness goals can then improve efficiency substantially, as in the case of the system Prendergast [2017] and his colleagues organized for allocating food to food banks. In still other cases, as with environmental markets (see, e.g., Fankhauser and Hepburn [2010a,b]; Bjørndal and Munro [2012]; Hanley, Banerjee, Lennox, and Armsworth [2012]; Teytelboym [forthcoming]) and global kidney exchange (Rees et al. [2017]; Nikzad, Akbarpour, Rees, and A. E. Roth [2018]), policymakers and/or institutions need to create private incentives for marketplace development.

Marketplace creation thus often relies on what we might call "bespoke" solutions carefully tuned to specific market conditions (and perhaps sometimes without more general theory). Even so, marketplace creation can be one of the most rewarding forms of market design. How many people can say they have designed an entire marketplace?

7. CONCLUSION

As this article illustrates, market design comes in many forms—and all of those forms have broad potential to "break barriers" and contribute to social good. Perhaps, then, it is no surprise that interest and progress in market design has also helped melt the boundaries between the disciplines that comprise the SIGecom research community.

If we may take a bit of liberty with Frost, we might say:

> [. . . The market] there is that doesn't love a wall,
> That wants it down." [. . .]

Good markets really do make for good neighbors—and lead to wonderful collaborations. $\mathbb{QED}$.

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