The Allocation of Food to Food Banks

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Abstract

Food banks throughout the U.S. provide nutrition to the needy. Yet the food that is distributed through food banks often originates with donors - large manufacturers or distributors - far from those needy clients. How that food is distributed to food banks across the country is the subject of this essay. An informal description is given of an innovation introduced in 2005 by Feeding America (at the time the organization was called America's Second Harvest) that would better allow food bank preferences to be reflected in their allocations. Specifically, Feeding America transitioned from the centralized allocation process, where they would make decisions based on their perception of food bank need, to one where local affiliates would bid for food items. To do so, Feeding America constructed a specialized constructed currency called "shares" that are used to bid on loads of donated food. The process by which this change came about, its necessary idiosyncrasies, and its outcomes are described.

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1 Introduction

Food banks throughout the U.S. provide nutrition to the poor and needy. The distribution of food to those in need typically occurs at a local and fragmented level, where food pantries and soup kitchens operate in churches, community centers, schools, and so on. Much of the food is donated by food producers or distributors. Sometimes it originates nearby, yet it often comes from donors far from its end users. As a concrete example, a Tyson Foods plant in Kansas has an extra truckload of frozen chicken. How does this end up in a small food pantry far from Kansas? The intermediary is typically a regional food bank: for example, the Chicago Food Depository provides food to a wide range of charitable organizations throughout the city. The subject of this essay is how a large not-for-profit organization, Feeding America, allocates food to these regional food banks across the United States. Its focus is on a transition in 2005 from a centralized system, where Feeding America made assignments based on its perception of their needs, to a market-like system based on food bank choice. In this new mechanism, food banks bid on loads of food using a specialized currency constructed by the organization.

Feeding America (the third largest not-for-profit in the United States after the Red Cross and the United Way) is a national human services agency whose mission is "to feed America's hungry through a nationwide network of member food banks". It does so through sourcing donations of food across the country, both from large food manufacturers (such as Kraft) and distributors (such as Walmart), and from smaller entities such as local grocery stores, and allocating that food to roughly 210 regional food banks. These solicitation efforts largely fit into two categories. First, in many cases Feeding America facilitates donations from a donor to *a particular* food bank.[1] Second, many donors give directly to Feeding America, who then allocates the food to food banks. The subject of this essay is an innovation in 2005 for allocating this second type of donation. At the time of the change, roughly 250 million pounds of food were allocated in this way.

Conceptually, this is not a difficult problem: they should ensure that the food ends up with the food bank whose need is greatest, taking account of transportation costs, spoilage, and storage issues. In practice, it is much more problematic. The difficulty is not primarily in estimating a measure of aggregate need in a "service area": one can construct measures of poverty at this level that reflect reasonably well aggregate food needs.[2] Despite this, there remain considerable obstacles in identifying how much any given food bank needs a particular load that Feeding America has to offer.

First, food banks receive an average of 20% of their food from this source, and

[1] So for example, Tyson in Kansas may have a relationship to the Kansas Food Bank and Feeding America's role is little more than encouraging these relationships and matching these parties when food is available.

[2] There is also data on usage of food pantries and soup kitchens by income level which can be used to fine tune these measures.

Feeding America knows little about much of the other 80%. Some of this variation is transitory, where for example a food bank may already have received eggs this week from another source, and does not really need those being allocated by Feeding America. A second source of variation on the supply side reflects permanent differences, known as "food richness". Some food banks have close ties with local manufacturers or distributors of food - these are called food rich - whereas others have little access to other food - these are the food poor. Because of these other sources of food, Feeding America typically knows little about what is sitting on the shelves of food banks. Beyond these supply issues, incorporating demand variation is difficult. For instance, regional diets vary across the United States. How should these be addressed? Finally, Feeding America assigns a wide range of food: pasta, produce, frozen meat, baby food, peanut butter, and so on. Some foods are more valuable than others to food banks, so how does Feeding America trade off quality versus quantity in its allocations?

Feeding America sees itself as trading off two key issues when allocating food: (i) incorporating the idiosyncratic food bank demand factors above, yet (ii) simultaneously making sure that those areas with greatest need receive the most food. There are, in general, two ways to attempt to do this: by centralized assignment of food - where Feeding America tells an individual food bank what it gets - or by allowing food banks to choose what they want, perhaps with some prices to guide that choice. Before 2005, the agency (like many not-for-profits) eschewed the use of choice and instead used an algorithm to centrally assign food based on its perception of need.

In 2004, a group of 14 - including the author - was charged with evaluating and appropriately changing the allocation mechanism used by Feeding America.[3] Nine members of the committee were directors of regional Food Banks, three were senior staff at Feeding America, and four were academics at the University of Chicago. The University of Chicago faculty became involved because of a connection between Bob Hamada and Feeding America.[4] That group recommended changing to an allocation system based on food bank choice, where individual food banks bid daily on loads of food. To do so they use a specialized currency called *shares* that was created by the organization.

This essay is a (largely informal) description of that change and its aftermath. By most metrics, the change has been a considerable success. Feeding America's equity considerations have largely been met by assigning more shares (on a daily basis) to their most needy members. On the demand side, food banks are engaged, bid actively, and speak highly of the merits of choice. Prices vary considerably by perceived quality of food. Food banks choices on both quality and quantity reflect not only transitory idiosyncratic variations in other supply, but also reflects permanent

[3]At the time, the organization was called America's Second Harvest, but throughout this essay, we will refer to the organization as Feeding America.

[4]The members of the Task Force and their affiliations at the time are named at the end of the essay.

differences such as food richness. Smaller food banks - a concern at the outset of this process - have benefited in particular from the ability to jointly bid with other food banks. The system has also benefited through a greater ability to move undesirable loads through the use of negative prices. Finally, many of the safeguards that were introduced at the outset have fallen into disuse due to lack of need.

Much of the market design literature in economics addresses how to better assign agents to a fixed supply of "slots": children to schools, courses to students, kidneys to patients, and so on (see Roth, 2008, for a survey). By contrast, one of the motivations for this change was to encourage greater supply of food to the poor. This potentially arises in a number of ways. First, by quickly placing food in the hands of the highest value user, food producers or distributors may be more willing to donate. Second, the greater liquidity generated by the bidding mechanism may make Feeding America more willing to accept donations that it would otherwise fear it could not place. Finally, food banks receive food from many other sources than Feeding America. The new system allows them to sell that food through the allocation system and gain additional shares. These were referred to as Maroon pounds.

Since the changeover, the total supply of food on the system increased by about 100 million pounds to 350 million pounds. There are many possible reasons for this, and it hard to parse out the component caused by the new system. However, within a narrow time window around the change - the first seven months - supply of food rose by 50 million pounds, on a base of about 140 million. Some of this increase can be directly related to the Choice System: during this short period, 12 million Maroon pounds were placed on the market. (The average was 15 million Maroon pounds per annum up to 2012.) These Maroon pounds have traded for almost twice the average price of a pound of food, so that these responses are even larger when quality adjusted. Allied to the demand side indicators above, this suggests encouraging evidence for the possibility of adding consumer choice to an atypical not-for-profit setting that may be of some value elsewhere.

2 Allocations before 2005

The old system allocated food based on a metric of need called *goal factors*. This is described more precisely below but was roughly a weighted measure of (i) the relative poverty of a food bank's service area compared to the nation, and (ii) the relative population of the service area. This was then multiplied by the total number of pounds allocated by Feeding America to construct "goal pounds": the total number of pounds of food that an affiliate *should* receive. Affiliates were ranked on goal pounds relative to pounds received, with the affiliate furthest below its goal pounds ranked highest. Food was then offered to a food bank based on its rank. This mechanism was used since the late 1980s, and allocated 250 million pounds of food in 2004.

At a concrete level, a food bank would receive a call from Feeding America letting them know that they had been assigned a "load". This sometimes had conditions,

such as a required pickup date. Food banks were (and remain) liable for transportation costs. The choice of a food bank was to either say yes or no. If a food bank refused a lot, these counted against their need measure as if it had been accepted. In effect, they received no credit for what were known as "turn down" pounds, so that need of an affiliate was based not on pounds *delivered* but rather pounds *offered*.[5] The second exception to the pounds offered calculation was that produce did not count against pounds offered. Produce is a difficult issue for the food banking industry, largely as it need to be moved quickly due to spoilage issues. This is particularly so as produce is sometimes only donated to Feeding America when it is close to spoiling anyway. If an affiliate was offered produce, it did not count against their "pounds offered" calculation. Produce was typically offered first to the nearest food bank to the donor. Finally, Feeding America would make some modifications based on geography: for example, food available in Alabama would sometimes not be offered to the Alaska Food Bank due to its transportation costs.

This allocation system was widely seen by food banks as representing Feeding America's commitment to fairness, allied to a desire to assign based on need. This sense of fairness was reflected in a number of ways. First, there was also an appreciation that the measures used were transparent. Second, Feeding America only reluctantly intervened to use it discretion over allocations: while it may know that a given food bank was unlikely to accept a given donation (for example, tinned fruit in North Carolina being offered to a food bank in California), they typically stuck to the rules of the allocation system to avoid any perception of favoritism. Despite these benefits, the allocation system had considerable drawbacks. Foremost among these is the absence of demand side indicators: Feeding America was deciding what was best for individual food banks without knowing what the food banks really wanted or needed. The role for individual choice was minimal other than a refusal to accept goods.[6] Due to the kind of unknown demand and supply information described above, incorporating food bank information was potentially of great value.

A second problem is that the assignment system treated all foods equally (subject to some minor modifications). A pound of potato chips was the same as a pound of frozen chicken. Yet some food is preferred to others: some are nutritionally better, whereas others involve higher transportation costs per pound (potato chips are

[5]This may seems strange to the reader: why penalize a food bank for refusing to take food that it does not want? This ignores an important issue faced by Feeding America, namely to maintain donor relations. Donors typically want excess food removed from their warehouses for a variety for 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 is sometimes felt by the affiliates.

[6]In some situations where there is centralized assignment, consumer preferences do not make much difference. For example, a patient waiting for a kidney transplant knows little more than does the hospital involved in the allocation process. Yet in other cases, knowing what consumers want can make an enormous difference. The canonical examples of this are school choice and the medical residency matching system, where parental information is important for optimal school choice and residents have both horizontal and vertical preferences over their preferred hospital.

particularly bad on both counts, whereas peanut butter is especially good). Feeding America did not delve into this issue, as it did not know enough about preferences to apply appropriate "weights". Instead, it would occasionally intervene in an ad hoc way where if a food bank received a particularly good product (hamburgers, say), it would not get meat the next time its turn came around. While this subjectivity was mostly believed to be exercised in the interests of fairness, it was at times a concern for food banks who worried about how they fared through its exercise.

Much of the discussion below addresses changes to the allocation system to reduce distorted allocations. But isn't there someone most places that needs the food? It is worthwhile deliberating a moment on the nature of these misallocations. The most obvious - but perhaps least important - is the scenario where the poor in one food bank transitorily fare better than those in another. For example, suppose that Feeding America assigns chicken to one food bank twice in a month, while another gets cereal twice. (Chicken is seen as more valuable than cereal.) While this outcome may not be ideal, perhaps the degree of inefficiency is not so great.[7]

A bigger concern is food that spoils and is not consumed. It is a feature of food banking that a considerable amount of food ends up in the trash, as landfill, or as animal feed. Some of this arises because donors often give food that is close to its expiration date. (Anyone who has volunteered in a food bank will know the experience of having the task of separating edible from inedible food.) This is exacerbated by capacity constraints on storage, particularly for foods that require refrigeration. Here not knowing the residual supply of food banks makes centralized allocation difficult. Take dairy products for example: sending eggs or cheese to a food bank that does not have excess refrigeration capacity - because its fridges are full - likely results in those products not being used. This is also a significant issue with produce.[8] Another important component of this inefficiency is where Feeding America turns down donations that it feels will be difficult to place quickly and effectively due to either spoilage concerns or an inability to pick up within the donor's deadline.

3 The Tradeoff Between Need and Allocative Efficiency

All of the above points to problems that arise with a centrally administered system, one that does not incorporate unknown food bank preferences and constraints. Economists are used to extolling the virtues of consumer choice in allocation mecha-

[7]This is more of a concern for foods that do not have close substitutes, such as baby food.

[8]One way around this was informal sharing between food banks. At the time the task force was convened, food banks shared 86 million pounds of food between themselves. For example, if a food bank did not need an offered donation, it could give it to another who might. However, the old system offered no mechanism to offer the food widely widely: many food banks did share this food with others, but usually only with food bank directors who they knew well.

nisms, with appropriately determined prices guiding those choices. Why not then let the food banks choose what they want?

Consumer choice as an allocation mechanism is predicated on one key premise: that "willingness to pay" by consumers is aligned with the objectives of the organization.[9] In order for consumer choice to play a role, it must be that - through some mechanism - a *budget* is created, by which we mean that if a consumer raises her hand to say she would like good x, it reduces the likelihood of receiving good y. Without the creation of such a budget, all hands are raised and so consumer choice becomes uninformative.[10]

The issue here becomes whether an appropriate budget can both incorporate unknown food bank preferences and simultaneously meet their overall needs. The most natural - and common - way to create such a budget is to attach prices to goods, and let consumers choose. In that way, preferences are incorporated as consumers compare the value of a good with alternative uses of their money. Consider this possibility in the context of food banking, where Feeding America could sell the food to the food banks, perhaps at subsidized prices.[11] Such pricing occurs further down the supply chain of food banking. For example, soup kitchens and food pantries in Chicago pay to receives some food from the Chicago Food Depository, where different food carries different (subsidized) prices. In this way, local food pantries are required to "put their money where their mouth is" to better reflect the strength of their preferences.

While this kind of pricing helps to identify whether a given food bank wants pasta or fish, it is less clear if it satisfies Feeding America's desire to locate most food with the neediest food banks. For this to happen, the food bank in greatest need must have the biggest budget. There is little confidence that in reality it would: instead, there is a very real danger of the opposite. Food banks would rely on fund raising to pay for this food, and those food banks in the areas of greatest need may have the least access to fund raising, thereby exacerbating the problem. Because of this, Feeding America was reluctant to use the price system in any meaningful way and instead used centralized assignment, despite its warts.

In sum, centralized allocation fails to reflect food banks' idiosyncratic demands, while pricing with real money fails to offer budgets based on need. Given this, how

[9] In most markets, this arises naturally: the person willing to pay most for a house is probably the one who should get it. Yet there are many settings where there is not enough trust that willingness to pay reflects social objectives. As one example, we do not allow people to buy kidneys for transplant, as we think that society should have other objectives in who gets a kidney than who is willing to pay the most.

[10] In many assignment settings, budgets are created naturally through the inability to consume more than one of the good in question. For instance, our children can only go to one school at a time, so a choice system that allows parents to say they want school x can be used to reduce their chances of achieving school y. In this way, tradeoffs can be used to elicit consumer information in a useful way.

[11] Legally, this can be done through something called a shared service agreement, where not-for-profit status is maintained by only charging enough to cover administrative costs.

about consumer choice with fake money? In theory, these two problems are separable: prices can be used to orient choice, and a free hand in choosing budgets could potentially satisfy overall need. As such, it became a promising candidate to resolve both problems.

4 The Choice System

When the Task Force convened to discuss a redesign of the allocation mechanism, it became clear that there was considerable discontent at the misallocation of food, often leading to spoilage. The example that routinely cropped up was when the Idaho Food Bank was offered potatoes, even though they already had a warehouse full of potatoes. Despite this, when the idea of a "market" was introduced as an alternative, it met with considerable resistance in many quarters. Food banks exist to serve the marginalized, often those that the market economy has left behind. The preferences of food bank directors often reflect that concern for marginalization, and a fear that markets tend to benefit the strong or powerful. Consequently, while the Task Force was open to change, the initial response to a consumer driven choice system was muted. As one food bank director told the author, "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".

The group met for over a year before converging on what is called the Choice System, using a currency called *shares* to bid on loads of food placed onto the system. Before describing its details, it is important to note that its ultimate introduction lay not in its broadest conceptualization. One indicator of this more generally is that specialized currencies are very rare in reality.[12] Instead, the success of this innovation lay in the myriad of tweaks and additional institutional details that were necessary both for buy-in from the relevant constituents and reflected important considerations on the ground. None of the academics involved in this redesign - the author included - understood the many pitfalls that could have derailed the implementation of this system successfully: for that they relied heavily and consistently on the food bank directors and the staff of Feeding America. The new system would not have occurred without a willingness to listen and adapt on both sides, and the patient and expert moderating of one of our members, Harry Davis.

The starting point of the new system was the creation of a currency called shares.

[12]The example that has received most attention in the market design literature has been the use of bidding systems for business school classes at top universities, where students are given points to bid on courses. In the absence of a some kind of budget, too many students want to take the most popular classes and some centralized assignment mechanism would be needed to allocate slots. Many top business schools now give bidding points to students that allow them to reveal the strength of their preferences for particular classes. While these mechanisms are not without their problems - especially as students have to bid on schedules, not courses - the central idea is that the creation of a budget allows useful information to be revealed (Budish and Cantillon, 2012).

These shares could only be used to bid on what Feeding America calls "yellow pounds". These are the donations that are made directly to Feeding America, and as mentioned above accounted for about 250 million pounds of food. The donations made to a specific food bank that were alluded to in the introduction (and called "blue pounds") were not included in the new Choice System.[13] Shares could not be traded for real money nor used for anything other than the items on the auction market described below.

At the outset of the Choice System, Feeding America distributed shares to each food bank. Shares were initially allocated to a food bank based on its *goal factor*, so the neediest received the biggest budgets.[14] Food banks then logged onto a website on which were posted a set of offerings of food: for example, a truckload of pasta from a food distributor in Tennessee. The offerings sometimes would have conditions: most commonly, how quickly the food needed to be picked up. At the time of implementation, there were approximately 30 to 40 offerings a day.

Based on this information, food banks would then use its shares to bid on any lot that they wished and could afford, and the winner of the auction was the food bank who bid most. The price paid was the bid of the highest bidder. That number of shares would then be subtracted from the winning bidder's balance. Any items that did not sell on a given day would be carried over to the following day for more bidding. Balances did not depreciate.

All shares that were spent on a given day were redistributed at midnight. The rebalancing was done using the same formula as the initial allocation, where the most needy received the greatest fraction of the spent shares. Hence, any food bank which had not purchased on the previous day would almost always have a higher balance the following day, with a greater increase for those in most perceived need.

This describes, in the broadest brush, the central details of the auction mechanism and the allocation of shares. However, fairness considerations dominated much of the group discussion, and many of the more precise details below reflect those considerations. In most cases, the concerns were not about who got how many shares, but rather other potential inequities could result in a playing field which might favor some food banks over others:

- The first concern was for the "little guys". Food banks vary in size and organizational sophistication, ranging from small banks with a couple of employees operating on a shoe string, to larger outlets in major cities with many employees. A concern that arose consistently was that the allocation process should not harm these smaller food banks relative to their larger counterparts.

[13] They continued to go directly to the chosen food bank. The reason for this is that the organization felt that it needed to respect the donor's wishes that a particular food bank receive the goods.

[14] The definition of the goal factor changed as part of this process. This is described in more detail below.

- Probably the greatest difficulty in designing the system concerned the issue of "food richness". Areas that have a denser network of food producers and distributors likely have more sources of alternative food than those that have few. Leveling the playing field in favor of food poor areas was a consistent source of discussion.

- A broader characterization of the food rich issue is unmeasured need, factors affecting need that are not captured in the goal factor. For example, what happens if there is a natural disaster in an area? Or, more commonly, a plant closing in a town? The old system allowed for some discretion by Feeding America by bumping food banks up on the priority list. Finding some way to incorporate these unmeasured needs was a concern.

The details of the Choice System, to which we now turn, reflect these (and other) concerns.

4.1 Bidding and Prices:

Bidding: Bidding occurs twice a day with sealed bids, with the winner paying the number of shares bid by the winning bidder.[15] Bidding closes at noon and 4pm, with the outcomes being revealed immediately by email after bidding closes. All food for each bidding cycle is posted at least two hours beforehand.

Joint Bidding: Food banks have the opportunity to bid jointly for items. Multiple banks coordinate by choosing fractional bids.

Delegated Bidding: Food banks can delegate bidding to Feeding America. To do this, they call a delegate at Feeding America and explain their needs, who bids on their behalf.

Credit: The food banks with greatest need can access credit. Specifically, they can increase their balances to the estimated cost of a highly desired item, where they pay off those debts with at least half their future allocations until the debt it paid off. There is no interest rate on these debts, and future credit cannot be attained until debts are paid.

[15]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 arguing for a second price auction, 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.

Clusters: Some Food banks have chosen to join together for allocation purposes. These are known as *clusters*. These entities will continue to bid as clusters.

Many of these institutional features reflect the concern for the smaller food banks. A worry that was raised early in the deliberations was that larger food banks could dedicate a staff person to the bidding process and if there was continuous bidding, those food banks could wait until the last minute and "snipe". Smaller food banks, which may have one or two employees, could not do this, and would ultimately lose from a system that placed a return to frequently checking the website. This was partially averted by twice-a-day sealed bid auctions, with all food posted at least two hours beforehand. It is worth pointing out that this is not without costs in this context: sometimes donors offer good which need immediate pickup and the twice a day sealed bid process can make these donations problematic.

A second concern for smaller food banks is through an important indivisibility, in that a truck is needed for transportation. Larger food banks can typically use a truckload of any offering, whereas their smaller counterparts may only be able to effectively distribute say a quarter of a truckload.[16] The joint bidding provision was implemented to aid smaller food banks to fulfill their needs while overcoming indivisibilities. Here two (or more) food banks would agree to split a truckload offering, where they submit online the fractions of who pays what.

Delegated bidding was also offered as an option to a food bank that simply did not feel that it had the resources to effectively manage the process. Those food banks could call Feeding America to let them know their needs and allow Feeding America to bid on their behalf. Such delegated bidding could also be done temporarily, say when the food bank director is on vacation for some period of time.

Finally, a concern that arose frequently - which we return to below - is that the smaller entities might never receive the most desired products. This was because a truckload of the most desired goods would likely sell for a larger bid than their balance of shares. This issue was circumvented by allowing most food banks access to enough shares to purchase the most desired options. As the larger food banks typically would hold a balance larger than this on any given day, this was only offered to the smaller and more needy food banks.

Hard-To-Move Product and Negative Prices: Under the old system, there was a degree of arm twisting that arose for product that the food banks did not want. This arose beyond the fact that if a food bank refused a product, it counted against future offering in exactly the same way as if the offering was accepted. This was done to maintain donor relations. The new system allowed for negative prices for goods, called "bonus shares", where shares would be credited to accounts of those food banks that would agree to take a product. In the first day of offering, bonus shares were

[16]It is worth noting that some offerings on the market are Less Than Truckloads.

not offered on a good, and the lowest bid possible was 0. However, if there were no bids after day 1, food banks could bid negative shares for lots (up to a limit of -2,000 shares per load) and the good is assigned to the food bank that offers the smallest number of negative shares.

This is largely transparent, and the negative shares an attempt to add consumer preferences into these hard-to-move items. The only unusual feature is that negative shares were not offered on day 1. This feature was introduced because there was a concern that if smaller food banks do not check offers every day, they might miss the opportunity to get bonus shares. The two day process gave them more time to see that they could gain shares from bidding on an item.

4.2 Unmeasured Hardship

As mentioned above, the old allocation system allowed a degree of discretion, where Feeding America could change rankings based on non-statistical metrics. In order to allow such discretion in the Choice System, a Fairness and Equity Committee was instigated. This committee, whose members would be other food bank directors, would meet quarterly to review applications from individual food banks who make a claim that their allocation of shares should exceed those currently offered under the measures of poverty included in the goal factor.

The committee could increase the goal factor of a food bank by up to 50% for up to three years, thereby entitling them to more shares. This would be used for both temporary relief measures, such as with a natural disaster or a plant closing, but also potentially for more permanent issues such as documented food poorness or high cost of living areas. The Fairness and Equity Committee would fund these extra shares offered to food banks through an annual allocation.

4.3 Supply

Market design solutions are often aimed at better matching unknown consumer demands to a fixed supply of "slots": schools to children, kidneys to patients, classes to students, and so on. So far, our discussion of the Choice System has largely reflected these concerns. However, a significant issue throughout the deliberations was how to generate more supply of food for the poor, both from traditional food donors (producers and distributors) and also from food banks themselves. This could potentially occur in a variety of ways:

More and better supply from traditional donors Much of Feeding America's activities come in soliciting donations of food from manufacturers, distributors, grocery stores, and so on. The new system potentially allows further inducements to

donate:

- The central objective of the new system is that food be used by those who need it most. One way in which donations could be more effectively solicited is with the message that any food given will be used to the best possible end, as the market will allocate food more efficiently.

- The ability of the Choice System to create liquidity (through many food banks bidding on food) could result in Feeding America accepting donations that were previously denied, due to a fear that they could not be quickly placed with a food bank.

- An auxiliary outcome of the Choice System is to identify those foods which are most valued. Previously there were no good indicators of what foods were most desired by end users: now there are prices. These prices could be used to focus solicitation on those donors who have the highest valued foods by users.

Maroon pounds Above, we described two kinds of offerings: yellow pounds (those donated to Feeding America) and blue pounds (those directly donated to specific food banks). The Choice System added another source of food called *Maroon Pounds*.

Maroon pounds are foods that an individual food bank already has, perhaps from another source, but for which it may not be the highest value user. It could be that a food bank already has something, but wants something else. (One example could be where a food bank wants quantity over quality, and sells high value chicken or fish to get a larger supply of pasta.) An alternative use of maroon pounds is where a food bank has food that will spoil before it can use it. Finally, the ability to resell food may make a food bank accept a donation when they cannot use the food themselves, but someone else can. The Choice System facilitated this by allowing food banks to place these on the market. These are bid on in exactly the same way as other product, but where here the winning bid is transferred to the seller rather than redistributed to all food banks.

These maroon pounds are designed to allow a final source of improved food distribution, which is through the ability to mix loads. Say a food bank has won three bids, with a truckload each of baby food, pasta, and tinned salmon. A smaller food bank may have no interest in an entire truckload of any of these, but would be interested in a truck that has a third of each. Mixing arises when a food bank takes these loads, reconfigures them, and then places them back on the market as Maroon pounds.

These Maroon pounds are treated differently to other offerings in two ways. First, they are not eligible for bonus shares (the negative prices), as their donor issues have already been resolved. Second, they are taxed. Specifically, a tax of 10% is imposed on the seller of any Maroon shares transacted.[17]

[17]The tax revenues were given to the Fairness and Equity Committee for disbursement.

The issue of taxing donations from outside the system was the subject of considerable discussion. The ultimate decision to tax these revenues revolved around a revealed preference indicator of "food richness". As mentioned above, there was a desire to level the playing field based on food richness. However, the Task Force was largely unwilling to "tax" food richness using objective statistical measures of such richness, such as the presence of large food producers or distributors in a service area. While it was generally acknowledged that these were likely correlated with food richness, staff or food bank directors were quick to point out exceptions: for example a food bank, which though located close to a major food distributor, was actually food poor. These exceptions rendered it impossible to use such measures in computing goal factors. Instead, there was more comfort with dealing with the food rich issue through revealed preferences. Specifically, if a food bank was putting food onto the market for shares, they probably had more than enough for themselves. As a result, maroon pounds became the revealed preference metric for food richness, and this became the reason for taxing them.

5 Money Supply Concerns

This system operates using the constructed currency of shares. Feeding America controls the supply of shares, and an important issue is what governs that supply. The main touching point of share supply on efficiency is through price transparency. A concern of a system such as this, with constructed currency, is that participants may find it difficult to know how much to bid for an item. To describe this slightly differently, it is typical for economists to extol the virtues of auctions, as bids reflect valuations. Yet valuations have to be denominated in some numeraire, and in normal markets, it is the usual Lagrange multiplier measuring the marginal utility of income. Here the numeraire is the marginal value of a share. Yet how can a food bank compute the marginal value of a share?

Individual food banks typically know nothing about the aggregate supply of shares in the system: all they can see are their balances and the prices of transacted lots. In order to aid bidders in making bids, it was felt that the historical price of a particular good should provide strong information about a reasonable price now. So, for example, seeing that a truckload of bread sold for 1,000 shares in the past would be a good indicator of the current market for bread, all else equal.

As a result, the desire was to choose share supply to generate zero inflation for a given good if demand and supply conditions are unchanged. This was felt to be particularly pertinent in the context of leveling the playing field for the "little guy". The reason for this is that smaller food banks may bid on a particular item (bread in Massachusetts, for example) quite infrequently compared to larger food banks, and this may give larger food banks an advantage in bidding as they know better how to compute reasonable bids. To that end, the system was designed such that the historical record of previous prices would be a strong reflection of current valuations.

Zero inflation as a theoretical objective is easier said than done in reality. To see this, consider the simplest Quantity Theory of Money

$$MV = PT \tag{1}$$

where M is the money supply (here shares), V is the velocity with which it is transacted, P is the price level, and T the quantity of transactions. The desire here was to try to ensure that $\dot{P} = 0$, *everything else equal*. What should be held equal is empirically a harder question to answer.

Some sources of price variation should clearly be filtered out via changes in the supply of shares. For example, suppose that T doubles from one year to the next (holding its composition constant). If the number of shares is left unchanged, prices would likely deflate by 50%. Hence, the number of shares would need to be scaled by the supply of goods on the market. Yet T is value weighted, so it may not be enough simply to scale the supply of shares by the number of pounds in the system. Specifically, the composition of T can also matter, and the makeup of the food supply changes considerably over time.[18] For example, if the supply of shares is held fixed, and say low value potato chips are substituted with high value peanut butter, the prices of all other goods will fall. Ideally, the share of supplies should be changed to reflect changes in average values of transactions.

Finally, there may be variation in V, the velocity with which the shares are trading. Two potentially sources of such variation arise. First, when the system began, participants did not yet know how to play and the concern was that velocity would be low until participants understood the game. Second, food banks are liable for all transportation costs, and changes in gasoline prices have a first order effect on their willingness to engage in the allocation process. For all these reasons, maintaining constant prices is empirically tricky.

Yet at the same time, there is information in prices that is important for determining demand and should not be filtered out. A prime example is the seasonality of the price of produce, which is important for guiding demand. As a result, one does not want to change the money supply in such a way that seasonal fluctuations are extracted. Furthermore, there could be changes in the aggregate supply of a given kind of good from year to year that should be reflected in changed prices.

The resolution to these issues was that Feeding America would track one measure of aggregate T - pounds supplied to the market - and adjust the money supply accordingly every year. This does not control volatility in the velocity of transactions, nor changes in the quality of food being offered to the Choice System, but would at least allow some adjustments based on total donation of pounds to the system.

[18] Charitable organizations often benefit from industry's mistakes, as usually donations are generated by inventory errors, where a firm or distributor produced or ordered too much. As firms become better at managing inventory, Feeding America is affected. This may vary by food quality.

Daily Reallocation of Shares All shares that are spent in a given day are reallocated at midnight. The shares are reallocated according to the same goal factor formula, where those in greatest need are topped up at a greater rate than those who are less needy.

There were a number of reasons for this. First, to maintain constancy of the "money" supply: if for example, the alternative was to only reallocate at the end of a given month, aggregate spending in the month could affect extant supply and hence prices in an undesirable way. Second, we wished to avoid the problem of food banks having to budget over any discrete time interval, with the danger of running out of money at the end of the month, or spending too much at the beginning of the month, much like the evidence on Food Stamp use (Shapiro, 2005).

Finally, and most importantly, one of the biggest conceptual hurdles faced in this process was to inculcate in the minds of the food banks that they are the owners of the food being donated, and not Feeding America. In effect, they are not only the buyers of the food, but also the sellers. This is not meant in the literal sense of food banks putting their own Maroon pounds onto the market, but rather the food that comes from Feeding America.

This became particularly pertinent when concerns were raised about the danger that only the large, food rich food banks would receive the most desirable items, as they would bid more than any other food bank. This was seen by many on the task force as inherently unfair: that the large food rich banks would get the "good stuff", leaving the rest for the others. This concern became mitigated when it was pointed out that the beneficiary of these high priced sales was not Feeding America but rather the rest of the food banks. This is because those shares would be reallocated to everyone else at midnight. The author remembers one of the other food bank directors on the committee joyfully pointing out "so if Los Angeles bids us out of the market by paying a fortune for a truckload of frozen chicken, we really get their shares that night?" That sense of ownership through the reallocation of shares indirectly helped buy-in across the food bank network.

6 Other Rollout Issues

Technology: The clarity and simplicity of the technology used played a central role in the Choice System. A screenshot of the website is provided at the end of this essay. Before it went live, food banks had played a demonstration version, designed by Don Eisenstein and implemented by Mike Halligan, for over three months and were familiar with its operation. Bidding continues to occur online in a simple and timely fashion. The technology allows a food bank to search only for items it might have an interest in, by excluding items based on either geographical constraints or certain kinds of food. A simple click also reveals the history of prices for similar items. Results of the bidding are revealed by email within five minutes of closing of the market, allowing food banks to consider items for either later that day or the next

day.

Buy-in: The academics' role in this process largely ended with a document describing the Choice System. Yet Feeding America is a democratic institution and the food banks voted on whether to pass the new proposal. The work for this was done by the food banking and staff members members of the committee, and it would never have been introduced without their commitment. At the end of their efforts, the new proposal passed resoundingly.

Other: The subject of this essay is to understand the transition of the allocation system from one that is administered to one that involves client choice. However, in the interests of completeness, it is worth noting that this group dealt with a number of other concerns. Two stood out. The first was a change in the definition of need, the "goal factor" used in calculating relative allocations. Under the old system, this was a weighted average of population and poverty of an area relative to the national average for food bank i via

$$[(Population_i/USPopulation) + (PovertyPopulation_i/USPovertyPopulation)]. \tag{2}$$

This was changed to one which applied empirical weights based on usage, as many over the national poverty level use food pantries and soup kitchens. The new definition has three components: those under the poverty line, those between the poverty line and 185% of the poverty line, and those above 185% of the poverty lone, using usage weights for the three groups. The formula is now given by

$$\frac{0.73(Pop < 100\% Poverty)_i + 0.22(Pop[> 100\% but < 185\%])_i + 0.05(Pop > 185\%)_i}{0.73(U.S.Pop < 100\%) + 0.22(U.S.Pop[> 100\% but < 185\%]) + 0.05(U.S.Pop > 185\%)}. \tag{3}$$

Second, due to a previous merger, Feeding America inherited some additional food banks which shared a service area with an exiting food bank. Previously these "Food Rescue Organizations" were not offered food through the allocation system, but they were successfully added as part of this process.

7 Outcomes

Somewhat surprisingly, the discipline of economics does not have a simple and robust methodology for estimating the merits of allocating goods through choice rather than through central administration. Such exercises often rely on a belief that choice is better, and imposing the assumption that differences in allocations between the two reflect the merits of choice. As such, impressions of the impact of the change on the efficiency of the system must be more indirect, and here will include both anecdotal

observation and some data. Some of the data are in a narrow window around its introduction - the first seven months - while some data are more recent.

Anecdotally, the transition has been a great success. Food banks are engaged, bid frequently, and largely extol the merits of being able to choose what they want over what they are told to take. The staff of Feeding America also speak very well of the new system. The operation of the market has also made it clear that a pound is not a pound, as there is large variation in prices across different kinds of good. Furthermore, there is considerable sorting of food banks on the spectrum of quality in a way that seems to benefit all. Supply to the system increased rapidly after its introduction. Finally, many of the safeguards that were put in place to protect against possible problems have largely not been used, and have fallen into benign neglect.

A number of specific benefits have been mentioned by relevant parties beyond the simple issue of allowing more choice (data are provided in Figures 2 to 4 below):

Demand Revelation: Much has been revealed about relative valuations through the bidding process. During the first seven months of the new system, each item received a mean of three bids. The range was from 1 to 29 bids. 46% of loads had more than one bid, and 5% of loads more than 10 bids. Remember that zero was (and remains) an acceptable bid. During that early period, a broad range of goods had little value to the network: 40% of loads sold for zero shares, with produce selling for zero 83% of the time. These zero price sales were (almost always) cases where there was only a single bidder.[19]

As mentioned above, donor relations are important in this setting, and keeping large donors happy often involves taking product that has negative share value to food banks (remember that they have to pay transportation costs). In the first seven months of the Choice System, 12% of all loads traded for bonus shares.

In the first seven months, the average price of a pound of food was 0.13 shares. In the nine years of operation since then, average prices have increased slightly to 0.17 per pound of food, ranging from a low of -0.14 shares per pound to a high of 1.80. The most desirable goods are meat, fish, and poultry, with the least desirable produce, sugary drinks and potato chips. The distribution of prices has also become more variable over time, with more negative and more positive prices, but much fewer good transacting for zero. In 2014, 68% of loads traded for positive prices, 7% for zero, and 25% for negative prices.

Engagement: All food banks became quickly engaged in the bidding process. Within the first 7 months, 97% of food banks won at least one load. No food bank chose to delegate bidding to Feeding America, and the only times that it currently

[19]The Choice System has a tie breaking rule, where if more than one entity ties for the highest bid, the good is offered to the food bank with the highest goal factor.

arises is for temporary reasons, such as when the director or relevant staff person is on vacation.

Transparency: The old allocation system involved considerable discretion by Feeding America. Most food banks accepted that this was done in the best interests of feeding the hungry, yet there were concerns about whether some food banks were being offered better food than others, perhaps based on location or contacts. A major benefit of the Choice System is its transparency: as an example, in 32% of cases in 2014 prices were zero or negative, yet there are few complaints about this as anyone could have bid on them.

The Safeguards: The committee spent a large amount of time deriving a series of explicit safeguards so that food banks would not be significantly disadvantaged by the changes. Two stood out: the Fairness and Equity Committee, and the ability by food banks to delegate bidding to Feeding America. As mentioned above, no food bank delegated bidding to Feeding America. More striking is that the Fairness and Equity Committee has *never* convened, due to the widespread satisfaction with the outcomes of the Choice System. Much of this likely has to do with sorting issues described below.

Price Stability: An objective of the system was that prices would remain relatively stable, to aid bidding. Until recently, this has by and large occurred. From its introduction in 2005, prices ranged from 0.13 shares per pound to a high of 0.24 in 2008, but most years between 0.17 and 0.21. However, the last two years (2013 and 2014) have seen a large decline to 0.07 and 0.06 respectively. This has appeared to have been caused by a change in product mix, but this has yet to be empirically verified.

The "Little Guys": Much of the interest in fairness on the committee was to protect the smaller food banks that may not have the resources to devote to the bidding process. However, there is general acceptance now that the smaller food banks have done especially well from the changeover. Much of this has to do with the ability to bid jointly, as now multiple smaller food banks can combine effectively in bidding for the indivisible truck load of food. Also important in this is their ability to use credit: in the first seven months, 38 food banks used credit, 7% of bids were made using credit shares, and 3% of winning bids used credit. These were largely smaller food banks. By 2014, 50% of food banks had used credit and in that year 7% of all winning bids involved credit.

A further example of the dissipation of these concerns is that the system has changed in the last few years such that now negative shares are possible on the first

day that a product is offered. Initially this was not done for fear that access to these bonus shares would not be equal if the smaller food banks check offerings and balances less frequently than the larger ones. As this is no longer a concern, the desire to quickly move this product has taken precedence.

Sorting: The Choice System allows food banks to sort based on their individual preferences. This takes many forms. First, they can respond to transitory shocks to preferences, typically generated by variation in food already in storage at the food bank. Second, some variation in demand may not be transitory but instead could reflect different demand conditions across service areas: the residents of some service area may prefer to get rice over potatoes, but this may not be true elsewhere. Again the Choice System allows these differences to be incorporated.

One noticeable feature of the Choice System is that there are a number of food banks who bid rarely, but when they do, they bid only on the most desired loads. It appears these actors are the food rich. One of the less expected outcomes of the Choice System has been akin to an "income effect" generated by food richness. Those food banks already have enough of the staple foods - indeed for storage reasons they often cannot store additional supplies of these staples. As a result, they tend to hold back their shares for the most desirable products, and bid aggressively to win these offerings. This leaves the staples and low end goods for the food poor regions. This has also resulted in a number of "bottom feeders" who acquire large quantities of food at little (share) cost. (The food bank director who told the author that he was not a fan of markets became one of the most delighted bottom feeders.) These are often the food poor food banks. This appears to be a development from which all benefit, where the price system allows food banks to choose a location on the quality-quantity tradeoff. That the shares spent by the high spenders is redistributed to the other food banks every night facilitates the overall satisfaction with this outcome.

The use of bidding has also likely facilitated a new form of sorting that has occurred over the last decade. A new trend among some food banks is to be less focused on volume of food for the poor, but instead nutrition has become the focus of many food banks. (It is of course ridiculous to claim that any food bank is not concerned with nutrition: instead, a recent trend is for some food banks to focus much more intensively on this issue.) For these food banks, their bidding is now more focused on a set of foods which Feeding America has labeled "Foods to encourage", those with the highest nutritional value. Yet this trend is far from universal, and for many food banks their priority remains the alleviation of hunger through a wide variety of foods. This divergence in preferences would have been very difficult to administer under a centralized assignment system. The Choice System allows this divergence to be naturally reflected in different offerings to the poor across geographic areas.

Supply of Food: An objective of the redesign of the allocation system through choice was that it facilitate the supply of more and better food to Feeding America.

This desire was operating against a backdrop where firms are becoming better at managing inventory, and having fewer errors to offer as donations. First, in the ten years of its existence, the amount of food on the Choice System has increased from 250 million pounds to an average of 350 million pounds. While we believe that this has been facilitated by the knowledge that donations are going to its highest end use, it is difficult to prove this.[20]

However, a clearer picture may be possibly seen by considering a narrow window around the time of its introduction. While the supply of food to the system was relatively constant before the change to the Choice System, the number of pounds of food on the system rose by 50 million pounds in the first seven months after its introduction. Specifically, after 7 months, 192 million pounds of food had been "sold" though the new allocation system, compared to roughly 140 million pounds by that time in a normal year.

Some of the increase in supply caused by the Choice System arose through Maroon pounds. From 2006 to 2012, an average of 15 million Maroon pounds per annum were sold, and 5% of all offerings are these Maroon pounds (the number for the first seven months was 12 million pounds). Also worth nothing is that these maroon pounds typically sell for about twice as many shares per pound as the average load (0.3 to 0.17).[21] As a result, the importance of Maroon pounds is almost twice as high when adjusted for quality.

The purpose of these last few pages is not to provide a definitive number for the benefits of the Choice System. Such an exercise would require much more data, and almost surely some parametric assumptions on demand. Instead, its purpose was simply to show that on all relevant dimensions, the arrow appears to point up, and in some cases to do so quite significantly. As more data becomes available, more precise statements can hopefully be made.

8 Conclusion

Seen from afar, the idea that a specialized currency could be used to allocate food more efficiently while simultaneously respecting the relative level of need in an area may seem straightforward. However, despite the conceptual simplicity of the solution, it is worth pointing out that it is very rare to observe these kind of "Monopoly money" solutions being used to allocate resources in real world settings. There are, of course, a large number of barter markets which involve the trading of scrip, but these are sparse and characterized by rampant illiquidity. Indeed, as one of the only examples offered of such mechanisms is bidding for business school courses, this surely points to the limited empirical importance of these kind of solutions.

[20] This is particularly so as the total amount of food allocated by Feeding America has increased from 2 billion pounds to 4 billion pounds (though Feeding America now buys a lot of food).

[21] Food banks placed their "money making" excess loads on the market, perhaps continuing to informally share the less valuable excess food with other foods banks.

Perhaps the rarity of these kinds of interventions is because there are not so many cases where one can create budgets in non-traditional currencies to reflect consumer preferences. Alternatively, it may be that it is not the broad conceptualization of the problem that generates success, but rather the myriad of small details that gets it over the line. Here these details involved a series of tweaks - simple bidding mechanisms, credit, negative prices, the opportunity to delegate bidding, a fairness committee, the ability to bid jointly and mix lots, the daily reallocation of shares, the use of a fully functioning demonstration game, and so on - that made the difference. That some of these buttresses were not ultimately necessary may hardly be the point, as much of the implementation of this system was political.

The apparent success of the Choice System raises other possibilities. First, could it be extended to other parts of the food distribution chain? For example, the Chicago Food Depository distributes food to many parts of the city, some of which are blighted with greater poverty than others. Would it be possible to set up a system of fake currency to do better than charging food pantries real money? As one possibility, could they give credit cards denominated in fake currency with which to distribute food from its warehouses? While this has its challenges - not least the fact that many clients of food banks commute from where they live to a food bank in another neighborhood - the outcomes of the Choice System may open some possibilities. Second, one of the desires of this system was to equalize inequalities caused by food richness. Yet it appears that the food rich are largely sorting into the most expensive goods as they already have an adequate supply of the staples. If so, how about taxing the most expensive goods in the sense that some of the proceeds from these sales are not distributed to everyone, but only to those foods banks whose average purchasing is of lower priced goods? While the Choice System has likely helped the food poor by allowing them to concentrate best on the lower priced good, perhaps more direct redistribution could be beneficial.

Despite the apparent success of this allocation system - with more food being better allocated across the country - the Task Force was far from omniscient. In retrospect, two issues seem worth mentioning. First, when the supply of shares was chosen, the discussion centered around the desire to induce an outcome where one share would equal to one pound on average. More valuable than average lots would trade for more, less valuable lots for less. We thought that this would be a useful benchmark by which to anchor beliefs about reasonable prices. In reality, prices are off by almost an order of magnitude (the average price has been 0.17 shares per pound). This error - which ultimately does not appear to have mattered, as food banks calibrated quickly - was caused by both a lack of understanding of how many loads would sell for a price of zero or below, and an overestimation of the velocity with which the shares were transacted. Some of that early low velocity was generated by food banks still learning the system, but it remains the case that average prices have been far from those anticipated.[22]

[22]There was also a large increase in gasoline prices at this time which likely was a factor.

The more substantive problem remains produce, which traded on the Choice System exactly like any other good. Produce is problematic as it spoils quickly.[23] As a result, it is a relatively low value food to food banks, especially as transportation costs can be large. The Choice System does take time; at least a day to sell, and then it needs to be transported to a food bank, and from there to a pantry or soup kitchen. As I write, a decision has been made at Feeding America to take produce from the Choice System, and reallocate it to a new platform that will allow it to move more quickly, where the food is simply given to the food bank that can collect it fastest. Perhaps it would have been valuable to adapt the Choice System for goods that need to transact rapidly. As such, the Choice System has not been a panacea for all ills. Despite this, we believe that its architecture has lead to some robust successes that may be valuable for other possible applications in the not-for-profit sector.

[23]Produce is also a problem as it is not clear how much is actually used by end users. Sometimes this is because they do not know well how to cook certain kinds of food. This part of the reason that some food pantries have moved towards prepared meals over the last decade.

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Figure 1: **Screenshot.**

Calendar Year	Pounds	Shares Spent	# of Loads	Shares/lb.
2005	143,684,016	22,445,305	5,351	0.16
2006	328,419,345	41,593,987	11,982	0.13
2007	348,098,864	59,545,038	12,288	0.17
2008	359,043,166	87,322,990	12,321	0.24
2009	350,446,167	73,862,313	12,073	0.21
2010	336,135,436	66,897,387	10,610	0.20
2011	337,081,335	52,455,270	10,601	0.16
2012	290,842,789	49,821,936	9,749	0.17

Figure 2: **Pounds, Prices and Shares: 2005-2012.**

Calendar Year	Pounds	Shares Spent	# of Loads	Shares/lb.	% Total # Loads
2005	8,938,663	2,102,886	315	0.24	5.89
2006	18,222,547	4,225,846	691	0.23	5.77
2007	19,705,479	5,666,488	740	0.29	6.02
2008	16,415,849	5,104,679	681	0.31	5.53
2009	14,798,513	4,179,117	606	0.28	5.02
2010	17,325,870	5,719,106	648	0.33	6.11
2011	10,151,223	3,237,053	387	0.32	3.65
2012	10,674,994	2,494,053	406	0.23	4.16

Figure 3: **Maroon Pounds.**

Shares Used on Won Loads Report

	%Tot.Weight	Total Weight	Shares spent	# of Loads	Shares/lb	% Total # of Loads
Won Loads with Regular Shares	63.31	179,258,508.00	18,152,289.00	5,755.00	0.10	61.07
Won Loads with Credit Shares	7.22	20,434,346.00	3,616,432.00	699.00	0.18	7.42
Won Loads with Zero Shares	8.11	22,962,037.00	0.00	620.00	0.0	6.58
Won Loads with Bonus Shares	21.37	60,504,423.00	-3,966,537.00	2,349.00	0.0	24.93
Total	100.00	283,159,314.00	17,802,184.00	9,423.00	0.06	100.00

Figure 4: **Prices in 2014.**