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Don't Bite The Hand That Feeds You: Food Pantries and Food Retailer Profitability

by Thomas Kopp and Lauren Chenarides

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Don't Bite the Hand That Feeds You: Food Pantries and Food Retailer Profitability

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Hunger-relief programs, such as food services provided through food banks, serve as emergency assistance to meet households' temporary food needs, yet a growing population in the United States regularly relies on these services. There is little empirical research that examines just how individuals factor hunger-relief programs into their planning horizons, whether the presence of these organizations diverts sales from grocers, and how that affects food retailers' revenues and profits. Further, the presence of multiple grocers in one market constitutes a common good problem, given that the savings in food waste disposal fees occur for each retailer privately, while a potential reduction of total demand affects all retailers' sales. This paper examines the extent to which the presence of food pantries diverts food sales from retail grocers. Using data on the location of food pantries and annual sales volume from retail grocers in Central Texas, we measure the statistical relationships between food pantry density and retail grocers' annual sales volume. Preliminary results show that food pantry presence does not affect retailers' revenues, suggesting that food pantries and food retailers do not directly compete for market share.

Keywords: grocery retailing; food access; food aid; food banks; food assistance

JEL Classification: L13; L81; H41

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1 Introduction

Hunger-relief agencies, in particular food banks and the food pantries they operate, serve a fundamental role in helping food-insecure households meet their food needs (CASWELL et al., 2013; GUNDERSEN and ZILIAK, 2018). In the state of Arizona, for example, nearly 20% of individuals rely on regular food distributions from food banks (MILLS et al., 2014). A Feeding America study found that food pantry clients depend on this assistance in order to cover other major and recurring costs, like rent and medical bills (WEINFELD et al., 2014). Although there may be a perception that food pantries function as temporary assistance, existing literature suggests that, for many individuals, they serve as a regularly used source of food (BAZERGI et al., 2016). As the role of hunger-relief organizations continues to straddle the line between a temporary resource for some and a more permanent solution in addressing food insecurity for others, it is imperative to study their economic impact. Because the sustainability of the food banks and pantries is made possible by donations from food retailers,¹ with nearly 50% of food supplied to families through their affiliated pantries donated by food retailers (FEEDING AMERICA, 2016), it is particularly important to understand how their presence interacts with the local food retail environment. In this study, we examine the question of whether the presence of food pantries affects the profitability of retail grocers and – if yes – in which direction. In doing so, we address a timely issue of the evolving role of food banks themselves, as current economic considerations create increased uncertainty about household food security.

While many federally funded programs exist to provide assistance to food-insecure individuals, food pantries serve a vital role for both those participating and not participating in federal nutrition programs. On one end of the spectrum, food pantry patrons may be currently enrolled in nutrition assistance programs like SNAP or WIC and use food pantries to supplement their existing benefits, while other visitors might not qualify for, or are not yet enrolled in, these programs. The latter might be temporarily affected by some economic hardship, such as the loss of a job or an unexpected large expense, but fully expectant to return to work in the short-run, in some cases rendering it inefficient to apply for SNAP or WIC. Across these consumer types, levels of pantry utilization vary. MABLI and WORTHINGTON (2017) find that SNAP recipients are less likely to visit food pantries once they are enrolled, which suggests that individuals enrolled in federal nutrition programs use food pantries as a supplement rather than a replacement to SNAP, whereas those temporarily unemployed are more likely to visit these outlets because of no other recourse. Given the heterogeneity among individuals in need

¹Federal commodity programs, purchases made directly by the food banks, and donations from other sources such as agricultural producers also account for portions of food sourced by food banks.

of food assistance, food pantries may serve a more prominent role not only in where consumers acquire food, but also how they factor into the existing competitive food retail environment. THOMPSON et al. (2019) stress the importance of expanding definitions of what constitutes the local food retail environment, not strictly supermarkets, especially in areas either marked by high unemployment or suffering from high rates of food insecurity where a greater portion of consumers rely on hunger relief services. In these communities, charity and third-sector businesses, such as food pantries, could account for a higher percentage of consumers' at-home food acquisitions with possible consequences on the local retail environment.

As food pantries become more prominent fixtures tasked with feeding higher than average numbers of economically vulnerable individuals, highlighted by events such as the 2008-2009 recession and the outbreak of the SARS-CoV-2 pandemic, the relationship we seek to address in this paper is whether the presence of food pantries could threaten market shares, determined as the portion of a market's total sales earned by a particular retailer, for local retail grocers. Whether, in fact, a relationship exists between the presence of food pantries and food retailer sales and – if yes – its direction is an empirical question. On one hand, retail grocers and food pantries could serve as substitutes, as food pantries capture the portion of market demand that would otherwise shop at the food retailer, i.e., the residual demand. If so, the existence of food pantries may first of all have a negative impact on grocery retailers' sales volumes. This can have substantial consequences for retailers, given that hunger-relief agencies, like Feeding America, report to serve millions of food-insecure individuals every year who rely on free-and-reduced meals made available at local food pantries (MILLS et al., 2014).

On the other hand, there is evidence that food retailers and food pantries are not necessarily (only) direct competitors, but instead may have a symbiotic relationship. Food donations not only benefit the food pantries and their clients, but the food retailer as well, as the costs associated with food waste disposal offer incentives to retail grocers to partner with food banks. With growing concerns associated with food waste and surmounting evidence of its environmental and social consequences, the federal and state governments have implemented tax incentives for retailers to donate leftover food.² Further, the fee charged for food waste disposal by waste management services are estimated at \$130 per month to remove up to 1,800 lbs of waste. Analysis of the total value of food loss at the retail level showed that spoiled foods resulted in \$46.7 billion in 2010.³ These costs can be reduced by simply reducing

²<https://www.refed.com/tools/food-waste-policy-finder/federal-policy/federal-tax-incentives>.

³The USDA estimated 43 billion pounds of food, or about 10% of the entire grocery retail supply, were lost in 2010 (BUZBY et al., 2014).

the volume of wasted food. Therefore, the food banks, and the food pantries they operate, serve an important function in the food retailer’s supply chain, namely cost-reduction, as food retailers can circumvent fees incurred with disposing unsold food while benefiting from pro-social implications of reducing food waste and feeding the hungry.

It is important to account for where the beneficial effects of donating leftover food (reduced costs associated with food waste) and the detrimental ones (reduced residual household demand) occur: While reducing food waste reduces the costs exclusively for the firm that donates this food, the disadvantages are shared with the retailers’ competitors in its vicinity which are likely all affected by households meeting a part of their food demand through food pantries. This creates a dynamic akin to the tragedy of the commons, yet from the retailers’ perspective, in which profit maximizing retailers donate more food than is optimal for their combined profits. From the perspective of both society and the environment, though, the retailers’ potential failure to cooperate in determining the amount of leftover food they donate may lead to a more desirable outcome.

With the exception of a few recent studies (LOWREY et al., 2020[a]; LOWREY et al., 2020[b]; PRENDERGAST, 2017), the economic relationship between food banks and food retailers has generally not been established in the literature. Empirical studies that examine the role of food banks within the food supply chain focus on how the amount of food donated by retailers affects store-level marketing outcomes. LOWREY et al. (2020[a]) find that food retailers who donate food realize higher margins than those who do not donate, but donations reduce store-level sales. The underlying mechanism is that retailers retain high-margin products and donate lower quality items, thus partitioning the market into two segments: high-valuation and low-valuation consumers. Following from LOWREY et al. (2020[a]), even if donating food to a bank would reduce sales, the retailer would benefit further because the otherwise leftover food would be thrown away, costing food retailers in food waste disposal fees. This has been empirically tested by LOWREY et al. (2020[b]), who finds that retailers who donate to food banks are more profitable than those who do not, due to the cost savings derived from tax write-offs. In our approach, we build upon the previous literature to model how density of pantries, and collusive behaviors of food retailers, could lead to an optimal outcome that preserves retailer profits when more than one retailer participates in food donations. What follows from our theoretical model is the expectation that retailers who jointly optimize the amount they donate would profit more than if they make donation decisions independently.

To begin, we model the decision-making process of grocery retailers to predict whether there is

an economic incentive to serve as a supplier of leftover food to food pantries. The purpose of the model is to develop an understanding of the circumstances in which it is profitable for retailers to donate food, and how much, to food pantries. We frame the retailer’s decision in this way because a dominant supplier of the food pantry is the retail grocer. The benefit of donating food to the pantry is that the retailer does not need to pay for disposing unsold food items. However, it may come at the cost of losing some customers to the pantry. Given that the savings in food waste disposal fees occur for each retailer privately, while a potential reduction of total demand affects all retailers’ sales, the presence of multiple grocers in one market constitutes a common good problem.⁴ Therefore, an extension of the model serves to understand the characteristics of the potential common goods problem in an oligopolistic environment; specifically, donating food relieves retailers of food waste disposal fees (i.e., representing a private benefit to that individual retailer), but might reduce aggregate residual demand that disadvantages all retailers in the area.

We develop this theoretical framework and pose several testable hypotheses. We posit that food pantry presence negatively affects food retailer revenues, though it remains possible that donating food to food pantries is profitable for retail grocers nevertheless due to the savings garnered by avoiding food-waste disposal fees. Finally, food pantries benefit from being located closer to a higher density of food retailers, as they benefit from a market failure vis-à-vis unsold, surplus food from nearby food retailers.

We use a combination of publicly available data on the location of food pantries and privately accessible data, namely Nielsen’s TDLinX Store Characteristics dataset. This data is used to map grocery retail establishments and provides annual store-level sales volume. Combining both datasets allows us to measure the statistical relationships between food bank density and annual sales at grocery retailers. We estimate a reduced-form econometric model to investigate the relationship between grocery retail revenues and the presence of food pantries. To deal with potential endogeneity issues, we rely on an instrumental variables approach. We find that the revenues of food retailers are not significantly affected by the presence of food pantries in their vicinity. This indicates that the individuals who rely on food donations would not shop at food retailers in the absence of food pantries, most likely due to income constraints. This suggests that food pantries do not cannibalize on the grocers on whom they rely in the first place. The results of this study imply that encouraging participation in federally

⁴This is the supply side equivalent to the Modern Agricultural Markets paradigm suggested by SEXTON (2012), which understands a steady supply base of agricultural producers a common resource to retailers, reducing their incentive to exercise market power to such a degree that the farms are driven out of the market.

funded food assistance programs among eligible, but not currently participating, food pantry clients would not necessarily decrease revenue for grocers,⁵ but would decrease food insecurity.

The remainder of the paper is organized as follows. In the next section, we describe our theoretical entry model and how we use this framework as a precedent to our empirical model. We then give an overview of the data and afterwards discuss our results. Conclusions follow.

2 Conceptual Model

We begin by developing a microeconomic framework that models the retailer’s decision-making process of whether to supply food to food pantries, and, if so, how much. As described above, the benefit of supplying food to the food pantry is that the retailer “saves” by avoiding (lessening) the fees associated with food waste disposal. However, this decision could potentially reduce the residual demand, i.e., the retailer losing some customers to the food pantry. Moreover, if multiple retailers compete in the same generally defined market, it is possible that food retailers donate more than they would if they were cooperating, because gains are private and costs are public.

To formulate empirically testable hypotheses, we present two modeling scenarios. The purpose of our first model is to develop an understanding of the circumstances in which it is profitable for a representative retailer to donate to food pantries. It is assumed that the decision on quantities in inventory have been made previously and the retail prices have been set, while the quantity sold may be affected by food donated. Because the retailer’s actions do not affect the price, the decision of donating food will be an all-or-nothing decision, i.e., to donate all leftovers or nothing. Based on these findings we will formulate two testable hypotheses for the empirical analysis.⁶

In a second scenario, we account for the fact that, in a world of multiple retailers, a market failure in the form of a “tragedy of the commons” may arise (HARDIN, 1968; OSTROM, 2008). In that extension to the model, two retailers can donate leftover food to food pantries and their actions have an effect on total demand and prices. If the retailers cooperate, they would jointly decide how much to donate to food banks. In the case of competition, one retailer might “free-ride” on the other(s) by donating a larger amount of leftover food to the food banks than the cooperative solution, because the benefits of donating, i.e., reducing the costs of depositing of leftover food/food waste, are incurred privately by each retailer, while the costs of donating, i.e., reducing total demand, are borne by all retailers, as the reduction of demand affects all retailers equally. Therefore, the retailer under consideration

⁵Federal funds via food assistance programs are accepted at most grocery retail locations in Arizona.

⁶The situation in which prices are affected by donations is represented in the second scenario.

only incurs a fraction of the forgone revenue. Since the retailers are assumed to be identical, all will behave egoistically, leading to all retailers donating more than under conditions of joint profit maximization. For simplicity, we assume monopoly and duopoly (with inventory quantities having been set previously).

2.1 Model 1: Representative Food Retailer

We first set up the supply side and then derive the demand function for food-at-home products, based on a representative consumer's utility function. We then derive the circumstances under which it is profitable for retailers to donate food to food banks at market equilibrium.

The quantities of leftovers (i.e., what is not sold in a specific period), q_L , is determined by a retailer's inventory, q_I , and sales quantity, q_s :

$$q_L = q_I - q_s. \quad (1)$$

Quantity wasted, q_w , which represents the food that retailers throw away, is the difference between the leftover food and the food bank supply, i.e., the quantity of food that food retailers give to food banks, q_{FB} :

$$q_w = q_L - q_{FB}. \quad (2)$$

Substituting q_L from (2) into (1) and solving for q_I yields

$$q_I = q_s + q_w + q_{FB}. \quad (3)$$

The retailer's profits are calculated as the revenue minus costs of procurement minus costs of waste disposal:⁷

$$\Pi = p_s q_s - c_p q_I - c_w q_w, \quad (4)$$

in which p_s stands for retail sales price, c_p for costs of procurement, and c_w for the costs of disposing of food waste. Substituting q_I from equation (3) in (4) yields

$$\Pi = p_s q_s - c_p (q_s + q_w + q_{FB}) - c_w q_w. \quad (5)$$

Next, we look at the demand side to determine how the food that is supplied to the food bank affects

⁷Costs of transportation to the food bank are abstracted from for simplicity.

sales at food retailers.

Total combined food consumption of all consumers, C , is given by the sum of food purchased at the retailer and obtained from the food pantry:

$$C = q_s + q_{FB}. \quad (6)$$

Household demand is determined by preferences, prices, and a budget constraint. Figure 1 depicts the scenario that if households obtain free food, they will consume more food and more non-food goods in total, but also reduce the amount of food they buy at retailers. The reason why not all people only consume food from food banks is simply because there is only a certain variety of products and amount of food available from the food bank.⁸ In Figure 1, the amount of food purchased at the retailer is reduced from q_s to q_s^* . The total consumption of food increases from q_s to $q_{FB} + q_s^*$, and the consumption of other goods increases as well, leading to an increase in the utility level from U_1 to U_2 .

Next, we derive the household's decision problem. The general utility function depicted in equation (7) shows that household utility is determined by the consumption quantities of food (including food obtained from food banks) and non-food goods:

$$U = U(q_o, q_s) = U(q_o^*, q_s^* + q_{FB}), \quad (7)$$

in which q_o^* denotes the “other,” or non-food, goods. We assume a Cobb-Douglas utility function, given by

$$U = (q_o^*)^\alpha (q_s^* + q_{FB})^\beta, \quad (8)$$

with $\alpha, \beta \in [0, 1]$ and $\alpha + \beta = 1$.

The budget constraint is given by

$$B = q_o^* p_o + q_s^* p_s, \quad (9)$$

where B stands for the budget available to a household. Reformulation yields:

$$q_o^* = \frac{B - q_s^* p_s}{p_o}. \quad (10)$$

To find the quantity demanded, the marginal rate of substitution, based on equation (8), is set equal

⁸According to Feeding America's donations data, most food items include storable food items, such as canned soup, fruit, vegetables, fish, beans, as well as dry goods, such as pasta and rice (MORELLO, 2020).

to the slope of the budget constraint, based on equation (9):

$$MRS = \frac{\frac{\partial U}{\partial q_s^*}}{\frac{\partial U}{\partial q_o^*}} = \frac{\beta (q_o^*)^\alpha (q_s^* + q_{FB})^{\beta-1}}{\alpha q_o^{*\alpha-1} (q_s^* + q_{FB})^\beta} = \frac{\beta q_o^*}{\alpha (q_s^* + q_{FB})} = \frac{\frac{\partial B}{\partial q_s^*}}{\frac{\partial B}{\partial q_o^*}} = \frac{p_s}{p_o}. \quad (11)$$

Substituting q_o^* from (10) into (11) and solving for q_s^* yields

$$q_s^* = \frac{\beta B - \alpha p_s q_{FB}}{p_s(\alpha + 1)}. \quad (12)$$

Solving equation (12) for the price gives

$$p_s = \frac{\beta B}{q_s^*(\alpha + 1) + \alpha q_{FB}}. \quad (13)$$

Differentiating (12) with respect to q_{FB} shows us the demand side effect:

$$\frac{\partial q_s^*}{\partial q_{FB}} = -\frac{\alpha}{\alpha + 1} \quad (14)$$

Since $\alpha > 0$, equation (14) is always negative, which means that the more a retailer sends to the food pantry, the less it will sell at the store.

To derive the aggregate profit effect for the retailer, we insert q_s^* from equation (12) and q_w from equation (2) into the retailer's profit equation (5):

$$\Pi^* = \frac{\beta B - \alpha p_s q_{FB}}{(\alpha + 1)} - c_p \left(\frac{\beta B - \alpha p_s q_{FB}}{p_s(\alpha + 1)} + q_w + q_{FB} \right) - c_w (q_L - q_{FB}). \quad (15)$$

Differentiating equation (15) with respect to the amount of food that is donated to the food pantry yields the total effect for the retailer:

$$\frac{\partial \Pi^*}{\partial q_{FB}} = c_w - \frac{\alpha}{\alpha + 1} (p_s - c_p). \quad (16)$$

If equation (16) is positive, then donating food to the food bank causes a net benefit to retailers and they will do so. This is the case if $c_w > \frac{\alpha}{\alpha+1} (p_s - c_p)$, i.e., when the costs of disposing of food waste are higher than the retailers' marketing margin (sales price minus purchase price) multiplied by a factor that captures consumers' preferences for the food good in relation to other goods.

For policy makers, this implies that setting higher prices for food waste disposal could incentivize

retailers to donate food. Also, if the retailers' margin is small, or if consumers do not value food highly (i.e., α is low), retailers are more likely to donate food to pantries, *ceteris paribus* (c.p.)

2.2 Model 2: Two Food Retailers

To model the tragedy of the commons in food donations, we introduce a second retailer to the model. Such an approach requires not only an assessment of whether donating food to food banks is, in general, profitable or not, but also to determine an optimal quantity. We achieve this by allowing the retail price to react to the amount of food given to consumers for free.

We assume a duopoly in which the amount of food donated to food banks, q_{FB} , affects the retail price because the two retailers (retailer A and retailer B) create the whole supply, and therefore jointly face a downward-sloping demand function. To isolate the effect of the amount of food donated from the effect of inventory, the inventory is assumed to be predetermined. We solve the model twice, differentiating between cooperative behavior and market failure (i.e., tragedy of the commons or free-riding).

The tragedy of the commons scenario is modelled by setting up a Cournot game of two retailers setting quantities of the food they donate and making this decision at the same time. We first develop retailer A 's Nash-reaction function given the other retailer's decision and then derive the optimal amount of food donated to the food bank, anticipating the other retailer's reaction function, by inserting retailer B 's reaction function into the profit function of retailer A . The counterfactual scenario of the retailers collaborating is modelled as a monopolist deciding alone how much food to donate to food banks.

On the household side, we assume a linear inverse demand function faced by both retailers, in which the amount of food donated to the food banks reduces the retail price. We specify this price by reducing the demand by the aggregated amount of food donations of two retailers, weighted by coefficient γ , which captures the size of this effect. Variables referring to the two retailers, A and B , are marked by superscripts.

$$p_s = \delta - \mu (q_s^A + q_s^B) - \gamma (q_{FB}^A + q_{FB}^B), \quad (17)$$

with the coefficients $\delta, \mu, \gamma > 0$.

Inverting (17) yields the following demand function:

$$q_s^A + q_s^B = \frac{\delta - \gamma (q_{FB}^A + q_{FB}^B) - p_s}{\mu}. \quad (18)$$

Given symmetry between A and B , the demand function, that one retailer faces, is half of the total demand function from (18):

$$q_s^A = \frac{\delta - \gamma (q_{FB}^A + q_{FB}^B) - p_s}{2\mu}. \quad (19)$$

When deriving retailer A 's profits, the negative marginal effect of q_{FB} on the quantity that is sold by retailers is implemented in the model by replacing q_s in the profit function by $q_s - \sigma q_{FB}$ with $\sigma > 0$. Retailer A 's profit is then given as

$$\Pi^A = p_s (q_s^A, q_s^B, q_{FB}^A, q_{FB}^B) (q_s^A - \sigma q_{FB}^A) - c_p c_I^A - c_w (q_I^A - q_s^A - q_{FB}^A). \quad (20)$$

Inserting p_s from (17) gives

$$\Pi^A = (\delta - \mu (q_s^A + q_s^B) - \gamma (q_{FB}^A + q_{FB}^B)) (q_s^A - \sigma q_{FB}^A) - c_p c_I^A - c_w (q_I^A - q_s^A - q_{FB}^A), \quad (21)$$

and the equivalent for retailer B is

$$\Pi^B = (\delta - \mu (q_s^A + q_s^B) - \gamma (q_{FB}^A + q_{FB}^B)) (q_s^B - \sigma q_{FB}^B) - c_p c_I^B - c_w (q_I^B - q_s^B - q_{FB}^B). \quad (22)$$

We now construct the Nash-reaction function for retailer B with the decision parameter q_{FB}^B by differentiating (22) with respect to q_{FB}^B , treating q_{FB}^A as given. This yields

$$\frac{\partial \Pi^B}{\partial q_{FB}^B} = \gamma q_s^B + \sigma \delta - \sigma \mu (q_s^A + q_s^B) - \sigma \gamma (q_{FB}^A + 2q_{FB}^B) + c_w. \quad (23)$$

To maximize B 's profits, we set (23) equal to zero and solve for q_{FB}^B , which gives

$$q_{FB}^B = \frac{\gamma q_s^B + \sigma \delta - \sigma \mu (q_s^A + q_s^B) - \sigma \gamma q_{FB}^A + c_w}{2\sigma \gamma}. \quad (24)$$

Retailer A has the same reaction function, given as

$$q_{FB}^A = \frac{\gamma q_s^A + \sigma \delta - \sigma \mu (q_s^A + q_s^B) - \sigma \gamma q_{FB}^B + c_w}{2\sigma \gamma}. \quad (25)$$

In the Nash equilibrium, both firms react identically to each other, so we insert (24) into (25) to derive the equilibrium and solve for the amount that retailer A donates to food banks, q_{FB}^A :

$$q_{FB}^A = \frac{3\delta}{2\sigma^2\gamma} + \frac{3}{\sigma\gamma}c_w - \frac{3\mu}{\gamma}(q_s^A + q_s^B) + \frac{3}{\sigma}(2q_s^A - q_s^B). \quad (26)$$

Because $q_s^A = q_s^B = \frac{1}{2}q_s$ we can simplify to

$$q_{FB}^A = \frac{3\delta}{2\sigma^2\gamma} + \frac{3}{\sigma\gamma}c_w + \left(\frac{3}{2\sigma} - \frac{3\mu}{\gamma}\right)q_s. \quad (27)$$

As a counterfactual, we calculate the solution of the two retailers jointly choosing the amount to donate by modelling them as one stakeholder. The profit function in this case is, based on (21),

$$\Pi = (\delta - \mu q_s - \gamma q_{FB})(q_s - \sigma q_{FB}) - c_p C_I - c_w(q_I - q_s - q_{FB}). \quad (28)$$

Differentiating with respect to q_{FB} yields

$$\frac{\partial \Pi}{\partial q_{FB}} = -\sigma\delta + \sigma\mu q_s + 2\sigma\gamma q_{FB} + c_w. \quad (29)$$

Setting (29) to zero and solving for q_{FB} gives

$$q_{FB} = \frac{\delta}{2\gamma} - \frac{1}{2\sigma\gamma}c_w - \frac{\mu}{2\gamma}q_s. \quad (30)$$

To see under which scenario more food is donated, we check if $2^*(27)-(30)$ is positive or negative:

$$2^*(27) - (30) = \frac{3\delta}{\sigma^2} - \frac{\delta}{2} + \frac{13}{2\sigma}c_w + \left(\frac{3\gamma}{\sigma} + \frac{11\mu}{2}\right)q_s. \quad (31)$$

Equation (31) is positive if $\delta < \frac{6\delta}{\sigma^2} + \frac{13}{\sigma}c_w + \left(\frac{6\gamma}{\sigma} + 11\mu\right)q_s$, where δ is the constant in the demand function. If that condition is fulfilled, then $2^*(27) > (30)$, which means that two firms give more food to food banks in the case of non-cooperating behavior than they would when jointly optimizing that amount.

2.3 Hypotheses

The theoretical considerations raise the following empirically testable hypotheses:

Hypothesis 1: Food pantry presence negatively affects food retailer revenues. This is true if the

marginal effect of q_{FB} on retailers' revenue, $-(\frac{\alpha}{\alpha+1})p_s$, from equation (14), is statistically significant.

Hypothesis 2: It is profitable for retailers to donate food. This is true if equation (16) is positive.

3 Empirical Framework

To test hypothesis 1, we assume that grocery profits are additively separable in both deterministic and error components. To estimate grocery store profits, we reparameterize equation (12):⁹

$$R = \phi + \rho(p_s q_{FB}) + \Lambda \mathbf{M} + \Gamma \mathbf{X} + \varepsilon \quad (32)$$

where our dependent variable, R , is annual sales volume ($p_s q_s$), ϕ is a constant, $p_s q_{FB}$ is the sales value equivalent of food distributed by the food pantries, ρ represents the demand-side effect that measures the effect of changes in food retailer sales quantity given a one unit change in the quantity of food donated to the food pantry from equation (14), \mathbf{M} is a vector of demand-side control variables that reflect local-area factors that represent households' budget, Λ is the vector of corresponding coefficients on \mathbf{M} , \mathbf{X} is a vector of supply-side control variables, Γ is the vector of corresponding coefficients on \mathbf{X} , and ε captures Gaussian errors with mean zero.¹⁰ Given data constraints, we proxy $p_s q_{FB}$ by the distance between retailer and the closest food pantry, Δ_{FB} . Driving distance plays a role for consumers' decision where to shop (HILLIER et al., 2017; VER PLOEG and WILDE, 2018), and the population density is distributed across the state, where each household faces different driving distances to their preferred store.

$$R = \phi + \rho(\Delta_{FB}) + \Lambda \mathbf{M} + \Gamma \mathbf{X} + \varepsilon \quad (33)$$

4 Data and Identification Strategy

4.1 Data

The data required to test our hypotheses are compiled from multiple sources: (1) Nielsen's TDLinX Store Characteristics Database, (2) an exhaustive list of active food pantry locations in Arizona, (3) demographic characteristics from the American Community Survey (ACS) five-year estimates of the U.S. Census for years 2013-2017, and (4) the USDA Rural-Urban Continuum Code (RUCC).

⁹We rearrange terms by cross-multiplying p_s on the RHS denominator with q_s on the LHS to get R on the LHS as our dependent variable.

¹⁰Full details of covariates are presented in the following section.

4.1.1 Mapping Grocery Retail Locations

Grocery store locations in Arizona are identified using Nielsen’s TDLinX Store Characteristics data for the year 2019. Each entry (store-level) includes the name of the store, the store format, annual sales volume, sales area (square footage), the number of stores within the chain that owns the store, as well as detailed geographic information on the store’s address. What follows from our theoretical model is store-level sales, R , thus annual sales volume, will serve as the preferred measure for our dependent variable.¹¹ We follow ÇAKIR et al. (2019) to classify retail grocers into one of three categories: independent stores, small (local) chains, and large (national) chains and construct binary variables that serve as control variables in \mathbf{X} from equation (33). Within the state of Arizona, there are 748 active grocery stores as of June 2019, presented in Table 1.

4.1.2 Mapping Food Pantry Locations

We use publicly available data to construct an exhaustive list of food pantry locations in Arizona.¹² All food pantries were active as of the summer of 2019. The dataset was compiled using multiple online resources, including the Association of Arizona Food Banks’ database of food relief organizations, the websites of Feeding America-affiliated food banks, and a list of The Emergency Food Assistance Program (TEFAP) and Commodity Supplemental Food Program (CSFP) locations provided by the Arizona Department of Economic Security. These lists provide street addresses of food bank, food pantry, and food relief organization sites, as well as often specifying the types of services offered.

To measure our variable of interest, Δ_{FB} , the distance between grocery locations and food pantry, we use the geoprocessing tool, Near, part of the ArcToolbox package in ArcMap. The distance is calculated as the Euclidean distance between each food retailer and the closest food pantry location.

4.1.3 Additional Covariates

Demographic data is collected from the U.S. Census ACS five-year estimates. We include numerous controls in our estimation equation, including population density, income, and demographic characteristics (e.g., percentage of the population with various levels of educational attainment, age, and

¹¹Alternative measures, such as annual sales per square foot, can be calculated by dividing store-level annual sales volume by the square feet of selling space at that store. This measure reflects the efficiency with respect to sales space at each store. Although this is an industry standard in measuring store-level profitability, what follows from our theoretical model is store-level sales, R , rather than profitability, and thus the former (1) will serve as the preferred measure for our dependent variable.

¹²Food pantries considered in this analysis include only those agencies that are affiliated with the four major food banks with jurisdiction in Arizona: Community Food Bank of Southern Arizona, St. Mary’s Food Bank Alliance, United Food Bank, and Yuma Community Food Bank, as well as Desert Mission Food Bank (an affiliate of St. Mary’s). In some cases, locations of active food pantries fall outside the borders of Arizona into bordering towns in California, Utah, Colorado, and New Mexico.

race/ethnicity). We classify areas according to their urban (metro) status using the RUCC data, and add these as control variables in our sensitivity analyses. These variables enter equation (33).

4.2 Identification Strategy

Our goal is to explain variation in food retail sales, where nearby food pantry locations may or may not affect food retailer profitability. The ideal experiment to measure the effects of food pantry presence would be to randomly assign food pantries to different neighborhoods. However, we cannot assume with confidence that pantries do not enter strategically, suggesting that these reasons may create endogeneity concerns. On one hand, food pantry location could be driven by poverty (low income). On the other hand, it could be driven by the origin of food, or the distance to their network of suppliers, which include food retailers.

To determine whether there is any evidence that food pantries strategically locate in areas that have a higher concentration of low income individuals or households in poverty, we examine if there is a statistical relationship between higher rates of poverty in an area and the presence of food pantries.¹³ We perform a series of regressions to determine the correlations between poverty and food pantry counts at various spatial units: block group, census tract, zip code, and county. We present these results in Table 2. Based on these results there is evidence that the presence of food pantries is positively correlated with poverty. If the unit of analysis is at the county-level, we do not see any statistically significant relationships, yet the number of counties in the state of Arizona are few. As the number of observations increases, we consistently observe strongly positive correlations up until the 35% of households in poverty.

Because poverty (i.e., a measure of local-area income) is likely to affect retailer profits and we find evidence that food pantry presence is correlated with poverty, then the presence of food pantries is likely to be correlated with lower retailer profits, suggesting there is an endogeneity issue. Therefore, to identify the effect of food pantry density on retailer profits we propose an instrument, namely the distance to the nearest food bank distribution center. This distance is unlikely to be correlated with poverty rates, and likely to be correlated with food pantry location.

¹³We use the definition of poverty established by the U.S. Census. The U.S. Census creates income thresholds determined by family size and composition. If a household's total income falls below this income threshold, then that family and the individuals in that family are considered in poverty. For detailed information on how poverty is measured, please visit <https://www.census.gov/topics/income-poverty/poverty/guidance/poverty-measures.html>.

5 Results and Discussion

In this section, we first present the results from estimating our baseline model, and conclude with a series of robustness checks to verify the validity of our results.

The results of the model and robustness tests are provided in Table 3, showing that the distance between food pantry and retailer has no statistically significant effect on retailers' profits. This means that hypothesis 1 can be rejected; there is no evidence for food pantries cannibalizing on retailer revenues. Hypothesis 2, on the other hand, can be confirmed. We do not observe any negative effects on sales quantities, which suggests that donating leftover food is unambiguously profitable for food retailers. Regarding robustness checks, all statistically significant coefficients are of the same sign and in the same order of magnitude over all specifications. The food pantries do not bite the hand that feeds them.

Taken together, our results indicate that households relying on food aid may not be part of the target group of retailers, i.e., low income households would – in the absence of food pantries – not shop there but instead search for other subsidized sources of food.

6 Conclusions

Though anecdotal concerns have arisen suggesting that the density of food pantries may negatively affect food retailers' sales, little empirical research exists that examines this possible consequence. If true, food retailers, a major supplier of food items to food banks, would be disincentivized in the long-run from continuing to donate food. However, retail grocers do benefit from donating food, as it reduces their costs associated with disposing food waste. Beyond this, the observed, continued donation of leftover food to food banks is a textbook example of the classic “common good” problem faced by the retailers: their savings from reducing food waste are incurred privately by the individual retailer, while the possibly undesired effect of reduced consumer demand is incurred by all retailers in a given area collectively. This paper develops a theoretical framework that conceptualizes the effect of food pantry density on retailers and retailer density on mean amount of food donated. The interesting – and somewhat paradoxical – implication is that the common goods problem, based on lack of agreement between firms and exacerbated by an increasing number of firms, potentially leads to a politically desirable outcome, namely the increased amount of leftover food that is not disposed in landfills, but provided free of charge for the ones in need.

This work provides empirical evidence for the effect of food pantry presence on food retailers'

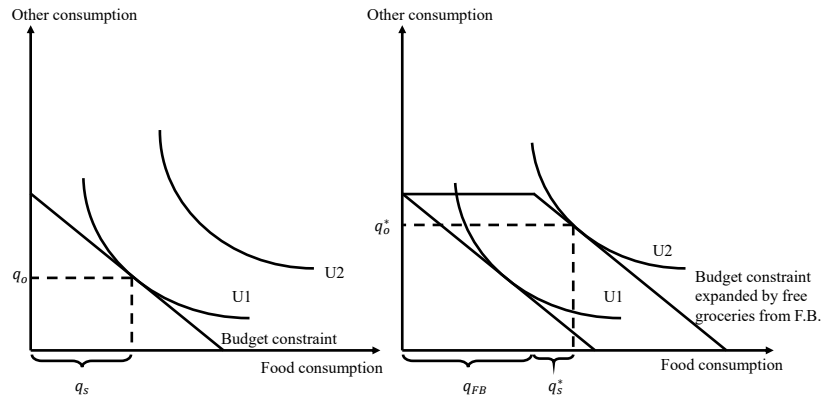
revenues. Results indicate that food pantry presence does not reduce retailers' profits, suggesting that their services are primarily used by households who would not shop for groceries in grocers in the absence of food pantries.

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Figure 1: Market diagram: Effect of free food from food banks on purchase behavior and utility.



The amount of food obtained by the food bank, q_{FB} , shifts the vertical axis and the demand function horizontally to the right. This allows consumers to obtain a higher level of utility by spending less money on food (but consuming more) and having more money available for the other consumption.

Source: Own production.

Table 1: Breakdown of Grocery Retailers by Store Classification

Store Classification	Description	Number of Stores
Independent	Operates a single store	139
Small/Local Chain	Operates fewer than 200 stores	155
Large/National Chain	Operates more than 200 stores	454
Total Number of Grocery Retailers in Arizona		748

Source: TDLinx Store Characteristics Data, 2019.

Table 2: Correlations between Poverty Rates and Food Pantry Density (OLS Regression Results)

	County Level		Census Tract Level		Block Group Level		Zip Code Level	
Percentage of house-holds in poverty	Coefficient	t-stat. sig.	Coefficient	t-stat. sig.	Coefficient	t-stat. sig.	Coefficient	t-stat. sig.
10	45.346	0.427	0.662	11.942 ***	0.241	13.184 ***	0.042	7.513 ***
15	-78.278	-1.104	0.709	12.212 ***	0.231	12.092 ***	0.046	7.354 ***
20	-40.154	-0.378	0.743	11.736 ***	0.236	11.541 ***	0.050	6.631 ***
25	-49.071	-0.339	0.753	10.485 ***	0.261	11.576 ***	0.057	6.352 ***
30	0.000	—	0.775	9.408 ***	0.279	11.171 ***	0.037	3.540 ***
35	0.000	—	0.915	9.220 ***	0.287	9.962 ***	0.036	2.990 ***
40	0.000	—	0.769	5.916 ***	0.228	6.698 ***	-0.012	-0.888
45	0.000	—	0.379	2.193 **	0.193	4.757 ***	-0.021	-1.420
50	0.000	—	0.273	1.221	0.151	3.015 ***	-0.030	-1.938 *
N. Obs.	15		1,526		4,178		33,120	

* Represents 10% significance level. ** Represents 5% significance level. *** Represents 1% significance level.

Table 3: Regression Table, Dependent Variable: Annual Sales Volume

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Δ_{FB}	176.9 (0.78)	-259.1 (-1.14)	-61.63 (-0.38)	-133.1 (-0.79)	-85.88 (-0.37)	-29.10 (-0.17)	-55.62 (-0.32)
<i>Demand-Side Control Variables (M)</i>							
PopDen		-0.419*** (-2.63)		-0.414*** (-3.48)	-0.600*** (-3.31)		-0.447*** (-3.30)
PCIInc		0.0235 (0.36)		-0.0234 (-0.48)	-0.00133 (-0.02)		-0.0378 (-0.75)
Sh_HighSch		-5242.0 (-0.68)		-1781.9 (-0.31)	-160.8 (-0.02)		-922.8 (-0.15)
Sh_College		17811.9* (1.72)		-6072.3 (-0.78)	14247.5 (1.36)		-7384.2 (-0.94)
Sh_CollegePlus		-3345.1 (-0.25)		-8834.9 (-0.90)	-484.4 (-0.04)		-5560.4 (-0.56)
<i>Supply-Side Control Variables (X)</i>							
Small (Local) Chain Dummy			12778.2*** (10.36)	13859.0*** (11.05)		13363.4*** (10.63)	14226.5*** (11.16)
Large (National) Chain Dummy			24669.9*** (24.13)	25702.2*** (24.03)		25204.3*** (23.91)	25852.1*** (23.71)
Constant (ϕ)	18415.1*** (9.56)	21035.4*** (9.71)	3164.9*** (3.45)	6391.0*** (3.69)	19027.2*** (6.95)	2194.7 (1.35)	4592.3** (2.14)
County FE	Y	N	N	N	Y	Y	Y
Observations	748	744	748	744	744	748	744
R^2	0.023	0.029	0.456	0.471	0.052	0.468	0.480

t statistics in parentheses

* p<0.1, ** p<0.05, *** p<0.01