How Food Banks Use Markets to Feed the Poor

Canice Prendergast

Imagine that someone gave you 300 million pounds of food and asked you to distribute it to the poor—through food banks—all across the United States. The nonprofit Feeding America faces this problem every year. The food in question is donated to Feeding America by manufacturers and distributors across the United States. As an example, a Walmart in Georgia could have 25,000 pounds of excess tinned fruit at one of its warehouses and give it to Feeding America to distribute to one of 210 regional food banks. How should this be accomplished?

This is a problem where regular markets are off the table: Feeding America does not sell food to the food banks. Instead, Feeding America has to find some other way to satisfy its desire for food to go where it is needed most. One way would be to simply assign food to each food bank. This is how most nonprofits allocate resources. However, a field of economics—often associated with the Nobel Prize winning contributions of Al Roth—has been aimed at designing mechanisms so that outcomes in such nonmarket settings can better reflect what consumers want. This area of research has made enormous advances, both theoretical and practical, in problems such as the allocation of children to schools, kidneys to patients, and medical students to hospital residencies (for examples, see Abdulkadiroglu, Pathak, and Roth 2005, 2009; Budish and Cantillon 2012; Roth 1984, 2008; Roth and Peranson 2004; Roth, Sönmez, and Ünver 1999). This paper tells the story of

■ *Canice Prendergast is the W. Allen Wallis Distinguished Service Professor of Economics, University of Chicago Booth School of Business, Chicago, Illinois. His email is canice.prendergast@chicagobooth.edu.*

a market design innovation at Feeding America in 2005. Specifically, the author was part of a group that designed a mechanism through which Feeding America transitioned from a centralized allocation system, in which food banks (implicitly) queued for food, to a system in which they bid daily in auctions for truckloads of food using a "fake" currency that the nonprofit designed.

A central focus of the market design literature is designing allocation procedures or "mechanisms" that credibly reveal the preferences of consumers. There are typically two ways to do this. The first is to ask consumers to rank a set of possible outcomes. For example, a student lists which school she likes best, second best, and so on on—or a budding medical resident ranks hospitals. Through appropriate choice of mechanism, the consumer finds it in her interest to report truthfully, and is then efficiently "matched" to an outcome. The second way is to use a more standard market setting where goods have prices, but where participants can only use a specialized currency to buy the goods in the allocation system. Perhaps the most celebrated example of this approach is Radford's (1945) classic description of how cigarettes acted as currency in German prisoner-of-war camps towards the end of World War II. Specialized currencies were also common during the US Depression: the typical case being a company town where wages paid in scrip could be redeemed in the company store.[1] Another commonly cited example here is course choice among MBA students who are given a fixed budget of points to bid for oversubscribed courses (Budish 2011; Budish and Cantillon 2012). A small number of universities have used similar mechanisms for allocating undergraduate courses. Here students face a budget much like the standard market setting but that budget can only be used on courses.

As one might imagine, many of those involved in food banks are skeptical of markets in general, and initially many had severe reservations about a market-based approach. As one example, John Arnold, a member of the redesign group who was for many years Director of the Feeding America Western Michigan Food Bank said to me once near the start of the process: "I am a socialist. That's why I run a food bank. I don't believe in markets. I'm not saying I won't listen, but I am against this." This paper describes how 300 million pounds of donated food are now allocated between regional food banks each year and how the initial reservations of some involved in the design process were overcome. I will use basic economic ideas to show how a market—with appropriate safeguards—was constructed to allow food banks to effectively express their preferences in ways not possible under a (well-intentioned) centralized system (for a more formal analysis, see Prendergast 2017).

---

[1] Other specialized currencies included community initiatives where (often unemployed) individuals provided services and goods for each other, using currencies that they created. Gatch (2008) discusses the range of such initiatives. Such local communitarian currencies continue to exist in small scale today, such as "Brixton pounds" in London (described at http://brixtonpound.org).

Before 2005

Until 2005, Feeding America had a method of allocating resources that is fairly common among not-for-profits: a "wait your turn" system, where it gave out food based on a food bank's position in a queue. The queue was determined by the amount of food that a food bank had received compared to a measure of need called the "Goal Factor," which is (roughly) the number of poor in a food bank's area compared to the national average. The formula is more nuanced than a simple head count, as it distinguishes between usage rates for those below the poverty line, between 100 and 125 percent of the poverty line, and between 125 and 185 percent.

When a food bank's position in the queue was high enough, it would receive a call or email from Feeding America to say that it had been assigned a "load." The load had to be collected from the donor, and food banks were (and remain) liable for transportation costs. The food bank had 4–6 hours to say "yes" or "no." After a food bank was offered food, its position in the queue would be recalculated, as its measure of food received relative to need would change. If it turned down the offer, the load would go to the next food bank in the queue. This mechanism had been used since the late 1980s, and it allocated 200–220 million pounds of food each year from 2000 to 2004. Feeding America did not distinguish much between different kinds of food, so that each food bank on average got a similar product mix from them (though randomly a food bank could get lucky or unlucky in whether it would get food that was popular among participants).

The objective of this centralized assignment mechanism was to offer an equal number of pounds of food to each *client* of the food bank (this outcome occurred because a 1 percent increase in Goal Factor meant 1 percent more clients, and the mechanism gave 1 percent more food). On average, the mechanism indeed accomplished this goal: regression results show that a 1 percent increase in Goal Factor was associated with a 1.01 percent increase in pounds of food. This way of handing out food works well if all food banks *should* get the same amount and kind of food. But by 2004, Feeding America had concerns that this was not the case.

The problem arises because Feeding America allocates only about one-quarter of all the food that food regional banks receive, with the rest coming directly to the food banks from manufacturers, distributors, grocery stores, and so on. But Feeding America knows little about the other three-quarters of what food banks have. Some food banks—sometimes called the "food rich"—have better contacts with potential donors and have larger amounts of food than the "food poor," who have little access to distributors and manufacturers. Moreover, food banks vary not only in how much food they have, but also in what kind. For example, a food bank's existing inventory of other food may already be heavily weighted towards dairy products, and its residual needs are for other kinds of food.

In this context, the queuing system faces two major problems. First, a food bank might get food that a different food bank values more. If a food bank already has enough for its clients at a point in time, any extra may even go to waste. This concern is exacerbated by spoilage issues: for example, fresh produce is often only donated

close to its expiration date. An example that routinely cropped up with the committee was when the Idaho Food Bank was offered potatoes even though they already had a warehouse full of them. Another reason for spoilage is the need for refrigeration. For example, sending eggs or milk to a food bank that lacks excess refrigeration capacity (because its fridges are currently close to full) likely results in those products not being used. Food-rich banks are often unable to efficiently use more of the staples like produce and dairy products for the reason above. However, additional stocks of some highly valued (and relatively rare) foods, like cereal and pasta, are always of use. On the other side, the food-poor banks are less fussy about what kind of food they get (though they still like cereal and pasta more), as they don't have enough of anything. As a result, an equal mix of food across food banks is unlikely to be efficient. Feeding America was aware of this issue, but did not know much about actual food bank inventories. While it may have suspected that, say, Los Angeles had more food per client from other sources than did Idaho, it lacked any data on which to base a (politically legitimate) policy that could respond to this situation.

The second problem with the old queuing system is that Feeding America could only offer food to one food bank at a time. A typical scenario was that a distributor had a truckload of excess food sitting in its warehouse or dock, and offered it to Feeding America. If the donation was accepted by Feeding America, it would contact the food bank at the top of the queue and offer it to them. The food bank had four to six hours to say "yes" or "no," and some of that time was inevitably spent on practical details like checking existing inventory, seeing if transportation to pick up the donation was feasible, and so on. Another food bank would be offered the load only if the first food bank demurred. This process implied that Feeding America could only offer the load to a small number of food banks before either the donor would become upset over the load being left on its dock for a long time, or the food would spoil.[2]

The Choice System

With this backdrop, Feeding America put together a committee to make recommendations on the redesign of its allocation system. The group consisted of eight food bank directors, three staff from Feeding America, and four University of Chicago faculty.[3] The group quickly realized that food banks had such variety in needs that it would be difficult to design any efficient system with Feeding America

[2] An additional, smaller, problem is due to randomness in what kind of food comes up when it is a food bank's turn. For example, suppose that a food bank gets lucky and is assigned cereal twice in a month, while another food bank gets produce twice. (As we will see, cereal is much more valuable to food banks than fresh produce.) While this result does generate inequality, it seems a relatively small issue compared to the other two.
[3] The committee consisted of John Alford, John Arnold, Al Brislain, Bill Clark, Phil Fraser, Maria Hough, Mike Halligan, Brenda Kirk, Rob Johnson, Susannah Morgan, Steve Sellent, Roger Simon, Harry Davis, Don Eisenstein, Robert Hamada, and the author.

deciding what was best for individual food banks. After considerable discussion about alternatives and practical details, Feeding America introduced what is called the Choice System, a market-based mechanism with food banks bidding on truckloads of food. This system involves twice-daily first-price auctions, the ability to borrow and save, fractional bidding, the possibility of negative prices for loads that are not wanted by food banks, and the capacity for food banks to put their own food up for auction on the system. As we will see, the Choice System seems to have alleviated many of the issues above.

Feeding America was well aware that having food banks pay for food (rather than simply giving it to them) would more credibly reveal demand. Indeed, these food banks distribute food to local food pantries and soup kitchens and often require *them* to buy food from the food bank. However, Feeding America feared that with a market-based system, a food bank's budget would be based on its fundraising skills and whether it was based in an area that was wealthier or denser. Given such differences, using money could exacerbate inequality across food banks. This concern was sufficiently important to Feeding America that it used the queuing system to ensure that the poorest areas are offered adequate food compared to their richer counterparts, despite the obvious drawbacks of such a system.

The redesign group met for over a year before converging on the Choice System. A central feature was the creation of a specialized currency called *shares* that are used to purchase food. By using fake money, Feeding America could set a food bank's budget for food based on measures of need rather than fund-raising capacity.

However, when the idea of a "market" was introduced as an alternative to waiting in line, it met with considerable resistance. Food banks exist to serve the marginalized, who are often those that the market economy has left behind. The preferences of food bank directors often reflect that concern about marginalization. But as the committee discussions progressed, it became clear that many of the concerns of the food bank directors on the design committee about a market-based system were not of a broadly philosophical kind, but rather originated in a fear that the details of markets often benefit the strong at the expense of the weak. As a result, many of the more detailed features described below were particularly aimed at ensuring that *smaller* food banks, typically with fewer resources and manpower, would not be harmed relative to their larger counterparts, where there are often dozens of workers or volunteers.

Budgets

Remember that a primary concern was that access to food should depend on need. This goal was implemented by allocating initial budgets of shares to the food banks in proportion to Goal Factor, thereby aligning capacity to spend with Feeding America's perception of a food bank's need. Shares could not be traded for real money nor used for anything other than the items on the auction market described below. Balances did not depreciate, nor was there an interest rate on savings. Budgets are replenished each evening by redistributing the spent shares to the food banks according to the rules described below.

Demand

On any given day, approximately 50 truckloads of food are offered to food banks (a truckload averages about 25,000 to 30,000 pounds). Food banks bid on truckloads of food using their shares. Sealed bid first-price auctions occur twice per day, from Monday to Friday.[4] Bidding closes at noon and 4 pm Central Standard Time. All food for each bidding cycle is posted at least two hours beforehand.

Several details of how bidding was designed can be understood as ways of leveling the playing field across food banks. For example, one concern was that under a continuous auction, some food banks (typically the larger ones) could dedicate a staff person to the bidding process and those food banks could wait until the last minute and "snipe." Smaller food banks, which may only have a handful employees on site, could not do this. This inequality of access was averted by sealed bids, with all food posted at least two hours beforehand.

Another instrument used to level the playing field was the option to use fractional bidding. Larger food banks are big enough to use a truckload of a desired food, whereas their smaller counterparts may only be able to effectively distribute say a quarter of a truckload. To alleviate this disadvantage for smaller food banks, they have the opportunity to bid jointly for items. Here two (or more) food banks coordinate and agree to split a truckload offering.

When the Choice System came into being, many food bank directors had never bid online for anything. A concern was that some food banks—again most likely the smaller ones—would find bidding so intimidating that they would largely withdraw from the allocation process. This concern was alleviated by Feeding America giving the option to delegate bidding to an employee of Feeding America, where a food bank could simply outline in broad terms its needs to that person.

The system also allows credit. Credit was implemented because of a concern that the smaller entities might never receive the most desired products, because a truckload of the most desired goods could sell for more than their share balance. Food banks below median Goal Factor, which tend to be the smaller ones, can use short-term credit to increase their balances to at least the estimated cost of a highly desired item. They pay off those debts with at least half their future allocations of shares—meaning the nightly redistribution of shares used on that day (described below)—until the debt is paid off. In this way, they cannot continue to accumulate credit. There is no interest rate on these debts.

The system allows food banks to bid negative prices. Some loads are not very desirable to food banks. Under the old queuing system, a food bank could say "no" to an offered lot. Food banks have a variety of sensible reasons to say "no": the food could be undesirable given its clients' needs, it might not have an available truck,

---

[4]The group went back and forth on what price would be paid by winning bids. A desire to minimize strategic considerations led to some members (well, the author anyway) arguing for a second-price auction (the highest bidder wins but pays only the amount of the second-highest bid), but the sense among the participants in the process was that the clarity of "you pay what you bid" was more important. As a result, a first-price auction was chosen.

or the value of the food might not be worth the transportation cost. However, if a food bank turned a load down, it was still counted against its position in the queue as if the load had been accepted. This may seem strange: Why penalize a food bank for refusing to take food that it does not want? The underlying reason was based on maintaining donor relations. Donors typically want excess food removed from their warehouses for a variety of reasons: to free up storage space, for tax reasons, and so on. As such, there are pressures on Feeding America to remove food quickly, and that pressure was sometimes felt by the affiliates. Placing this undesired food was a source of tension under the old system. To facilitate the movement of these kinds of goods, the Choice System allows for negative prices. These are called "bonus share": Food banks could bid negative shares for loads (up to a limit of –2,000 shares per load), which means that the food bank received additional shares for agreeing to pay the costs of picking up a load.

Finally, the Choice System includes a mechanism called the Fairness and Equity Committee for overriding the allocation rule in extreme circumstances. Under the old system, Feeding America at times would use its discretion to divert food to some food banks if they realized that they had needs that were not addressed under the Goal Factor formula. As part of the Choice System, a Fairness and Equity Committee (staffed by three food bank directors) would take appeals from food banks for greater allocations of shares based on some unobserved factor, and decide its merits on a case-by-case basis. As one extreme example, Hurricane Katrina hit New Orleans soon after the redesign committee's deliberations. A less-extreme example might be the closure of a major local manufacturing plant.

Supply

A significant issue throughout the deliberations was finding ways to increase the supply of food reaching the poor. One piece of this was a new source of food called Maroon pounds. This is food that an individual food bank already has, perhaps from another source, but for which it may not be the highest-value user. The Choice System allows food banks to place this food on the internal market. These loads are bid on in exactly the same way as other products, but here the shares from the winning bid are transferred to the seller rather than redistributed to all food banks. Negative prices are not available for Maroon Pounds.

Money Supply

Food banks bid with a constructed form of money, and one design aspect that consumed much of the committee's time was an appropriate money supply rule. An objective converged upon relatively early in the process was to ensure that prices remain constant if demand and supply conditions do not change. This objective mattered because it helped food banks know how much to bid: specifically, observing historical prices of a good would give a food bank a good indication of a reasonable price.

This goal was implemented in two ways beyond the initial share allocation. First, consider short-run money supply calibration: Over a typical day, shares are

spent and money balances are drawn down. Say that aggregate purchases total 10,000 shares. These 10,000 shares are then recirculated at midnight of that day, and a food bank's slice of this pie is its Goal Factor relative to the sum of all Goal Factors. As such, the flow of resources to food banks also depends on this measure of need. In this way, the money supply additionally remains constant over the short run. Second, over the longer run, the supply of food to the system could change. Suppose that from one year to the next, supply rises by 5 percent. To maintain constant prices, all else equal, the supply of shares is changed in proportion to that increase in total number of pounds of food in the system. (It was deemed too complicated to make this depend on changes in the quality of food.)

The Website

Food banks bid online. The web page lists available offerings: kind of food, its weight, location, and any other conditions. Bidders simply type in their sealed bid. (In order to help participants become comfortable with the online setting, the system was used as a test run for three months before it went live, where the participants would simulate bidding.) Two such screens will be seen each day, one for the offerings at noon and the other for the 4 pm auction. Outcomes are transmitted by email to all bidders immediately at the close of the auction.

Outcomes

We now turn to how food banks responded to the new allocation mechanism, using data from its introduction on July 1, 2005, to the end of 2011.[5] We begin by considering the most general source of gain from a market: that it allows consumers to express their unknown preferences. We do this by identifying the extent to which outcomes differ from the old way of assigning food. We additionally show that the Choice System resulted in the food poor spending more of their "money" than the food rich, once again redistributing resources to those most in need. Finally, we show how the Choice System system has induced more supply of food through Maroon pounds. Before beginning, it is worth noting that almost any kind of food can be offered to the system—fruit, vegetables, dairy, pasta, rice, meat, and prepared meals. Nonfood items such as health care or beauty products can be offered as well (particularly valuable are paper plates and plastic cutlery, primarily used by soup kitchens). Yet almost half of pounds are either produce or beverages, and as will become clear below, these are the least-desired foods.

---

[5]The data used here come in two forms. For some exercises, aggregates will be provided both before and after the change to the choice system, from 1999 to 2011. Analysis of what happened after the changeover derive from aggregating data on 64,570 auctions from 2005 to 2011.

Figure 1

The Average Price of a Pound of Food by Food Type, 2005–2011

(the price of the median good is normalized to one)
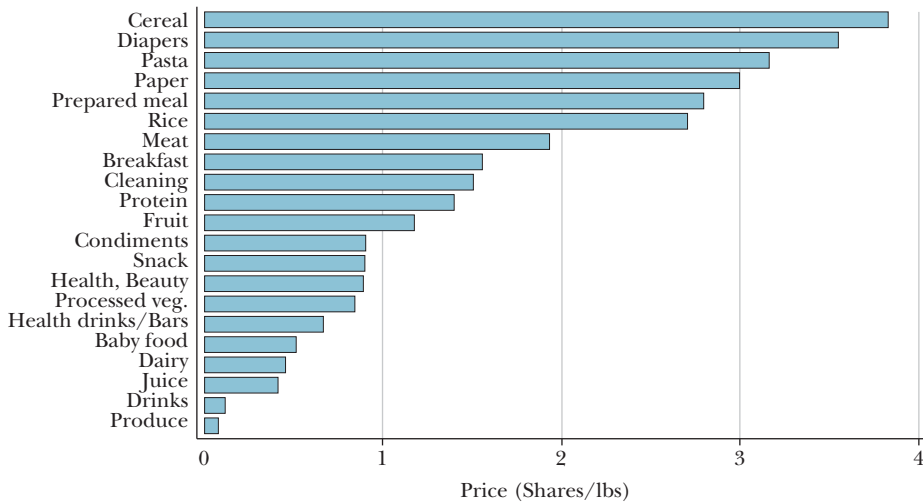
Note: Figure 1 shows how average prices vary by food type. The numbers have been normalized so that the median good has a pseudo-price of 1.

Reallocation of Demand

To show reallocative benefits of the Choice System, we begin by documenting that food varies wildly in its desirability. Remember, in the older queuing approach, Feeding America treated all pounds of food as equal. With the bidding system, some food banks have chosen to buy mainly large quantities of cheap food, while others buy smaller quantities of more expensive food. Moreover, some food-rich banks never spend all their shares, which benefits the food poor. (A food bank can accumulate shares until they get 200,000 shares, at which point, Feeding America gives them no more because it seems they don't really need them.)

Some foods are valued more than others, which is apparent in how the price of a pound of food varies enormously. Figure 1 shows how average prices vary by food type. The numbers have been normalized so that the median good has a pseudo price of 1. At the cheaper end of the distribution, produce sells for only 7.7 percent of the price of the average good, and beverages trade for 11.6 percent. On the other hand, cereal, diapers, and pasta are the most desired categories, and trade for over three times the price of the average good. To put this concretely, a food bank can buy 49 pounds of produce for the price of a single pound of cereal.

These price ratios are often wildly different than those one would see in a supermarket because they reflect the residual demand of food banks after taking account of all the other food that they have. Trading almost 50 pounds of produce

for one pound of cereal does not necessarily tells us that food banks do not like produce, but rather that they already have so much of it from other sources that their marginal valuation of it is close to zero. In this sense, the extreme prices tell us how far the food supplies of food banks are from the mix of foods they desire.

Of course, prices vary for reasons beyond the broad categories used here: for instance, based on quality of product within a category, whether the donation is at a convenient location, whether it is a time of the year when the product is more or less available, and so on. From its inception in June 2005 to December 2011, a food bank on average received three to four pounds of food per share. However, there is enormous variation. For almost 50 percent of auction outcomes, a food bank received 20 pounds per share, and in 25 percent of cases, it received at least 100 pounds of food. About 5 percent of prices are negative. Those goods with negative prices are typically loads of produce or carbonated beverages. At the other extreme, in 10 percent of cases, the buyer got two pounds of food per share or less.

The Sorting of Food Banks

Showing that goods vary in their desirability does not necessarily tell us anything about the value of the new system unless food banks vary in what they choose. Here we show variation on the quality–quantity tradeoff: do food banks spend their money on a small amount of expensive goods or on large quantities of cheaper foods?

To do this, we create a binary categorization of goods. The goods in Figure 1 that are more expensive than the average good are denoted "high quality," and those less expensive than the average good are "low quality." Specifically, all foods below Fruit in Figure 1 are low quality, and the others high quality. Low-quality food accounts for about 65 percent of the pounds of food, but 25 percent of expenditures.[6] We also offer a binary categorization of buyers: we denote any food banks that buy more of the expensive goods than average as "food rich," and a food bank that buys less of the expensive goods as "food poor." In effect, this allows us to compare the average net buyer of expensive goods to the average net buyer of cheap goods. To compute these averages, we weight by the Goal Factor of the food bank, so that we do not overcount smaller food banks compared to larger ones. (This adjustment has the effect of making food bank clients the unit of analysis rather than the food bank per se.) With this binary classification, we can cleanly show sorting on the quality–quantity dimension.

To understand magnitudes, for the period 2005 to 2011, each food banks wins an average of 2,483,000 pounds of food every year, of which 1,910,000 are low quality and 573,000 are high quality. This is given by point *A* in Figure 2. This would be the outcome under the old allocation system. However, the food rich and food poor have different preferences between high-quality and low-quality food; in particular,

---

[6]This calculation weights the goods in each category by price. For example, if a pound of snacks sells for 20 pounds of produce, it receives 20 times the weight. We price-weight the goods so we can treat this as a two-dimensional problem for expositional purposes with a single budget line.

Figure 2
The Reallocation of Demand
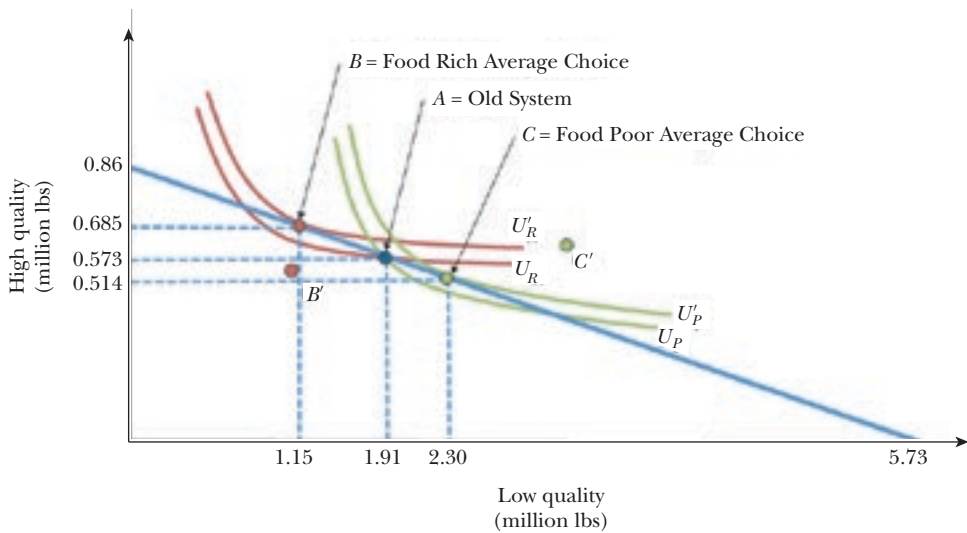
Note: For the period 2005 to 2011, each food banks wins an average of 2,483,000 pounds of food every year, of which 1,910,000 are low quality and 573,000 are high quality. This is given by point *A*. Now let the food banks trade at the equilibrium prices given by the slope of the budget line. The food rich can now attain point *B* (where its indifference curve U'_R is tangent to the budget line), while the food poor can be a net seller of the high-quality goods to reach point *C* (with indifference curve U'_P). Empirically, the food rich don't spend as high a proportion of their shares as do the food poor. But if the food rich reside inside their budget line, the food poor can reach a higher budget line. Points *B′* and *C′* show actual choices of purchased composite low-quality and high-quality goods. The food rich end up at a point interior to the budget line. In turn, this allows the food poor to choose a point beyond the budget line.

the food rich already have a lot of the low-quality staples per client compared to the food-poor food banks, and more may go to waste. Now let the food banks trade at the equilibrium prices given by the slope of the budget line: empirically, food banks trade almost 7 low-quality pounds for a single high-quality pound. The food rich can now attain point *B* (where its indifference curve U'_R is tangent to the budget line), while the food poor can be a net seller of the high-quality goods to reach point *C* (with indifference curve U'_P). Choice offers gains to both parties.

To provide an empirical estimate of points *B* and *C*, we need to consider a time frame. Here we offer two time frames in order to measure what food banks do both over the long run and over a shorter time frame. First consider the average annual choice made by a food bank over the first five years of the system. Over this long time frame, what kind of food does each type of food bank choose to buy, and how different is it from what they were given before? To isolate just the sorting of food banks on the quality dimension, we first assume that savings do not differ between

the two kinds of food banks.[7] (We deal with savings below). Then instead of getting 1,910,000 pounds of low-quality food (point *A*), the food rich get 1,150,000: they give up over 700,000 pounds of that food to increase their purchases of high-quality foods by 100,000 pounds (point *B*). By contrast, the typical food-poor food bank consumes 2,300,000 pounds of low-quality food: they buy 400,000 extra pounds of low-quality food by giving up 60,000 pounds of high-quality food (point *C*).

These numbers measure the average choice made by a food bank over the entire five years. This is a very conservative measure of gains from being able to choose, because, for example, the food rich do not choose 1,150,000 pounds of food every year, nor indeed proportionately each month. Instead, they vary their demands based either on what their clientele want, what other food they happen to have, refrigeration capacity, and so on.

Efficiency Gains from Short-Run Choices

To measure the gains from short-run adjustments, we posit a time period over which food banks seek balance in the kind of food that they receive. Consider a time frame of just two months. (For time intervals much shorter than two months, there is likely to be randomness in whether a food bank happens to win or lose an auction, which obviously does not reflect preferences of the food bank.) Here we denote a food bank as "food rich" if during that two months it spends more per client than does the average food bank on expensive food. (Notice that food banks in the "food rich" category over a two-month time horizon are not necessarily the same as the ones in that category on average over the five-year period.)

The two-month time horizon shows much more transitory variation. The banks that are food poor over a two-month horizon receive .62 million pounds of low-quality food. We multiply by 6 to get 3.72 million pounds of low-quality food per year for banks that are food poor over a two-month horizon. This is much higher than the 2.30 million pounds per year that food-poor banks received when the definition of "food poor" is based on a five-year average. Conversely, the banks that are food rich according to the two-month estimates received only 0.81 million pounds of the less-expensive food annually, compared with the 1.15 million pounds food rich banks received when this category is defined by the five-year average. Said another way, the long-run results (discussed earlier and shown as points *B* and *C* in Figure 2) involved the food poor increasing consumption of less-expensive food by 20 percent, and the food rich reducing consumption of this food by 40 percent. Adding short-run variation in demand changes the first number to 94 percent and the second to 58 percent. Hence, much of the value of the Choice System is temporary rebalancing.

Efficiency Gains From Savings

Some food banks never spend their shares. Empirically, the food rich—who already have a lot of food—don't spend as high a proportion of their shares as do the

---

[7] This calculation weights the goods in each category by price.

food poor. (This is perhaps because they have to pay transportation costs.) As such, the Choice System implies that the food rich reside inside their budget line. But if the food rich reside inside their budget line, the food poor can reach a higher budget line. This is because if the food rich do not spend their shares, average prices fall.

Thus, in Figure 2 we added a couple of points that show actual choices of purchased composite low-quality and high-quality goods. Here rather than predicted consumption of *B*, which was based on an assumption of full expenditure of shares, the food rich end up at point *B′*, interior to the budget line. In turn, this allows the food poor to choose *C′*, beyond the budget line. These differences are large: compared to the old system (point *A*), the food poor receive more of both kinds of food (though proportionately more-aimed at low-quality food) and the food rich receive less of both. (As the food rich and food poor have been selected on the kind of food that they buy, not the amount, this result is not hard wired into the analysis.) The food poor receive 66 percent more inexpensive food and 10 percent more expensive food.

In this way, the Choice System has had the effect of redistributing resources to the neediest areas of the country, which some of the food bank directors both noticed and appreciated. John Arnold, the member of the redesign committee and Director of the Western Michigan Food Bank who was highly skeptical of the Choice System, eventually became one of the most ardent users and supporters of the system, and focused his purchases on the less-expensive items.

Efficiency Gains at a More Granular Level

It is solely for expositional purposes that we are treating food banks and goods as binary (food banks being net buyers or sellers of high-quality goods; goods being high- or low-quality). In reality, there is much more dispersion than this. In Figure 3, we present the distribution of food banks according to total pounds of food received per Goal Factor (and remember shares received are proportional to Goal Factor) over the period 2005 to 2011. This distribution reflects both sorting on quality (those who buy more expensive goods would have fewer pounds of food) and permanent saving (as those who do not consume get fewer pounds). The figure is normalized so that Pounds/Goal Factor has a median of 1. Under the old assignment mechanism, this distribution would be bunched around 1. With the Choice System, food bank purchases in Figure 3—over a five-year period—diverge radically from this. For example, 25 percent of food banks get less than half as many pounds as before, while another 25 percent of food banks receive twice as many. Not surprisingly, dispersion over shorter intervals is even greater.

Hence, sorting occurs throughout the distribution of food banks. Taking into account the sorting across this distribution, not just high and low categories, reveals larger efficiency gains.

Maroon Pounds

Along with these efficiency gains, a second potential benefit of the new system is increased supply of food. Supply increased enormously after the introduction of

Figure 3
The Distribution of the Average Number of Pounds of Food per Share, 2005–2011
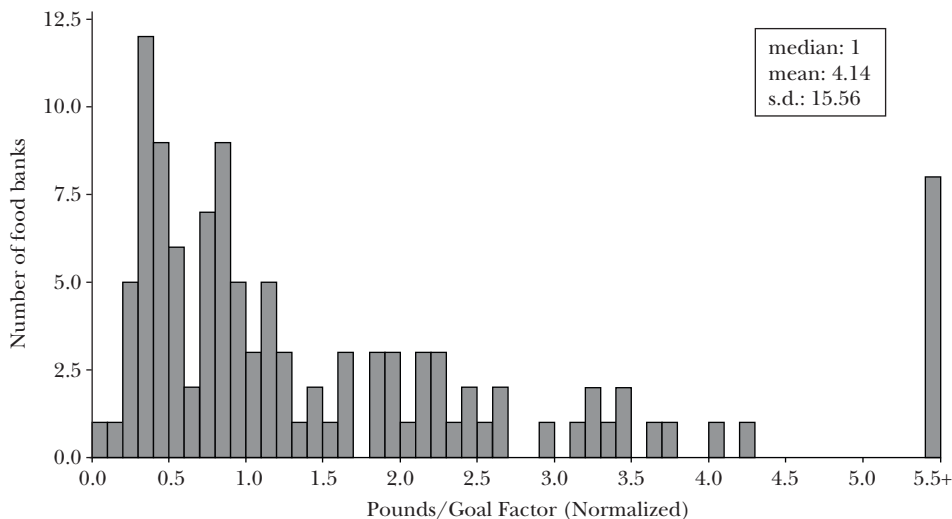
Note: We present the distribution of food banks according to total pounds of food received per Goal Factor (and remember shares received are proportional to Goal Factor) over the period 2005 to 2011. The figure is normalized so that Pounds/Goal Factor has a median of 1.

the Choice System. In the first year after its introduction, the supply of food rose by over 50 million pounds. As mentioned above, an important source of this gain was Maroon pounds. Maroon pounds add approximately 12 million pounds to supply each year from 2005 to 2012, with a range between 10 million and 18 million. It is also the case that these goods are on average higher quality than the average good in the system, and sell for 50 percent more.

Donor Issues and "Hard to Move" Products

Under the old queuing system, it was difficult to place "hard to move" product, as Feeding America called them. Arms were twisted so that someone would take little-desired items in order to keep donors happy. An innovation of the Choice System is to allow negative prices. In its first two years, 11 percent of loads involved the need for "bonus" shares, yet this has declined considerably to only 5 percent in 2010 and 2011. The 5 percent level is relatively small, and suggests that the need to keep donors happy involves relatively little distortion.[8]

---

[8] The Choice System does not allow negative prices for produce. This decision was made because produce is so abundant in the system that there was a concern that on some days the average price paid could be negative, which would result in the reallocation of shares at midnight reducing balance from one day to the next, which was seen as politically infeasible.

Before concluding, it is worth noting that these reallocative effects ignore two other welfare gains. First, we have not addressed rebalancing that occurs within price categories. For example, consider a food bank that already has a lot of yogurt. It can rebalance by buying other goods that sell for the same price as yogurt, such as milk or snacks. Gains from such rebalancing are not reflected here. Second, we have said nothing about the geography of the problem. Under the old system, food banks were often offered food far from their location, and would incur significant transportation costs to get it. The market system allows food banks to gain by focusing their purchases on loads of food that are geographically close, and so cut down on transportation costs.

To summarize, Feeding America knew that its previous system of offering the same amount, and kind of food, to food bank clients might not be optimal, but it did not have the hard information to design a better system. Indeed, given the information that Feeding America had available with the queuing system, it is likely that offering everyone the same thing was close to the best option.[9] The Choice System has allowed the participants to match outcomes to their preferences more effectively. Auctions have revealed willingness to pay for different kinds of food (who would have guessed that one pound of cereal was worth almost 50 pounds of produce?), which has allowed food banks to sort more efficiently on the quality–quantity dimension. In this way, the market system has allowed gains not possible with centralized assignment.

Leveling the Playing Field

We alluded earlier to concerns that a market-based system may not offer a level playing field to some food banks, particularly the smaller ones, and pointed out that the Choice System added a series of features to protect the interest of these food banks. Here we evaluate these features.

Credit

Smaller food banks have access to credit. This is extensively used. In the early stages of the Choice System, the use of credit was relatively rare, with only 4 percent of winning bids involving the use of credit shares in the first 18 months. However, over time, food banks have learned to make use of credit, so that from 2008 to 2011, the fraction of winning bids using credit has remained stable at roughly 11 percent. Remember that only about half of all food banks qualify for credit, so that among those food banks that qualify, almost one-quarter of all the winners use credit.

---

[9] Prendergast (2017) shows that Feeding America could have designed a somewhat better centralized assignment system than the one they used: for example, by offering higher Goal Factor food banks less food but giving them better food. However, given the information available, even a better-designed centralized system such as this does not get close to the outcomes that arise with the Choice System.

Joint Bidding

From 2005 to 2011, joint bids averaged between 1.2 and 2 percent of winning bids. Each joint bid on average has three bidders, so an alternative way to state the number above is that in 4 to 6 percent of cases, the winner is a joint bidder. A feature of joint bidding is that not so many food banks use it, but of those who do, some use it extensively. For example, the five food banks that use joint bidding most extensively use it for half of their winning bids.

Delegation and the Fairness Committee

Feeding America offered food banks the option to delegate bidding to Feeding America, and to appeal to the Fairness and Equity Committee if they felt they had been harmed through the Choice System. No food bank has ever chosen to delegate bidding control to Feeding America except for cases where the director is on vacation for a short period. Even more striking is that food banks have never submitted a request for a special hearing by the Fairness and Equity Committee, and so that committee has never convened.

The combination of credit use, joint bidding, and the absence of any need for Feeding America to intervene either to fix problems or to bid for the food banks strongly suggests that any concern that "small guys" would be disadvantaged has been alleviated.

Conclusion

As seen from afar by an academic economist, the idea that a specialized currency could be used to allocate food more efficiently while simultaneously respecting the relative needs of different areas may seem straightforward. However, despite the conceptual simplicity of the solution, it is worth pointing out that we rarely observe this kind of "Monopoly money" solution being used to allocate resources in real world settings. Why did it work for Feeding America?

Several unusual features of this setting allowed the use of the Choice System, but two stand out. First, dynamic markets with money only work if a participant who cannot find what is wanted today is willing to wait until tomorrow to spend the budget. In the Feeding America setting, the ongoing flow of goods is large—over a million pounds of food every day. As a result, participants who do not find what they want today likely will not have to wait long for a preferred good to come along. Second, the players here are long-lived: food banks are participants in an extended game with no known end point, which it is plausible to approximate as an infinitely repeated game. Again, this setting facilitates food banks foregoing consumption today if desired products are not currently available.

It is probably best to view the experience of Feeding America with the Choice Program not as a victory for markets per se, but rather as an illustration of how a flexible choice-revealing allocation system can be combined with a myriad of small details that include a focus on equity concerns. These tweaks—simple bidding

mechanisms, access to credit, negative prices, the opportunity to delegate bidding, a fairness committee, the ability to bid jointly, the daily reallocation of shares, the use of a fully functioning demonstration game, and so on—seem to have made the difference for the acceptability and thus the longevity of this system. As such, it may be of some value in other not-for-profit settings aimed at improving allocative efficiency though consumer choice.

References

Abdulkadiroglu, Atila, Parag A. Pathak, and Alvin E. Roth. 2005. "The New York City High School Match." *American Economic Review* 95(2): 364–67.

Abdulkadiroglu, Atila, Parag A. Pathak, and Alvin E. Roth. 2009. "Strategy-Proofness versus Efficiency in Matching with Indifferences: Redesigning the NYC High School Match." *American Economic Review* 99(5): 1954–78.

Budish, Eric. 2011. "The Combinatorial Assignment Problem: Approximate Competitive Equilibrium from Equal Incomes." *Journal of Political Economy* 119(6): 1061–103.

Budish, Eric, and Estelle Cantillon. 2012. "The Multi-Unit Assignment Problem: Theory and Evidence from Course Allocation at Harvard." *American Economic Review* 102(5): 2237–71.

Gatch, Loren. 2008. "Local Money in the United States during the Great Depression." In *Essays in Economic and Business History*, vol. 26, edited by Lynne Pierson Doti, 47–61. Economic and Business Historical Society.

Prendergast, Canice. 2017. "The Allocation of Food to Food Banks." http://faculty.chicagobooth.edu/canice.prendergast/research/foodwithmodel.pdf.

Radford, R. A. 1945. "The Economic Organisation of a P.O.W. Camp." *Economica* 12(48): 189–201.

Roth, Alvin E. 1984. "The Evolution of the Labor Market for Medical Interns and Residents: A Case Study in Game Theory." *Journal of Political Economy* 92(6): 991–1016.

Roth, Alvin E. 2008. "What Have We Learned from Market Design?" *Economic Journal* 118(527): 285–310.

Roth, Alvin E., and Elliott Peranson. 1999. "The Redesign of the Matching Market for American Physicians: Some Engineering Aspects of Economic Design." *American Economic Review* 89(4): 748–80.

Roth, Alvin E., Tayfun Sönmez, and M. Utku Ünver. 2004. "Kidney Exchange." *Quarterly Journal of Economics* 119(2): 457–88.