Location and Profit Drivers of Local Food Hubs

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Abstract

Local food is increasingly important for consumers and small farms. However, smaller farmers often focus on production and have few resources to devote to distribution or marketing activities. Food Hubs (FHs) may offer a non-conventional solution to local food aggregation and distribution from small and mid-sized local farms to restaurants, schools, and final consumers; but they may be an expensive policy if they rely on government grants and outside funds to remain in business after establishing. Such hubs also have recently been shown to provide positive economic benefits. We compare locations and profit drivers of conventional Merchant Wholesalers (MWs) and local FHs in order to shed light on activities and community attributes that may increase the profit viability of FHs, with a particular focus on the role of social capital in the establishment and on-going profitability of FHs. To our knowledge, this is the first study to examine FH profit drivers, economic viability, and the importance of social capital to FHs on a national scale using a formal economic model. We not only uncover attributes associated with profitable FHs, but also estimate the county population needed for FHs to at least break-even and therefore remain viable in the long run. We compare FH profit drivers to those of MWs to understand how FHs may need to operate differently from MWs to be sustainable and the dimensions in which conventional MWs may offer lessons to burgeoning FHs.

JEL Codes: L81; O13; Q18; R39

Key Words: Food hubs, local food, local food systems, food hub location, social capital.

Local Food Hubs: Profit Viability and Social Responsibility

Local food systems have been linked with enhancing the rural economy, the environment, food access and nutrition, and strengthening agricultural products and markets (Low et al. 2015).[1] Moreover, farmer involvement in local food systems and the value of local food sales appear to be increasing (Low et al. 2015), and there is a growing interest among policymakers, researchers, and community members to support local food systems (Jablonski, Schmit, and Kay 2016).

However, it remains challenging for small farms to reap directly the benefits associated with increased demand for local foods: farms selling only via intermediated channels reported more than 3 times the local food sales as farms selling only via direct channels in 2008 (Low and Vogel 2011). Though small, local food and direct selling of local food remains an important channel, particularly for small and mid-sized producers.[2] For example, from 2002 to 2012 the number of farms with direct sales of food increased about 23% and farms selling local food via direct channels were more likely to remain in business than farms not using direct channels (Low et al. 2015). However, small and mid-sized farms do not specialize in distribution and marketing activities and coordinating resources among promotion, production, and distribution in a cost-effective way presents a hurdle for local food producers (Woods et al. 2013). A recurring barrier faced by smaller farmers continues to be a lack of distribution infrastructure and services (Barham et al 2012), which presents a significant challenge for scaling up local food systems (Day-Farnsworth et al. 2009). Improved access to distribution infrastructure and related services could help small producers aggregate output to achieve a scale that better serves the growing

[1] A locally grown food is defined, by U.S. Congress, to be a product sold within 400 miles or within the state (Hand and Martinez 2010). However, the concept of local varies widely in practice by both type of product and the region in which it is sold (Woods et al. 2013).

[2] In 2008, small (medium) farms comprised 81% (15%) of all farms reporting local food sales (Low and Vogel 2011). Also note that there is a separate literature on "Ag of the Middle" which notes that mid- or medium-sized producers may face unique challenges.

demand for local foods from formats with larger sales (e.g., grocery stores, restaurants, schools, hospitals, and universities; Barham et al. 2012; Martinez et al. 2010).

Food Hubs (FHs), defined as "business[es] or organization[s] that actively [manage] the aggregation, distribution, and marketing of source-identified food products primarily from local and regional producers to strengthen their ability to satisfy wholesale, retail, and institutional demand" (NGFN 2016, 6), reduce transactions costs by aggregating products to a single location and providing a dependable supply from local and regional producers (Barham et al. 2012).[3] Aggregation and distribution centers can help address some supply channel disadvantages smaller producers encounter when seeking to create a network including conventional food retail and service markets; for example, by combining local foods from several small or mid-sized producers, FHs can achieve the scale necessary to reach these markets (Woods et al. 2011).

FHs can add significant value by acting as aggregators and distributors for small farms (Barham et al. 2012). FHs actively search out new market opportunities for small and mid-sized producers (Barham et al. 2012). About 32% of FHs work solely with producers that are small or midsized and about 44% of FHs work mostly with producers that are small or midsized (Fischer et al., 2013). Scale economies associated with distribution are significant and have been a major driver for food retailing consolidation; however economies of scale may not be as important in markets where consumers value uniqueness and small size (Woods et al. 2013). However, a lack of distribution systems for moving local foods into mainstream markets has been described as a barrier for small and mid-sized farmers to reach the scale necessary to meet customer demand (Martinez et al. 2010).

[3] According to Woods et al. (2011) there are six attributes that characterize a FH: 1) organization of aggregation, distribution, and marketing of mostly local foods to multiple markets; 2) a commitment to purchase from small and mid-sized local producers; 3) collaboration with farmers to increase capacity; 4) an attempt to negotiate "good prices" for farmers using product differentiation; 5) a partnership with producers; and 6) a desire to effect positive economic, social, and environmental change while maintaining financial viability.

FHs not only benefit producers, but consumers and communities as well. Barham (2012, 6) notes that “[b]ecause most food hubs are firmly rooted in their community, they often carry out a number of community services.” In addition, general local food sales are predominately vegetables, fruits, and nuts (Low and Vogel 2011) and many FHs are part of a coordinated effort to increase service to areas with low access to healthy and fresh food (Barham et al. 2012). Bringing local food to consumers also offers a significant environmental advantage over consumers traveling to local farms by reducing carbon emissions.: carbon emissions are likely to be greater if a customer drives a round-trip distance of more than 4.16 miles in order to purchase local food than from the entire transport system (including refrigeration and packing) to a regional hub (Coley, Howard, and Winter 2009). Despite these benefits, evidence demonstrating that FHs are a sustainable business model is mixed (Woods et al. 2011). Some researchers suggest that in order for a FH to be financially viable once established, it may have to limit the scope of its original social or environmental goals (Franklin et al. 2011).

One defining characteristic of FHs, differentiating it from mainstream and conventional aggregation and distribution establishments, is the adherence to a mission or value statement reflecting a desire to effect economic, social, and/or environmental change (Woods et al. 2011). The majority of FHs have “supporting farmers” as a central theme in their mission statements; however, mission statements can reflect such values as: local food, food access, local economy, reshaping the food system, justice and/or equity, human health, increasing consumer awareness, environment, and community development (Fischer et al. 2013). Among FHs included in a national survey, only 2% of mission statements included the word “profits” (Fischer et al. 2013).

According to Agricultural Market Service (AMS) data, about 49% of FHs are for-profit while 31% are non-profit and 14% are classified as a consumer or producer cooperative, see Figure 1.[4]

In this article, we compare locations and profit drivers of conventional Merchant Wholesalers (MWs) and FHs in order to shed light on activities and community attributes that may increase the profit viability of FHs with a particular focus on the role that social capital plays in the establishment and on-going profitability of FHs. To our knowledge, this is the first study to examine FH profit drivers, profit viability, and the importance of social capital to FHs on a national scale, and, as such, we do not benefit from the hub-specific operations data utilized in a case-study approach. Since profits of these establishments are not directly observable, our empirical approach is based on the seminal entry model of Bresnahan and Reiss (1991), henceforth B&R, in which profits are inferred via the observed number of firms. Using this approach, we not only uncover attributes associated with profitable FHs, but also estimate the population in the market needed for FHs to at least break-even and therefore remain viable in the long run. Moreover, by comparing FH profit drivers to those of MWs, we can understand how FHs may need to operate differently from MWs to be sustainable and in which dimensions conventional MWs may offer lessons to developing FHs.

This article proceeds as follows. We begin with some background information on FHs and MWs. Then we describe the empirical approach used to compare FH and MW profitability, profit drivers, and break-even market sizes. This is followed by a detailed description of the data, variables, and assumptions used to operationalize the model. After this we discuss the statistical validity of our approach, results, and their application to policy. We end with conclusions, a discussion of the limitations of our analysis, and final thoughts.

[4] This is comparable with data from other sources: Fischer et al. (2013) classify 47% of FHs as for-profit, 34% as non-profit, and 13% as cooperatives.

Local Food Hubs and Conventional Merchant Wholesalers

Conventional food distribution channels, such as MWs, are primarily concentrated in the West (35%) and South (30%), with the smallest percentage locating in the Midwest (12%), see Table 1. In contrast, FHs are more equally dispersed with the percentage locating in a region ranging from 21-32%, with about 23% locating in the Midwest. Conventional MWs also appear to target metro areas, locating 90% of their establishments there, with about 63% in areas with a population of 1 million or more. Less than 3% are located in non-metro, non-metro adjacent areas and only 0.6% are located in completely rural areas. FHs are relatively more dispersed across urban and rural areas. Although the majority are established in metro areas (about 70%), they also have a relatively stronger presence in non-metro, non-metro adjacent areas than MWs with about 6.5%. Importantly, approximately 3.25% of FHs are located in completely rural areas, signifying that they are able to have a greater rural presence than conventional channels.[5]

In 2013, there were 220 self-reported food hubs across the U.S., which was an increase of 68% from 2008 (Jablonski, Schmit, and Kay 2016; USDA 2013). However, establishment of FHs appears to be slowing. Figure 2 shows the number of FHs established each year since 2005 (USDA 2016). While FHs saw mostly steady growth from 2008 to a peak in 2012, there seems to have been a drop in new FH establishments from 2013 onwards. This could be a lagged response to the passing of the Food Safety and Modernization Act (FSMA) in 2011, which called for broad and diverse changes to the U.S. food safety system (Low et al 2015). However, according to a national FH survey, only 3% of FHs listed "meeting food safety requirements" as their greatest challenge (Fischer 2013). It could also point to market saturation; however given

[5] This is comparable with the findings of a national FH survey, which reflected responses from about 107 FHs. The survey found that 75% of FHs located in metro areas, 16% located in non-metro, metro adjacent areas, and 9% located in non-metro, non-metro adjacent areas. They also reported that 2% were located in completely rural areas (Fischer et al. 2013).

the number of FHs, estimated to range from 170 to 396 in about 139 to 281 counties, this appears unlikely. It could also be that relatively newly established FHs have yet to list themselves on the searchable directories.

The wave of FH establishment in 2012 may have been large enough to impact MWs.[6] From 2007 to 2012, the size composition of MWs appears to have altered, see Table 2. There was a decline in the number of smallest and largest MWs, with a consolidation to more mid-sized companies. Of the small MWs, there was a decline in every size category except the largest (50 to 99 employees), which grew about 5%.[7] Of the large MWs, those with 100 to 249 and more than 1,000 employees shrink, while the middle categories grew. This could be the result of mainstream channels becoming more vertically integrated—supercenters, for example, may source their own produce without relying on a MW. FHs, rather, are predominantly small—only about 6% have more than 40 full-time employees (Fischer et al. 2013). The majority of FHs (75%) have 0-5 full-time employees (Fischer et al. 2013).

A Model of Food Hub Location and Profits

Our objective is to investigate the economic viability of FHs by comparing drivers of their profits and their break-even market sizes to those of conventional MWs. To achieve this, we adapt an entry-threshold model in the style of Bresnahan and Reiss (1991), henceforth B&R, and investigate the conditions under which FHs or MWs will find it profitable to set up business in a county, which types of counties foster an environment likely to lead to FH growth or

[6] Depending upon their primary revenue-generating activity, some FHs may be included in the counts of MWs. This is discussed in more detail in the 'Data and Variables' section.
[7] According to the Small Business Association (SBA), a "Fresh Fruit and Vegetable Merchant Wholesaler (NAICS 424480) is considered "small" if it has less than 100 employees (Cornell 2016).

profitability, and potential policy impacts on the local environment that are likely to lead to the introduction or growth of FHs that will remain viable in the long run.[8]

Since our objective requires comparing the location and profit drivers of two unique business models, we use the same metric to evaluate both: break-even market sizes. The break-even market size is the population necessary for each establishment to at least cover their variable costs and remain in business, even if they do not make a profit. The break-even market size for N establishments operating under business model i (i = FH or MW), S_{Ni}, is determined by both demand and cost considerations. We assume that the factors affecting an establishment's demand can be divided into those determining the size of the market, $\mathbf{Y_i}$, and per capita demand, $\mathbf{X_i}$. Under this specification, we allow that FHs and MWs may face different markets and per capita demands. Following B&R, we assume that total demand is given by $Q_i = d(\mathbf{X_i}, P_i)S(\mathbf{Y_i})$, where $d(\mathbf{X_i}, P_i)$ is the demand function of a representative consumer and $S(\mathbf{Y_i})$ is the number of potential consumers for each business model. On the cost side, we assume that FHs and MWs may incur different fixed costs, $F(\mathbf{Z_i})$, since many FHs establish with outside funding or grants. We also allow average variable costs, $c(q_i, \mathbf{W_i})$, to vary with the business model, as FHs and MWs may face different cost considerations. $\mathbf{Z_i}$ and $\mathbf{W_i}$ contain exogenous variables affecting fixed and variable costs for each business model i, respectively, and q_i represents output for each business model.

We assume that both FHs and MWs must at least break even upon entering a location.[9] Even though many FHs may not act under a for-profit motivation, in order to remain viable in

[8] Since the seminal entry work of B&R, there have been several extensions to their model with the aim of improving competition measures (e.g., Schaumans and Verboven 2015). However, even though data availability has increased dramatically for most industries since B&R's seminal work allowing for the estimation of more sophisticated models, this type of information is not available for FHs.
[9] This assumption may not hold for all FHs, especially if initiated by a pilot study. In order to overcome this potential limitation, we examine the 2012 demographic landscape, but use the number of FHs as of 2016. This will be discussed further in the Data and Variables section.

the long-run they must at least break even. Entry into a county occurs if total variable profits at least cover fixed costs (which may be low for FHs founded using grants or other outside funding). N establishments of each business model, i, earn profits given by

$$\pi_{Ni} = S_{Ni} d_{Ni} [P_{Ni} - c_{Ni}(q_{Ni}, \mathbf{W}_i)] - F_{Ni} = S_{Ni} V_{Ni}(P_{Ni}, q_{Ni}, \mathbf{X}_i, \mathbf{W}_i) - F_{Ni}(\mathbf{Z}_i) \quad (1)$$

where $P_{Ni} - c_{Ni}(q_{Ni}, \mathbf{W}_i)$ is the per-unit profit margin, $F_{Ni}(\mathbf{Z}_i)$ is fixed cost, and $d[P_{Ni} - c(q_{Ni}, \mathbf{W}_i)] = V_{Ni}(P_{Ni}, q_{Ni}, \mathbf{X}_i, \mathbf{W}_i)$ depicts per unit variable profit.

As more establishments enter, the portion of the market each establishment serves shrinks (as it becomes served by other establishments), making industry-wide variable profits decrease with N_i.[10] Also, successive entrants may face more costly barriers to entry than the first entrant faced. If entry in a county will result in an overall loss, meaning that the establishment cannot at least recapture costs, then it will not enter; that is, establishments will no longer enter the market when $\pi_{Ni} \geq 0$ and $\pi_{Ni+1} < 0$. Therefore, we use the break-even condition to determine the population required for N_i stores. Setting profits given by (1) equal to zero and solving for S_{Ni} yields

$$S_{Ni} = \frac{F_{Ni}(\mathbf{Z}_i)}{V_{Ni}(P_{Ni}, q_{Ni}, \mathbf{X}_i, \mathbf{W}_i)}, \quad (2)$$

which is the population N_i establishments must serve in order to cover costs and remain viable. A key contribution of this paper is that we use S_{Ni}, which is free of the scale properties characterizing the profit equation, to make comparisons between FHs and MWs; it further allows us a common metric to compare the influence of location characteristics on profits. That is, we can compare the magnitudes of location characteristics' influences to understand which have greater associations with profitable FHs or MWs.

[10] In the current specification, we do not allow MWs and FHs to influence each other's variable profits, which assumes their output is differentiated enough that they do not compete in the same space. A test for the validity of this assumption is discussed in the 'Empirical Results and Discussion' section.

Two such characteristics that we will explore here are social capital and local businesses. How these characteristics are associated with profits and population thresholds is an empirical issue we will discuss further below; here we allow for social capital to influence both fixed costs and variable profits. Let *k* be a measure of social capital in a location. Since social capital could potentially influence both fixed costs and variable profits, $k \in Z_i$ and $k \in X_i \cup W_i$. Therefore, suppressing function arguments, the effect of social capital on the population threshold, S_{Ni}, is given by

$$\frac{\partial S_{Ni}}{\partial k} = S_{Ni}\left(\frac{\partial F_{Ni} / F_{Ni}}{\partial k} - \frac{\partial V_{Ni} / V_{Ni}}{\partial k}\right) \tag{3}$$

which shows that social capital's influence on S_{Ni} can be decomposed into its effects on fixed costs and variable profits allowing us to examine the relative strength of each effect, which could be important for policy.

Local businesses can also present important policy options. Unlike social capital, we have no conceptual link between local businesses and fixed costs. Therefore, we allow local business to influence profits only through variable costs and per capita demand. The effect of local business, *b*, on break-even population thresholds is therefore given by

$$\frac{\partial S_{Ni}}{\partial b} = -\frac{\partial V_{Ni}}{\partial b} F_{Ni}, \tag{4}$$

which shows that the although the magnitude of the effect of *b* is gradated by F_{Ni}, the sign is completely determined by its effect on variable profits.

There is also some concern that FHs may cannibalize each other's sales and resources if multiple hubs establish in the same location. B&R develop a ratio to measure competitive effects of successive firms on monopoly profits, the per firm population thresholds ratio; we use the same ratio to understand how successive establishments influence the profits of all firms in the location. That is,

$$R_{Ni} = \frac{S_{Ni+1}/(N_i + 1)}{S_{Ni}/N_i} \qquad (5)$$

measures the per-establishment relative population necessary to support an additional firm. When this ratio is equal to one, it means that an additional store requires the same population to set-up as the first establishment. When this ratio is less than one, it means that each firm requires a smaller population to be profitable with an additional establishment; this would occur for industries in which positive location externalities are important. When this ratio is greater than one, it means that each firm would have to serve more than the population that one establishment would have to serve to be profitable; this would occur for industries in which additional firms cannibalize resources or sales.

The Empirical Model

We would like to estimate profits using data on prices and quantities; however, although much data on FHs has been collected by AMS and NGFN through serious efforts, data on prices paid and quantities sold are not available. Instead, we use the number of establishments, N_i, in a location to infer profitability, which means that our dependent variable is limited to discrete and finite values. Since we are using limited dependent variables, we can only estimate profits up to an arbitrary scale factor. To bring the model to data, we assume that profits are additively separable in a deterministic component and the unobservable error following B&R among others.[11] To estimate profits, we parameterize (1) and add an error term so that

$$\pi^*_{Ni} = S_{Ni}V_{Ni}(\mathbf{X}_i, \mathbf{W}_i, \alpha_i, \beta_i, \phi_i) - F_{Ni}(\mathbf{Z}_i, \lambda_i, \gamma_i) + \varepsilon_i \qquad (6)$$

where α_i, β_i, λ_i, ϕ_i, and γ_i are parameters, $\mathbf{X}_i$, $\mathbf{W}_i$, and $\mathbf{Z}_i$ are as described above, and ε_i are assumed to be independent and normally distributed. Note that π_{Ni} are per-firm profits, implying

[11] This assumption is typical of models of this types.

that all terms, including those representing unobservables, are the same for each establishment belonging to the same business model in the market.

FH and MW profits are not directly observed, so we treat them as latent variables empirically, and instead use the observed number establishments for each business model to infer the profitability of different locations. That is, if there is no firm in a location, we assume that the location is not profitable. Similarly, if we observe one firm in a location, we assume that it can be profitable for one firm, but not for two; and we continue this for three and four firms. Therefore, the probability that no firm will establish in a location is equal to

$$P(\pi_{1i} < 0) = 1 - \Phi(\pi^*_{1i}), \tag{7}$$

where $\Phi(\bullet)$ is the normal cumulative density function and π^*_{1i} is the profit of a single establishment, or N_i=1. Likewise the probability that N_i establishments will locate in an area is equal to

$$P(\pi_{Ni} \geq 0 \, \& \, \pi_{Ni+1} < 0) = \Phi(\pi^*_{Ni}) - \Phi(\pi^*_{Ni+1}). \tag{8}$$

The assumption that the unobservable portion of profit is distributed standard normally means that we can use an ordered probit for the estimation.

As mentioned above, both social capital, *k*, and local businesses, *b*, can influence variable profits. We assume that social capital enters V_{Ni} linearly to understand if there is evidence of at least a first-order effect; however, this assumption may be too restrictive for local businesses which may have both a number and size effect on FH and/or MW profits. For instance, the number of small farms selling direct may have different influences on FH and MW profits than the number of large farms selling direct. Therefore, we allow for local business' numbers, b_1, and sizes, b_2, to influence profits in a location.

Following B&R, we assume that V_{Ni} and F_{Ni} are linear in parameters and that all other elements of $\mathbf{X_i}$ and $\mathbf{W}_i$, excluding *k*, b_1 and b_2, belong to $\mathbf{U}_i$ so that,

$$V_{Ni} = \alpha_{1i} + \phi_1 b_1 + \phi_2 b_1 b_2 + \beta_k k + \mathbf{U}_i \,'\boldsymbol{\beta}_i - \sum_{n=2}^{N} \alpha_{ni}, \quad (9)$$

where the α_{ni} parameters ($n \geq 2$) show negative signs when per-establishment variable profits are lower for successive entrants. F_{Ni} is given by

$$F_{Ni} = \gamma_{1i} + \lambda_k k + \mathbf{Z}_i \,'\boldsymbol{\lambda}_i + \sum_{n=2}^{N} \gamma_{ni} \quad (10)$$

where the γ_{ni} capture the differences in fixed costs faced by successive firms. If barriers to entry or inefficiencies increase the costs of additional establishments, these parameters will be positive.

Our main objective is to compare profit drivers of FHs and MWs to learn how these entities differ and explore location characteristics associated with economically viable FHs. However, given that we do not directly observe profits, we can only estimate them up to a scale factor.

Using (9) and (11) we can estimate the empirical counterparts of (2), (3), (4), and (5).

Data and Methods

We estimate equation (5) separately and jointly for FHs and MWs using county-level data collected from publicly-available sources for one year, which encompasses 3,106 contiguous U.S. counties.

As discussed previously, FHs are identified by their values around local foods. As such, to our knowledge, there is no complete database with the number of FHs. Therefore, we rely on self-reported data from two sources to construct three measures of the number of FHs per county as of August 2016. We use data from 1) the Agricultural Marketing Service (AMS) and 2) the National Good Food Network (NGFN) to construct the number of 1) AMS FHs, 2) NGFN FHs, and 3) composite FHs. The AMS collects extensive data on FHs, including the county FIPS code, state FIPS code, and Zip code of their location.[12] Market managers are encouraged to list their business with the AMS as a form of advertisement. As of August 2016, the AMS included information on 170 FHs. The NGFN provides information on the name of the FH, a link to its website if available, and the city and state names of its location (NGFN 2016, 12). These were matched to county data by mapping the city and state names and recovering the FIPS code of the county to which the combination belonged. In cases where the combination did not belong to a unique county FIPS, only one of the county FIPS was assigned.[13] The NGFN asks visitors to the site to suggest FHs that may be missing from the list. As of August 2016, the NGFN included information on 296 FHs. Either one of these sources may underreport the number of FHs, especially if FH managers or owners self-report to only one site. Therefore, our third measure is constructed using both of these measures: composite FHs takes the value of whichever is larger, the AMS number of FHs or the NGFN number of FHs, by county. In this way, we expect to have a more comprehensive measure of FHs without double counting FHs that may be captured by both sources. Composite FHs reflects the presence of 369 FHs across all counties.

One goal of this article is to compare FHs to their conventional counterpart, MWs. Numbers and locations of MWs are available from the County Business Patterns Database (U.S. BLS 2012). The County Business Patterns Database provides information on nine groups of grocery and related product MWs (NAICS 4244): general line grocery, packaged frozen food, dairy product, poultry and poultry product, confectionery, fish and seafood, meat and meat product, fresh fruit and vegetable, and other grocery and related product. For data collection and analysis purposes, the County Business Patterns assigns each firm a unique NAICS code, which is based on the source activity of the majority of its revenue (US Bureau of Census 2016).

[12] County location was missing in three instances, these locations were recovered by matching Zip codes to counties.

[13] In most cases, the underlying county could be recovered by examining the address given by the FH's website. In the remaining cases, the FH was assigned randomly to one county that it matched.

Although FHs may participate in most of these activities, according to a national survey, 93% of FHs carry fresh produce and fresh produce comprises, on average, 68% of total gross sales, the highest grossing category by a large margin-- the second most grossing category of sales is "meat and poultry" at 21% (Fisher et al 2013). Therefore, in order to make the most relevant comparison to FHs, we use the number of NAICS 424480 "Fresh fruit and vegetable merchant wholesalers" to measure MW presence.[14]

The number of MW per county, N_{MW}, can reach large values and most of the information on the number of FHs per county, N_{FH}, is concentrated between 0 and 3. Therefore, for our baseline specification involving the first two definitions of FHs, we allow the dependent variables N_i^* to be equal to the establishment counts if N_i is between 0 and 3, after which it takes the value of 4 for all counties that have 4 or more establishments. This will allow us to measure market sizes for 1, 2, and 3 establishments, which given the small number of FHs, allows us to make the most relevant comparisons between FHs and MWs. In a subsequent specification, we restrict the values of N_i^* further to be equal to actual establishment counts for values between 0 and 2, and to take the value of 3 for all counties that have 3 or more establishments. This allows us to investigate FH locations relying solely upon the AMS data; however we can only calculate market sizes for 1 and 2 establishments.

A key independent variable is total county population (*POP*) from the U.S. Census Bureau Population Estimates Program (PEP), which is used as a proxy for market size and is multiplied by all the variables belonging to the variable profit equation (8), consistent with our specification of equation (5). Other key variables in our model are those used to assess the economic viability of FHs. Fresh produce from local farms is important for FH success,

[14] In referencing the "conventional produce aggregation and distribution sectors," Wholesome Wave (2014) also utilizes NAICS code 424480.

therefore, we include the per capita number of farms selling direct (*pc_dsfarms*), per county and the per capita value of products sold directly from farms (*pc_dirsales*) to proxy for the size of farms selling direct per county from the National Agricultural Statistics Service (NASS) of the USDA's 2012 Census of Agriculture. The value of products sold directly to individuals for human consumption is defined as "the value of agricultural products produced and sold directly to individuals for human consumption from roadside stands, farmers' markets, pick-your-own sites, etc.…" (Census of Agriculture 2012, Appendix B). The Census of Agriculture suppresses direct sales data that could lead to disclosure of private information. We estimate these suppressed data by summing all direct sales across all counties in a state, comparing this sum to the state total, and then dividing the excess state sales equally among all farms for each county with suppressed data. We would expect that many, but smaller local farms selling direct would positively influence FHs' variable profits while larger farms may have a greater variety of cost-effective options to get their produce to final consumers.

The value-driven nature of FHs also makes social capital integral for their advancement. For example, a national survey reveals that 49% of FHs listed their inability to increase staff as a barrier to growth and indicated that some FHs rely on volunteers to comprise 11 – 13% of their staff. In order to capture social capital differences across counties, we use the 2009 social capital index (*sk09_0100*) from the Northeast Regional Center for Rural Development at The Pennsylvania State University (Rupasingha et al. 2006). This variable is constructed from four indicators of social capital: an aggregate of community involvement, voter turnout, census response rate, and number of non-profit organizations (excluding those with international approaches), using principal component analysis.[15] We rescaled social capital to range from 0

[15] Community involvement is an aggregate of religious organizations, civic and social organizations, business associations, political organizations, professional organizations, labor organizations, bowling centers, physical fitness centers, public golf courses, and sports clubs, managers, and promoters.

(the county with the least social capital) to 100 (the county with the most social capital observed in the data).

Local businesses are also important for FH success. We hypothesize that the size of local businesses may be influential to their effect on FHs' profitability. For example, larger chain restaurants may be more constrained in their buying choices and operate under different business philosophies than smaller, locally-owned establishments. In our baseline specification we include per capita number of establishments (*pc_est**) and per capita number of employees (*pc_emp**) to proxy for size of establishment for several local businesses collected from the County Business Patterns Database: supermarkets and other grocery stores (NAICS 445110); colleges, universities, and professional schools (NAICS 6113); community food services (NAICS 624210); full-service restaurants (NAICS 722511); and mobile food services (NAICS 722330). We also include the number of supercenters and club stores (NAICS 452910), however we do not include a size proxy for supercenters and club stores because these stores are not much differentiated by size.[16]

To control for other factors that may influence variable profits, we also included median per-capita income in $1,000 (*pcinc*) from the U.S. Bureau of Census Small Area Income and Poverty Estimates (SAIPE), share of Supplemental Nutrition Assistance Program (SNAP) participants (*shsnap*) from SAIPE, share of Black population (*shblack*) from PEP, share of Hispanic population (*shhisp*) from PEP, share of population 25+ with some college (*somecollege_sh*) from PEP, share of population 25+ with at least a bachelor's degree

[16] In subsequent specifications at times we included: baked goods stores (NAICS 445291); convenience stores (NAICS 445120); fruit and vegetable markets (NAICS 445230); elementary and secondary schools (NAICS 6111); food services and drinking places (NAICS 722); limited-service restaurants (NAICS 722513); cafeterias, grill buffets, and buffets (NAICS 722514); snack and nonalcoholic beverage bars (NAICS 722515); caterers (NAICS 722320); food service contractors (NAICS 722310); hospitals (NAICS 622); continuing care retirement communities (NAICS 623311); assisted living facilities for the elderly (NAICS 623312); and/or nursing care facilities (NAICS 623110).

(*gebachelor_sh*) from PEP, and the state-level commercial electricity price in cents per Kwh (*elec_pr*) from the U.S. Department of Energy.

Key variables included in the fixed costs are fruit and vegetable production and imports and the home price index. Fruit and vegetable production in and imports into the county are used to understand the effect of fresh produce general availability. We rely on data collected and estimated by Ge et al. (2015) to proxy for fruit and vegetable production and imports per county (*fv_pro*).[17] The home price index (*HPI*) from the Lincoln Institute of Land Policy is based on adjusted Federal Housing Finance Agency (FHFA) quarterly repeat-sales (constant quality) house prices and provides a proxy for building costs.

We allow our model to capture differences in variable profits and fixed costs across areas showing different levels of urbanization by using indicator variables for counties that are classified as Metropolitan (*metro*), and Non-Metro Metro Adjacent (*rma*), obtained using the 2013 Rural-Urban Continuum Codes (RUCCs) from the Economic Research Service of the U.S. Department of Agriculture.[18] Lastly, we capture regional variation in variable profits and fixed costs, respectively, including regional fixed-effects for the Northeast (*northe*), Midwest (*midw*), and West (*west*) in equations (8) and (10).

A summary of all the variables used in the estimation, along with the distribution of our dependent variable across the U.S. and for counties with at least one MW, composite FH, NGFN FH, and AMS FH are provided in Table 3.

[17] These authors use data from NASS USDA 2007 Census of Agriculture for 37 (43) states, 21 (34) fresh market vegetable commodities (fresh fruit and berry crops), and overcome data suppressions utilizing a constrained maximum likelihood mathematical programming model. This model is estimated simultaneously for state and county to produce maximum likelihood estimates of all suppressed county harvested acreage statistics. Fruit and vegetables are summed after conversion to a common unit (1,000 lbs).

[18] Metropolitan counties are those belonging to RUCCs 1 to 3; Non-metro Metro Adjacent counties belong to RUCCs 4, 6, and 8, Non-metro Not Metro adjacent counties are RUCCs 5, 7, and 9.

It is interesting to note that while nearly 25% of counties have a MW, FHs are only in about 5-10% of counties, depending upon the data used to measure the number of FHs. Also, even though FHs have a greater relative presence in non-metro counties than MWs, the mean population in counties with at least one FH is larger than those counties with a MW.

The social capital index ranges from 0 to 100, with a mean across all counties of 18.33 signifying that those counties with very high amounts of social capital are few. MWs are located in counties with a mean social capital index of 16.24. It is interesting to note that, independent of how we measure FHs, FHs are located in counties with a higher mean social capital index than MWs, but a lower mean social capital index than the average county. This could point to the possibility of FH growth. The distribution of social capital across metro and non-metro areas is also interesting: about 87.7% of counties in the top 5% of social capital are located in completely rural areas (RUCCs 8 and 9). This coupled with FHs relatively larger (versus MWs) presence is non-metro areas may point to FHs being positioned to increase fruit and vegetable availability in rural areas by leveraging the relatively high social capital there.

The average per capita number of farms selling direct as well as the average per capita direct sales from farms are greater in counties that have at least one FH versus counties with at least one MW, however, both are lower than the national average. Conversely, fruit and vegetable production and imports is larger than average in counties that have a MW or FH, however, in counties with MWs this value is larger than counties with FHs.

Moreover, the per capita income in counties with at least one FH is greater and the share of SNAP participants lower than the average across all counties. It also appears that FHs, as well as MWs, are located in counties with more diversity (*shblack* and *shhisp*) than the average U.S. county; although this could be due to most MWs and FHs locating in more metro areas, where populations are more diverse.

Equation (5) is estimated by maximum likelihood using Stata 14's `oprobit` command. Due to the high number of counties with zero FHs and/or zero MWs, we estimate a first stage equation determining the likelihood of observing an establishment in a county and from this, we generate an Inverse Mills Ratio (IMR) to be included in the second stage (equation 6) as an additional control in order to accommodate selection bias (Greene and Hensher, 2009), following Wynand and van Praag (1981) among others. Results of the first stage regressions are available upon request.

Empirical Results and Discussion

Model validation

As discussed previously, we cannot rule out that some of the FHs collected via NGFN and AMS are not also represented in the County Business Patterns data on MWs. In order to test if conventional MWs and FHs are profit-dependent, we estimated equation (5) for each establishment type in a system by bivariate ordered probit and then tested for independence. The likelihood ratio test of independent equations fails to reject the null hypothesis that the profits of each establishment type are independent with a chi-squared, with one degree of freedom, test value of 1.03 and a p-value of 0.3099. Therefore, we conclude that each is properly estimated independently and the remaining discussion will refer to the statistically-preferred, independent specification.

Results

The estimated parameters of equation (5) for the baseline model (N_i^* up to 3) are presented in Table 4 along with standard errors and Maddala's Pseudo R^2. The model fits the data relatively well, with a pseudo R^2 of 32.4% for the composite FH measure and 39.8% for MWs.

As exemplified in equation 9, the estimated parameters can be directly interpreted as the variable's effect on profits, although arbitrarily scaled. We will first qualitatively compare the coefficients of the composite FH profit equation to those of the MWs. Then we will discuss estimated population thresholds, population threshold ratios, and the effects of social capital and local businesses on population thresholds.

One of the key variables comprising variable profits is population. The coefficient on population reflects the effect of a change in population on profitability; it can also be structurally interpreted via its role as α_1, which is a component of the variable profits when a single establishment locates in a county, independent of other demand and cost considerations.[19] For MWs and FHs the coefficient on population is positive and significant. α_{i2} and α_{i3} show how variable profits change when subsequent establishments enter a county. For FHs, α_{i2} and α_{i3} are positive and significant at the 1% level, indicating that establishment of successive FHs reduce each FH's profits. Although the alphas allow some insight into inter firm behavior, the population threshold ratios offer more because they are not scaled by an unknown factor and will be discussed in more depth later.

Social capital is associated with increases in FH variable profits and has no statistically significant effect on the profits of MW. It could be that counties with higher social capital also have residents who value FHs or shop for the local foods that the FH in their area provides. However, it could also be that counties with higher social capital index have a population more likely to engage in volunteer work, which would decrease FH variable costs (thus increasing variable profits). A national survey of FHs found that 49% responded that inability to increase their staff was a barrier to growth (Fischer et al. 2013). We also allow social capital to influence

[19] Since the α_{ni} of subsequent entrants are subtracted from profits, α_{1i} is a component of the maximum possible profits, ceteris paribus.

fixed costs. In the fixed costs component of the profit function, the coefficient on social capital for composite FHs is 0.014 and is not significant at the 10% level, indicating that social capital may have little effect effect on FH profitability or that the effect is too small to capture given the data.

County per capita income is negatively associated with FH and MW profits.[20] It could be that resources for these establishments are relatively cheaper in poorer locations. For FHs, this could reflect that FHs locate in relatively poorer areas in order to fulfill their missions, which include non-profit motivations such as expanding access to fresh foods in underserved areas (Barham el al. 2012). For example, in a national survey of FH value themes, 22% included "food access," 20% included "local economy," and 14% included "justice and/or equity" (Fischer et al. 2013).

The coefficient on the share of SNAP recipients is negative and significant for FHs and not significant for MWs. This, again, could point to the different missions pursued by the mostly profit-seeking MWs and the value-driven FHs. MWs do not directly sell to the public and their place in the channel may preclude them from experiencing a measurable effect from SNAP consumers. Conversely, selling to SNAP participants fulfills values such as improving food access, justice, and equality. Because some FHs target SNAP consumers (Barham et al. 2012), it appears counterintuitive that as the share of SNAP recipients in a county increases, FH profits decrease. However, according to a national survey of FHs, of those FHs that accept SNAP benefits, 22% are highly dependent and 39% are somewhat dependent on outside funding to remain in business (Fischer et al. 2013). Likewise, of those FHs offering matching programs for

[20] Per capita income entered the profit equation as level and squared, allowing income to have a U-shaped effect on profits. Although we do find evidence to support the U-shape effect of income (both the coefficient of per capita income and per capita income square are statistically significant at the 1% level), only 35 counties (about 1.1% of the observations) are past the inflection point to experience a positive effect from per capita income. Even though it appears that most of our data are subject only to the level effect, we find evidence of omitted variable bias when the squared term is not included.

SNAP dollars, 36% are highly dependent and 36% are somewhat dependent on outside funding.[21] In order to become more profitable, FHs could refrain from accepting or matching SNAP benefits, however such a change will run counter to several FH values.

FHs rely on providers of local fruits and vegetables. Direct sales from farms may compete with FHs or may act as a proxy for the types of farms that are also likely to use FHs to distribute their products. However, the value of direct sales does not have a statistically significant effect on FH profits. Conversely, the number of farms selling direct positively impacts FH variable profits. The opposite pattern is found for WMs. These establishments are positively influenced by the value of direct sales from farms and are not significantly influenced by the number of farms selling direct. Different from our FH explanation, with 753 counties hosting 4,797 MWs across the U.S., it is unlikely that the effect is too small to identify with the current number of observations. Barham et al. (2012, 6) note that "wholesale buyers often find it too costly to purchase products directly from numerous farms." Moreover, farms that have a lot of direct sales are the same farms that have a lot of sales through other channels as well, thus lowering MWs' variable costs (and increasing variable profits).

We also allow for a size effect of full-service restaurants. While neither the number nor the size of full-service restaurants has a significant impact on MW profitability, both have a significant impact on the profitability of FHs. The coefficient on the per capita number of full-service restaurants is positive while the coefficient on the per capita number of employees in full-service restaurants is negative. This signifies that full-service restaurants have a positive impact on FH profits that decreases with the size of the restaurant. This suggests that profitable FHs locate in areas with smaller and many restaurants.

[21] In comparison, of all FHs, 17% report being highly dependent and 32% somewhat dependent on outside funding to remain in business.

We find a positive coefficient on the per capita number of mobile food service and a negative coefficient on the per capita number of employees of mobile food service, indicating that FHs can increase profitability by serving counties with more and smaller mobile food services.

We also looked at the effect of the number and size of community food services. The County Business Patterns Database classifies businesses like Food Banks and "Meals on Wheels" as community food services. We find no statistically significant effect of community food services on the profits of MWs or FHs.

We find no significant effect on presence or size of traditional supermarket and other grocery stores on FH profits. It could be that the effect is too small for the current number of observations with positive numbers of FHs to accurately capture. However, we do find a positive and statistically significant coefficient on number of grocery stores for MWs. The presence of supercenters and club stores is also not statistically significant for either FHs or MWs.

As well as local businesses, we included demographics of final consumers in our variable profits specification. The share of the population that is black has a positive and significant influence on FH profits and no significant effect on the profits of MWs. A recent ERS report found that "non-Hispanic blacks were the only racial/ethnic group to increase whole fruit and total fruit consumption between 1994-98 and 2007-8" (Lin and Morrison 2016, 4). Perhaps this group is also increasingly consuming fruit from local sources. The share of the population that is Hispanic is positively associated with both MW and FH profits. This finding confirms the profound importance of Hispanic workers in the U.S. agricultural labor force. While education has no effect on the profits of MWs, locating in counties with more educated individuals does increase the variable profits of FHs, which resonates with a recent finding of Handbury, Rahkovsky and Schnell (2015) relating level of education with healthier food choices.

Given that produce needs to be refrigerated, we also included the electricity price as a variable cost. The coefficient on electricity price is negative and significant, as expected, for MWs and FHs.

The coefficients on variables composing the fixed costs can be structurally interpreted as the effect of the variable on the fixed costs of the firm. In addition to social capital, which was discussed above, the fixed cost variables also include the HPI as a proxy for relative building costs. The HPI negatively influences MWs' profits (by increasing fixed costs) but only has a marginally significant effect on the profits of FHs. 70% of FHs use some sort of physical space or assets to conduct business (e.g., office space, warehouse, processing facilities, retail space, etc.) (Fischer et al. 2013). However, an indicator of the price of these spaces, HPI, was not found to have a negative effect on FH profits. 40% of FHs' primary funding sources were foundation grants and 41% relied on donations from individuals (Fischer et al. 2013), which they may have used to offset the cost of their physical space.[22]

To determine the robustness of these results we also used only NGFN FHs as a dependent variable. Although we find quantitative differences, the qualitative results remain the same. Moreover, we also used only the AMS FHs as a dependent variable. Since there are fewer FHs reported in those data, we restricted the dependent variable only to take up to three values, as explained previously. Again, although quantitative differences arise, the qualitative results remain the same.

[22] FHs also reported that payments toward facility space are only 4% of their revenue, while employees' salaries and benefits and food and/or product purchase are much greater at 23% and 61% of revenue, respectively, (Fischer et al. 2013). Even though these are operational expenses and are better compared to variable profits, they may point to FHs relying on outside funding to begin FH operations.

Break-even Market Sizes

A central goal of this paper is to understand the minimum county population required to support a viable FH. We are able to estimate this metric using the empirical equivalent to equation 2. Table 6 reports the market sizes (in thousands of people) necessary for composite FHs, NGFN FHs, AMS FHs, and MWs to break-even in a county. Population thresholds are measured using the results from the base line model for 1, 2, and 3 establishments and using the restricted dependent variable model for 1 and 2 establishments.

Using results from our baseline model and the composite measure of FHs, we estimate that a county seeking to establish a FH should have a population of about 182,660 for that FH to be viable. Moreover, for a county to sustain two FHs, about 2.75 times the population is required, about 502,880 residents, for all FHs to at least break-even. When the third FH enters the threshold is a little over three times as big as that for two FHs. These findings are qualitative similar when only FHs collected from the NGFN are used to estimate the break-even populations.

In contrast, MWs need only 105,380 people in a county for the first MW to be viable and the second requires just about 1.8 times that population for both to be viable. Indeed, to support three MWs in a county, the population is less than that to support only two FHs: 342,440.

Using results from the model further restricting the dependent variable yields slightly higher break-even market sizes for MWs, composite FHs, and NGFN FHs. Under the further restricted dependent variable specification, we can also estimate break-even market sizes using only the FHs in the AMS data. These estimates are substantially larger than those using the composite FHs or NGFN FHs. Using only the AMS FHs, we estimate that about 206,150 county residents are required to support one FH. The estimate for the population needed to support two FHs is not statistically significant is about 608,450.

Population Threshold Ratios

Table 7 reports the per firm population threshold ratios described in equation 5. All population threshold ratios are statistically different from zero, and more importantly, from one, suggesting that neither MWs nor FHs are competitive. The population threshold ratio comparing 2 establishments to 1 is 0.89 for MWs, signifying that a single firm requires only 89% of residents/firm to profitably support it than if there were two firms. Likewise, two MW in a location require about 21% fewer residents/firm than if there were three firms. Conversely, the population threshold ratio comparing 2 establishments to 1 is 1.38 for FHs, signifying that a single firm requires about 38% fewer residents/firm to profitably support it than if there were two firms. Two FH in a location require about 121% fewer residents/firm than if there were three firms. Requiring more than a double population to sustain each firm can indicate that successive FHs cannibalize sales and/or resources.

Social capital

As discussed above, social capital can be important for FHs and there is not statistical evidence that it is important to MWs. Table 8 shows the changes in the break-even population thresholds associated with social capital. We find no statistically significant effect of social capital for MWs. However, a 1 percentage point increase in social capital is associated with a 3,740, or 2.05%, decrease in the population threshold for the first FH. Its relationship with the population to sustain 2 food hubs is similar: reducing the threshold by about 2.15%; however, there is no statistically significant relationship with the third threshold. This suggests that policies aiming to increase social capital may also have a beneficial impact on FHs, for at least up to two FHs; for example, offering support to professional or business organizations.

Local businesses

We also estimate the changes in the break-even population threshold for one establishment linked with local business presence. We find that different types and sizes of business are linked with profitable MWs than with profitable FHs.

Interestingly, we find that large farms selling direct are linked with lower population thresholds for MWs, by about 2,850, but have no statistically significant effect on FHs. Conversely, small farms selling direct are linked with lower population thresholds for FHs, by about 700 people, but have no statistical effect on MWs, indicating the presence of smaller farms being more beneficial to FHs. In 2008, small farms comprised 81% of all farms reporting local food sales (Low and Vogel 2011). It could also signify that more farms can provide a diversity of local produce, thereby enriching FHs' supply. About 37% of FHs listed "balancing supply and demand" as the greatest challenge they face and 14% listed it as their second greatest challenge, according to a national FH survey (Fischer et al. 2013). It is possible that a greater number of farms selling direct aids FHs to balance inventory with customer demands. Moreover, FHs appear to have an intricate and synergistic relationship with farms. While FHs buy local produce from farms (among other channels), FHs can also supply Community Supported Agricultural (CSA) efforts, farmers markets, and mobile retail units (Fischer et al. 2013), all of which can be counted as farms' direct sales (Census of Agriculture 2012, Appendix B). Viewed from this perspective, the number of farms selling direct may have a positive effect on FHs' variable profits by increasing their customer base.

Grocery stores and supermarkets of any size are linked with lower thresholds, and therefore more profits, for MWs, but are not statistically significant for FHs. Interestingly, average and small sized grocery stores and supermarkets have a larger effect than large ones for

MWs. 27% of FHs sell to traditional grocery stores or supercenters making up, on average, 29% of total gross sales (Fischer et al. 2013); however we find that FHs locating in counties with these stores may not be more profitable.

Some FHs listed that there are expansion opportunities with elderly care programs, for example, retirement communities (Fischer et al. 2013). However, our estimates suggest that assisted living facilities for the elderly are actually associated with an increase in population thresholds. That is, FHs locating in counties with assisted living facilities require a larger population to be economically viable.

Community food services, such as “Meals on Wheels” were also listed as growth opportunities for FHs (Fischer et al. 2013). We find the smallest and average size community food services are linked with profitable FHs, but the largest have no statistically significant effect.

We also looked at relationships by size for full-service restaurants. We find that small and average sized restaurants are associated with lower population thresholds for FHs, but have no statistical link with MWs. We also find that FHs that locate in counties with large full-service restaurants require a larger population to remain viable. 58% of FHs sell to restaurants, caterers, or bakeries, to generate, on average, 33% of their total gross sales (Fischer et al. 2013), which provides evidence of a potential causal mechanism for our finding.

Whereas a majority of FHs already sell to restaurants, only 6% sell to mobile retail units, comprising, on average, 14% of their total gross sales (Fisher et al. 2013). We find that mobile food services of all sizes are positively linked with FH profitability, however, smaller and average sized mobile food services are associated with lower population thresholds than larger ones. Moreover, the threshold effects of the mobile food services are about 33 times larger than those of full-service restaurants, meaning that the FH-profit-driving effect of mobile food service is stronger than that of full-service restaurants. Mobile food service does not have a significant effect on MWs' profits.

Conclusions

We examined the profit-drivers and profitability of FHs on a national scale to determine how they compare with conventional MWs and what attributes of communities are associated with their business success. We found that social capital plays unique roles for FHs that are not present for MW and may provide an advantage for long-run FH success. Another key result is that when more than one FH locates in a county, cannibalization of local food sales can occur. Policies supporting new FH establishments may want to support successive entrants that are differentiated from incumbents. To this end, there has been growing interest in branding to help consumers know where their food comes from by using producer profiles to accurately identify local foods; however, as product volumes increase and come from a greater number of farms, accurate identification may be intractable (Woods et al. 2013). FHs may be positioned to aid in this by developing their own brand, which could also increase differentiation and limit cannibalization.

To our knowledge, this is the first analysis of FH profitability on a national scale. However, our analysis is limited by the self-reported nature of the data, which in a comparison of sources, reveals that these may not be comprehensive or complete. Our results will reflect the bias of the underlying data, if any.

Also, some FHs may be included in the number of MWs and therefore may bias that as a means of comparison. Last, we also do not capture wages or employees (as they may be endogenous), but these encompass some of the greatest expenditures of FHs and may represent important costs excluded from our analysis. FHs may serve more than the population solely within their own county. However, our current analysis does not account for this. This should be explored in future work.

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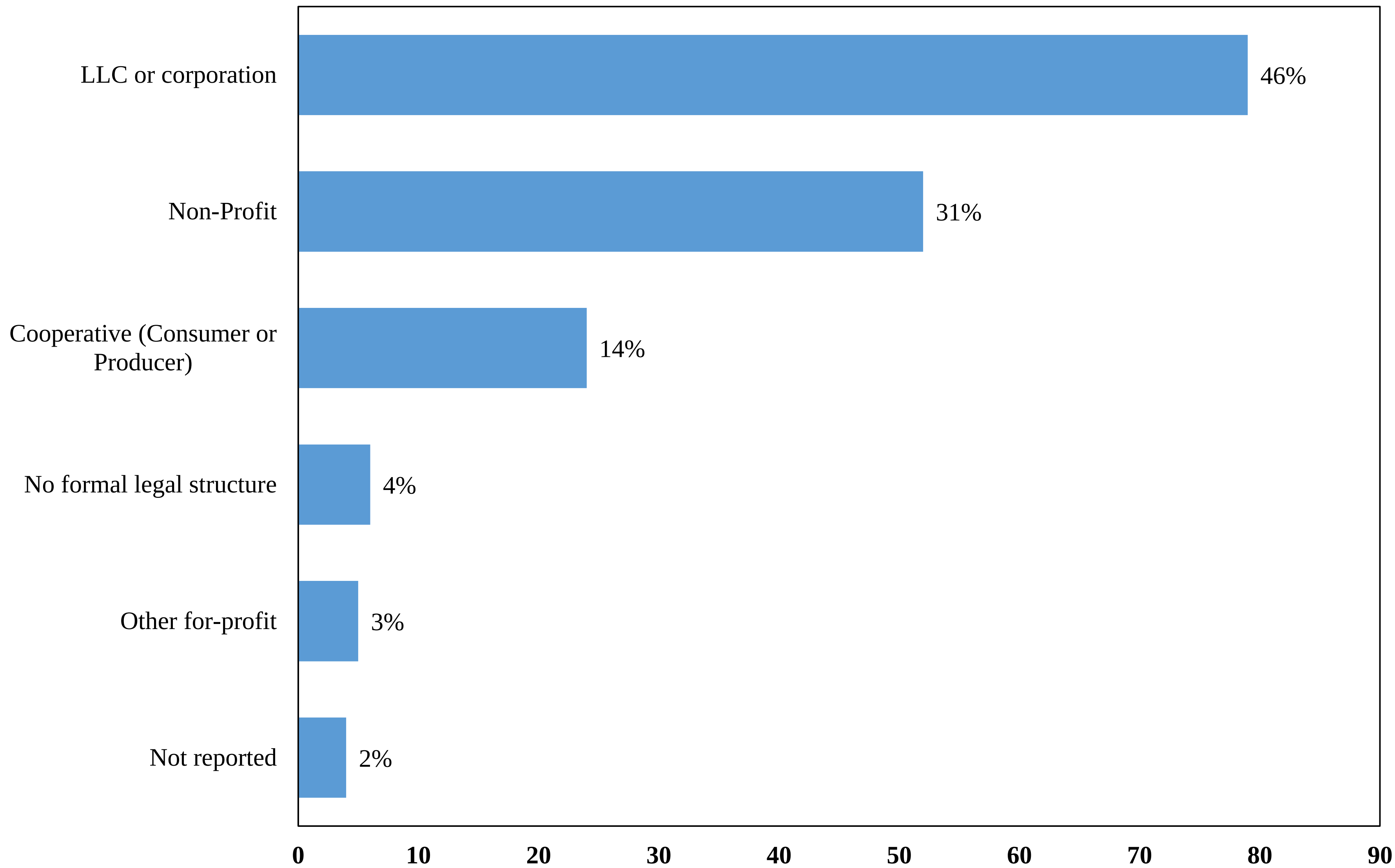
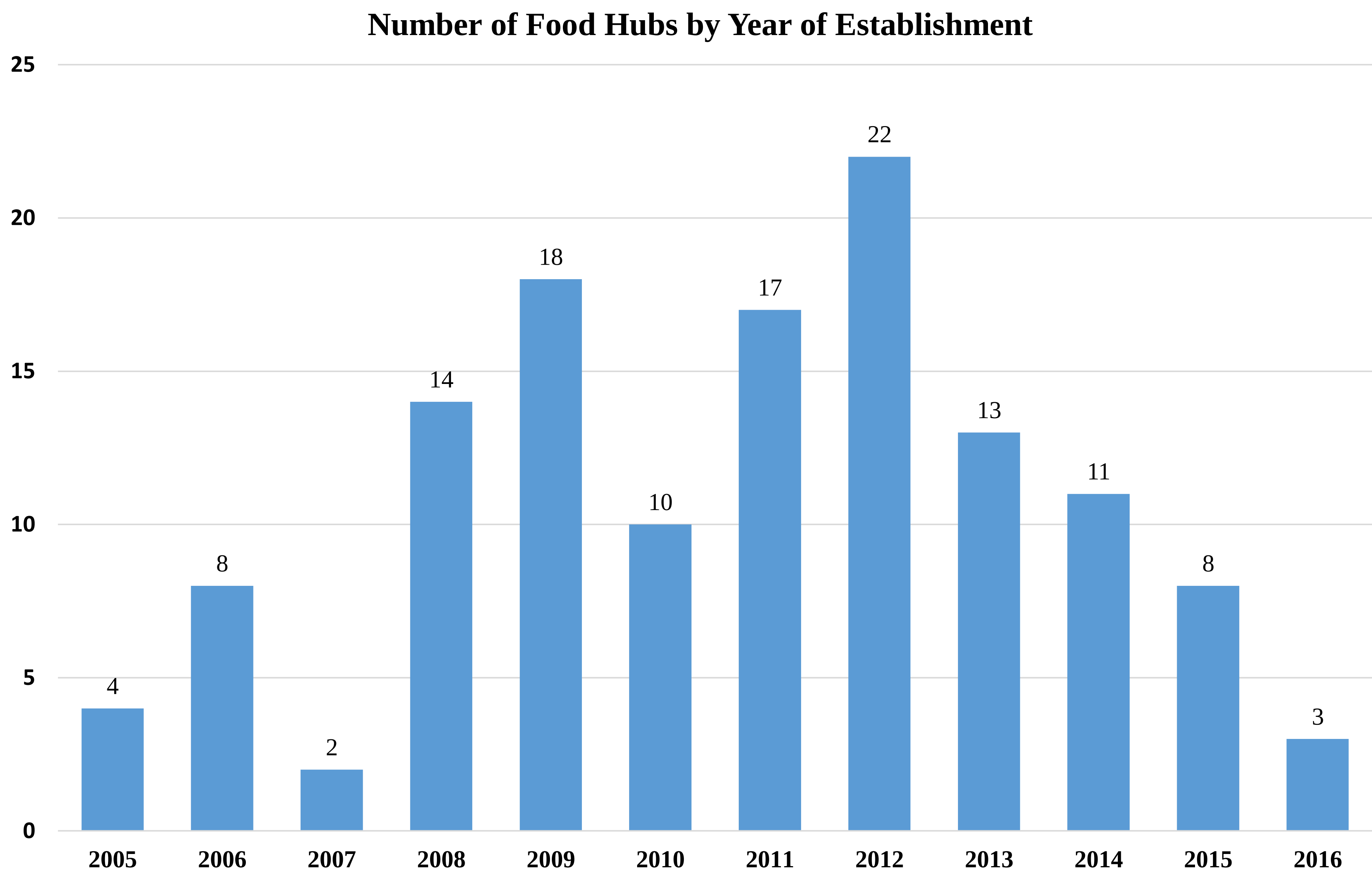
Number of Food Hubs By Legal Status



Source: Authors' elaboration using data from USDA, Agricultural Marketing Service, "Local Food Directories: Food Hub Directory". Downloaded from https://www.ams.usda.gov/local-food-directories/foodhubs on September 9, 2016.



Note: According to the AMS data, 75% of Foods Hubs established post-2004. The earliest reported year of establishment for a Food Hub was 1919. A total of 170 Food Hubs are included in the AMS data.

Source: Authors' elaboration using USDA, Agricultural Marketing Service, "Local Food Directories: Food Hub Directory". Downloaded from https://www.ams.usda.gov/local-food-directories/foodhubs on September 9, 2016.

Table 1. U.S. Fruit & Vegetable Merchant Wholesalers and Food Hubs by Location

Description	Fruit & Vegetable Merchant Wholesalers[1]		Aggregate of Food Hubs[a]		NGFN Food Hubs[2]		AMS Food Hubs[3]	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
All establishments	4797	100.00%	369	100.00%	296	100.00%	169	100.00%
Northeast	1082	22.56%	84	22.76%	72	24.32%	38	22.49%
Midwest	585	12.20%	86	23.31%	71	23.99%	38	22.49%
West	1673	34.88%	78	21.14%	64	21.62%	34	20.12%
South	1451	30.25%	119	32.25%	89	30.07%	57	33.73%
Metro areas	**4347**	**90.62%**	**259**	**70.19%**	**204**	**68.92%**	**124**	**73.37%**
Counties in metro areas of 1 million population or more	3042	63.41%	140	37.94%	112	37.84%	76	44.97%
Counties in metro areas of 250,000 to 1 million population	998	20.80%	78	21.14%	61	20.61%	34	20.12%
Counties in metro areas of fewer than 250,000 population	307	6.40%	41	11.11%	31	10.47%	14	8.28%
Non-metro, metro adjacent	**321**	**6.69%**	**86**	**23.31%**	**72**	**24.32%**	**35**	**20.71%**
Urban population of 20,000 or more, adjacent to a metro area	173	3.61%	30	8.13%	28	9.46%	12	7.10%
Urban population of 2,500 to 19,999, adjacent to a metro area	135	2.81%	46	12.47%	36	12.16%	19	11.24%
Completely rural or less than 2,500 urban population, adjacent to a metro area	13	0.27%	10	2.71%	8	2.70%	4	2.37%
Non-metro, non-metro adjacent	**129**	**2.69%**	**24**	**6.50%**	**20**	**6.76%**	**10**	**5.92%**
Urban population of 20,000 or more, not adjacent to a metro area	44	0.92%	6	1.63%	5	1.69%	1	0.59%
Urban population of 2,500 to 19,999, not adjacent to a metro area	69	1.44%	16	4.34%	14	4.73%	8	4.73%
Completely rural or less than 2,500 urban population, not adjacent to a metro area	16	0.33%	2	0.54%	1	0.34%	1	0.59%

Note:

a The aggregate of food hubs combines the number of NGFN food hubs and AMS food hubs in the following manner: by county, it takes the value of whichever is larger.

Sources:

1 County Business Patterns, NAICS Code "424480", 2012.

2 National Good Food Network, "US Food Hubs - Map." Downloaded from http://ngfn.org/resources/food-hubs/food-hubs#section-10 on August 31, 2016.

3 USDA, Agricultural Marketing Service, "Local Food Directories: Food Hub Directory". Downloaded from https://www.ams.usda.gov/local-food-directories/foodhubs on September 9, 2016.

Table 2. U.S. Fruit & Vegetable Merchant Wholesalers by Size

	2012		2007		2007 to 2012
Description	**Number of Establishments**	**Percent of Establishments**	**Number of Establishments**	**Percent of Establishments**	**Percent Change**
All establishments	4797	100.00%	4950	100.00%	-3.09%
Small (<100 employees)	**4592**	**95.73%**	**4716**	**95.27%**	**-2.63%**
1 to 4 employees	2138	44.57%	2180	44.04%	-1.93%
5 to 9 employees	844	17.59%	889	17.96%	-5.06%
10 to 19 employees	707	14.74%	749	15.13%	-5.61%
20 to 49 employees	633	13.20%	641	12.95%	-1.25%
50 to 99 employees	270	5.63%	257	5.19%	5.06%
Large (>100 employees)	**205**	**4.27%**	**234**	**4.73%**	**-12.39%**
100 to 249 employees	152	3.17%	196	3.96%	-22.45%
250 to 499 employees	45	0.94%	35	0.71%	28.57%
500 to 999 employees	7	0.15%	1	0.02%	600.00%
> 1000 employees	1	0.02%	2	0.04%	-50.00%

Source: County Business Patterns, NAICS Code "424480", 2012 and 2007.

Table 3. Summary Statistics for Counties with Fruit and Vegetable Merchant Wholesalers and Food Hubs

		Across U.S.		Merchant Wholesalers		Aggregate Hubs		NGFN Hubs		AMS Hubs	
Number of Observations (counties)		3106		753		281		221		139	
Variable Description	**Variable**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**
Counties with 0 establishments	N=0			2353		2825		2885		2967	
Counties with 1 establishments	N=1			361		222		172		118	
Counties with 2 establishments	N=2			117		41		32		18	
Counties with 3 establishments	N=3			66		12		11		1	
Population (in $1,000s)	POP	99.53	317.82	306.65	594.64	401.04	847.65	443.14	930.82	404.27	682.30
Income, per capita	pcinc	44.71	11.32	49.44	13.23	50.14	12.49	50.62	12.70	50.14	12.44
Income, per capita squared	pcinc2	2126.78	1233.46	2619.35	1581.32	2669.81	1562.04	2723.21	1619.15	2667.51	1496.19
SNAP participants, share	shsnap	16.06	8.03	16.02	6.74	15.15	5.95	14.95	5.91	15.48	5.94
Black, population share	shblack	9.22	14.55	11.13	13.55	11.13	14.52	10.71	13.76	11.58	15.28
Hispanic, population share	shhisp	8.68	13.38	12.16	14.63	10.24	12.78	10.21	12.81	10.60	12.52
Some college, population share 25+	somecollege_sh	30.05	5.21	30.13	4.81	29.48	4.74	29.27	4.64	29.50	5.06
Bachelor's or higher, population share 25+	gebachelor_sh	20.06	8.91	25.64	10.34	28.40	10.60	29.12	10.55	28.23	10.69
Commerical electricity price	elec_pr	9.06	1.64	9.94	2.22	10.20	2.40	10.30	2.47	10.08	2.36
Social capital index	sk09_0100	18.34	6.25	16.24	4.04	17.50	4.05	17.50	3.77	17.60	4.22
Direct sales from farms, per capita	pc_dirsales	8.39	14.01	7.76	13.47	10.61	15.62	11.44	16.06	10.20	16.89
Farms selling direct, per capita	pc_dsfarms	1.34	1.33	0.82	0.94	1.14	1.36	1.19	1.41	1.15	1.48
Supermarkets and other grocery stores, per capita	pc_est445110	0.25	0.20	0.20	0.11	0.21	0.11	0.22	0.11	0.22	0.11
Employees of supermarkets and other grocery, per capita	pc_emp445110	8.15	4.54	9.04	3.88	9.74	3.78	9.97	3.97	9.55	3.55
Assisted living facilities for the ederly, per capita	pc_est623312	0.06	0.08	0.06	0.06	0.07	0.06	0.07	0.06	0.07	0.06
Employees of assisted living facilities for the ederly, per capita	pc_emp623312	1.14	1.61	1.48	1.14	1.62	1.19	1.65	1.22	1.54	1.07
Community food services, per capita	pc_est624210	0.04	0.12	0.02	0.03	0.02	0.04	0.02	0.04	0.02	0.03
Employees of community food services, per capita	pc_emp624210	0.23	1.00	0.16	0.33	0.19	0.28	0.19	0.26	0.19	0.32
Full-service restaurants, per capita	pc_est722511	0.79	0.59	0.76	0.37	0.85	0.43	0.87	0.46	0.81	0.30
Employees of full-service restaurants, per capita	pc_emp722511	12.16	9.38	16.24	8.77	17.43	10.14	17.61	10.56	16.98	7.61
Mobile food services, per capita	pc_est722330	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Employees of mobile food services, per capita	pc_emp722330	0.02	0.08	0.04	0.06	0.04	0.06	0.04	0.06	0.04	0.06
Supercenters and club stores, per capita	pc_est452910	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.02
Fruit and vegetable production and imports	fv_pro	48.34	329.50	180.02	649.87	173.45	715.46	173.73	757.88	217.62	911.33
Home price index	HPI	1.45	0.20	1.44	0.21	1.46	0.20	1.46	0.19	1.47	0.22
Metro county indicator	metro	0.37	0.48	0.70	0.46	0.66	0.48	0.64	0.48	0.70	0.46
Non-metro, metro adjacent county indicator	rma	0.33	0.47	0.21	0.41	0.27	0.44	0.29	0.45	0.23	0.42
Northeast region indicator	northe	0.07	0.25	0.18	0.38	0.21	0.41	0.24	0.43	0.19	0.39
Midwest region indicator	midw	0.34	0.47	0.23	0.42	0.24	0.43	0.24	0.43	0.22	0.42
Western region indicator	west	0.13	0.34	0.18	0.39	0.19	0.39	0.19	0.39	0.23	0.42

Table 4. Parameter Estimates and Standard Errors for the Baseline Model

Variable Description	**Variable Name**	**Merchant Wholesalers** coef/se	**Food Hub Composite** coef/se	**NGFN Food Hubs** coef/se
Variable Profits				
Per capita income ($1,000)	pcinc_S	-0.00049 ***	-0.00033 ***	-0.00032 ***
		(0.00011)	(0.00007)	(0.00008)
Per capita income ($1,000), squared	pcinc2_S	0.00000 ***	0.00000 ***	0.00000 ***
		(0.00000)	(0.00000)	(0.00000)
Share of SNAP recipients	shsnap_S	-0.00003	-0.00012 ***	-0.00010 **
		(0.00007)	(0.00004)	(0.00004)
Share of Black population	shblack_S	0.00004	0.00006 ***	0.00006 ***
		(0.00002)	(0.00002)	(0.00002)
Share of Hispanic population	shhisp_S	0.00007 ***	0.00004 ***	0.00006 ***
		(0.00003)	(0.00001)	(0.00002)
Share of 25+ with some college	somecollege_sh_S	0.00005	0.00023 ***	0.00022 ***
		(0.00007)	(0.00006)	(0.00006)
Share of 25+ with at least a bachelor's	gebachelor_sh_S	-0.00003	0.00011 ***	0.00014 ***
		(0.00004)	(0.00003)	(0.00004)
Social capital index	sk09_0100_S	0.00010	0.00017 **	0.00016 **
		(0.00009)	(0.00007)	(0.00007)
Electricity price	elec_pr_S	-0.00044 ***	-0.00016 **	-0.00021 **
		(0.00014)	(0.00008)	(0.00010)
Metro county indicator (RUCCs 1-3)	metro_S	-0.01662 ***	-0.01388 ***	-0.01395 ***
		(0.00318)	(0.00416)	(0.00447)
Metro-adjacent county indicator (RUCCs 4,6, and 8)	rma_S	-0.01227 ***	-0.00936 **	-0.00895 *
		(0.00356)	(0.00459)	(0.00491)
Northeast region indicator	northe_S	0.00292 ***	0.00041	0.00039
		(0.00109)	(0.00065)	(0.00071)
Midwest region indicator	midw_S	-0.00017	0.00049	0.00113 **
		(0.00065)	(0.00043)	(0.00050)
West region indicator	west_S	0.00037	-0.00040	-0.00035
		(0.00088)	(0.00054)	(0.00062)
Per capita value of direct sales from farms	pc_dirsales_S	0.00019 ***	0.00002	0.00005
		(0.00005)	(0.00004)	(0.00004)
Per capita number of farms selling direct	pc_dsfarms_S	0.00071	0.00409 ***	0.00432 ***
		(0.00077)	(0.00073)	(0.00078)
Per capita number of grocery supermarkets	pc_est445110_S	0.01932 ***	-0.00122	0.00012
		(0.00514)	(0.00149)	(0.00145)
Per capita number of employees in grocery supermarkets	pc_emp445110_S	-0.00008	0.00005	0.00010
		(0.00010)	(0.00007)	(0.00008)
Per capita number of assisted living facilities for the ederly	pc_est623312_S	-0.00762	-0.00994 *	-0.01176 *
		(0.00776)	(0.00575)	(0.00633)
Per capita number of employees in assisted living facilities for th	pc_emp623312_S	0.00068 **	-0.00004	-0.00002
		(0.00034)	(0.00026)	(0.00028)
Per capita number of community food services	pc_est624210_S	0.01438	0.02891	0.02137
		(0.01889)	(0.01785)	(0.01963)
Per capita number of employees in community food services	pc_emp624210_S	0.00077	-0.00124	-0.00173
		(0.00132)	(0.00106)	(0.00122)
Per capita number of full-service restaurants	pc_est722511_S	0.00184	0.00451 ***	0.00458 ***
		(0.00170)	(0.00106)	(0.00109)
Per capita number of employees in full-service restaurants	pc_emp722511_S	0.00002	-0.00014 ***	-0.00016 ***
		(0.00007)	(0.00004)	(0.00004)
Per capita number of mobile food services	pc_est722330_S	0.01263	0.09508 ***	0.08108 ***
		(0.03218)	(0.02343)	(0.02743)
Per capita number of employees in mobile food services	pc_emp722330_S	-0.00243	-0.01560 ***	-0.01049 **
		(0.00406)	(0.00457)	(0.00501)
Per capita number of supercenters and club stores	pc_est452910_S	0.00780	-0.03973	-0.02910
		(0.02973)	(0.02524)	(0.02759)
V2-V1	alpha2	0.00161 ***	0.00294 ***	0.00302 ***
		(0.00050)	(0.00035)	(0.00039)

V3-V2	alpha3	0.00080 *	0.00355 ***	0.00463 ***
		(0.00048)	(0.00059)	(0.00081)
V4-V3	alpha4	0.28533	0.15549	0.23777
		(5.72164)	(1.58942)	(1.62150)
Population (in 1,000s)	POP	0.03303 ***	0.01558 ***	0.01407 **
		(0.00593)	(0.00527)	(0.00569)
Fixed Costs				
Fruit and vegetable production and imports	fv_pro	0.00138 ***	0.00021 **	0.00015 *
		(0.00016)	(0.00009)	(0.00009)
Home price index	HPI	-0.59138 ***	0.21514	0.19795
		(0.16299)	(0.21488)	(0.24226)
Social capital index	sk09_0100	-0.00296	0.01812 **	0.01662 *
		(0.00777)	(0.00820)	(0.00897)
Metro county indicator (RUCCs 1-3)	metro	0.84851 ***	0.91169 ***	0.80421 ***
		(0.13030)	(0.17865)	(0.19898)
Metro-adjacent county indicator (RUCCs 4,6, and 8)	rma	0.46142 ***	0.68894 ***	0.66538 ***
		(0.13513)	(0.18422)	(0.20403)
Northeast region indicator	northe	0.20540	0.27838 *	0.31394 *
		(0.15872)	(0.15230)	(0.16202)
Midwest region indicator	midw	-0.12317	-0.10816	-0.15293
		(0.09389)	(0.11029)	(0.12476)
West region indicator	west	0.23059 **	-0.05051	-0.13733
		(0.11369)	(0.13838)	(0.15726)
F1	gamma1	1.14622 ***	3.19890 ***	3.23000 ***
		(0.28432)	(0.39107)	(0.43700)
F2-F1	gamma2	2.06076 ***	4.52743 ***	4.53929 ***
		(0.28690)	(0.40489)	(0.45218)
F3-F2	gamma3	2.67546 ***	5.77579 ***	5.71103 ***
		(0.29102)	(0.44578)	(0.49270)
F4-F3	gamma4	3.24068 ***	8.13891 ***	13.08008 ***
		(0.29629)	(1.00826)	(2.67247)
Pseudo R2		39.103%	30.336%	32.853%

Table 5. Parameter Estimates and Standard Errors, Up to 3 Establishments

Variable Description	Variable Name	Merchant Wholesalers coef/se	Food Hub Composite coef/se	NGFN Food Hubs coef/se	AMS Food Hubs coef/se
Variable Profits					
Per capita income ($1,000s)	pcinc_S	-0.00052 ***	-0.00029 ***	-0.00032 ***	-0.00019 **
		(0.00012)	(0.00007)	(0.00008)	(0.00009)
Per capita income ($1,000s), squared	pcinc2_S	0.00000 ***	0.00000 ***	0.00000 ***	0.00000 **
		(0.00000)	(0.00000)	(0.00000)	(0.00000)
Share of SNAP recipients	shsnap_S	-0.00008	-0.00010 **	-0.00010 **	-0.00005
		(0.00009)	(0.00004)	(0.00004)	(0.00005)
Share of Black population	shblack_S	0.00004	0.00004 **	0.00005 ***	0.00006 ***
		(0.00003)	(0.00002)	(0.00002)	(0.00002)
Share of Hispanic population	shhisp_S	0.00008 ***	0.00005 ***	0.00006 ***	0.00003 *
		(0.00003)	(0.00001)	(0.00002)	(0.00002)
Share of 25+ with some college	somecollege_sh_S	0.00003	0.00018 ***	0.00017 ***	0.00012 **
		(0.00008)	(0.00005)	(0.00005)	(0.00006)
Share of 25+ with at least a bachelor's	gebachelor_sh_S	0.00004	0.00010 ***	0.00012 ***	0.00004
		(0.00005)	(0.00004)	(0.00004)	(0.00004)
Social capital index	sk09_0100_S	0.00012	0.00021 ***	0.00020 ***	0.00016 **
		(0.00011)	(0.00007)	(0.00007)	(0.00007)
Electricity price	elec_pr_S	-0.00056 ***	-0.00023 ***	-0.00026 ***	-0.00025 ***
		(0.00017)	(0.00008)	(0.00009)	(0.00008)
Metro county indicator (RUCCs 1-3)	metro_S	-0.01549 ***	-0.00980 **	-0.00965 *	-0.00776
		(0.00345)	(0.00452)	(0.00494)	(0.00543)
Metro-adjacent county indicator (RUCCs 4,6, and 8)	rma_S	-0.01127 ***	-0.00481	-0.00431	-0.00246
		(0.00383)	(0.00489)	(0.00531)	(0.00596)
Northeast region indicator	northe_S	0.00430 ***	0.00036	0.00072	0.00053
		(0.00129)	(0.00064)	(0.00068)	(0.00074)
Midwest region indicator	midw_S	0.00056	0.00029	0.00089 *	0.00055
		(0.00078)	(0.00046)	(0.00053)	(0.00051)
West region indicator	west_S	-0.00023	0.00017	0.00030	0.00142 ***
		(0.00096)	(0.00051)	(0.00055)	(0.00053)
Per capita value of direct sales from farms ($1,000)	pc_dirsales_S	0.00021 ***	-0.00005	-0.00001	-0.00002
		(0.00005)	(0.00004)	(0.00004)	(0.00005)
Per capita number of farms selling direct	pc_dsfarms_S	0.00062	0.00418 ***	0.00444 ***	0.00205 **
		(0.00082)	(0.00076)	(0.00081)	(0.00085)
Per capita number of grocery supermarkets	pc_est445110_S	0.02649 ***	0.00048	0.00076	-0.00019
		(0.00655)	(0.00144)	(0.00142)	(0.00198)
Per capita number of employees in grocery supermarkets	pc_emp445110_S	-0.00009	0.00011	0.00014 *	0.00018 *
		(0.00012)	(0.00008)	(0.00008)	(0.00009)
Per capita number of assisted living facilities for the ederly	pc_est623312_S	-0.00156	-0.00370	-0.00293	-0.00860
		(0.00837)	(0.00551)	(0.00593)	(0.00603)
Per capita number of employees in assisted living facilities for th	pc_emp623312_S	0.00040	-0.00026	-0.00029	0.00003
		(0.00036)	(0.00028)	(0.00029)	(0.00033)
Per capita number of community food services	pc_est624210_S	0.02173	0.02566	0.01786	0.02254
		(0.02136)	(0.01809)	(0.02002)	(0.02148)
Per capita number of employees in community food services	pc_emp624210_S	-0.00186	-0.00069	-0.00103	0.00023
		(0.00185)	(0.00117)	(0.00128)	(0.00119)
Per capita number of full-service restaurants	pc_est722511_S	0.00230	0.00308 ***	0.00327 ***	0.00114
		(0.00201)	(0.00112)	(0.00117)	(0.00128)
Per capita number of employees in full-service restaurants	pc_emp722511_S	-0.00003	-0.00014 ***	-0.00015 ***	-0.00006
		(0.00008)	(0.00004)	(0.00004)	(0.00004)
Per capita number of mobile food services	pc_est722330_S	0.02698	0.02229	0.03246	0.02610
		(0.03677)	(0.02139)	(0.02237)	(0.02348)
Per capita number of employees in mobile food services	pc_emp722330_S	-0.00440	0.00497 *	0.00446	-0.00145
		(0.00510)	(0.00270)	(0.00275)	(0.00325)
Per capita number of supercenters and club stores	pc_est452910_S	0.02814	-0.00757	0.00206	0.00215
		(0.03283)	(0.02646)	(0.02876)	(0.02570)
V2-V1	alpha2	0.00177 ***	0.00361 ***	0.00364 ***	0.00468 ***
		(0.00052)	(0.00042)	(0.00045)	(0.00074)
V3-V2	alpha3	1.20478	0.52442	0.52438	0.01024
		(15.86752)	(6.94029)	(8.98664)	(0.14281)
Population (in 1,000s)	POP	(0.03396) ***	(0.01163) **	(0.01176) **	(0.00743)
		0.00675	0.00545	0.00587	0.00664
Fixed Costs					
Fruit and vegetable production and imports	fv_pro	0.00134 ***	0.00020 **	0.00016 *	0.00027 ***
		(0.00017)	(0.00008)	(0.00009)	(0.00009)
Home price index	HPI	-0.60222 ***	-0.00302	-0.06586	0.23637
		(0.17114)	(0.22009)	(0.24831)	(0.26304)
Social capital index	sk09_0100	-0.00880	0.02122 ***	0.01974 **	0.01588

		(0.00839)	(0.00821)	(0.00896)	(0.00963)
Metro county indicator (RUCCs 1-3)	metro	0.79600 ***	0.86881 ***	0.75872 ***	0.79365 ***
		(0.13731)	(0.18524)	(0.20883)	(0.21856)
Metro-adjacent county indicator (RUCCs 4,6, and 8)	rma	0.44325 ***	0.65876 ***	0.64539 ***	0.45608 **
		(0.14149)	(0.18971)	(0.21294)	(0.23014)
Northeast region indicator	northe	0.09543	0.43539 ***	0.44738 ***	0.39334 **
		(0.17281)	(0.15349)	(0.16295)	(0.18991)
Midwest region indicator	midw	-0.15898	-0.17215	-0.21737 *	-0.04739
		(0.09952)	(0.11279)	(0.12736)	(0.13799)
West region indicator	west	0.23965 **	-0.14902	-0.25868	0.09313
		(0.11726)	(0.14228)	(0.16237)	(0.16243)
F1	/cut1	1.04351 ***	2.89388 ***	2.86904 ***	3.31300 ***
		(0.30111)	(0.39987)	(0.44758)	(0.48257)
F2-F1	/cut2	2.02824 ***	4.36704 ***	4.35308 ***	4.66799 ***
		(0.30383)	(0.41674)	(0.46699)	(0.50714)
F3-F2	/cut3	2.79363 ***	7.25281 ***	6.98837 ***	8.34339 ***
		0.30941	0.61766	0.65226	1.06778
Pseudo R2		42.877%	34.006%	36.656%	26.875%

Table 6. Population (in 1,000's) needed to support 1, 2, and 3 establishments

	Merchant Wholesalers[1]	Food Hub Composite[a]	NGFN Food Hubs[2]	AMS Food Hubs[b,3]
Estimated with up to 3 establishments				
To support 1 establishment	105.38 ***	182.66 ***	191.37 ***	
	(10.59)	(25.49)	(27.69)	
To support 2 establishments	188.40 ***	502.88 ***	507.41 ***	
	(31.86)	(103.90)	(111.67)	
To support 3 establishments	342.44 ***	1669.27 **	1867.85 **	
	(71.53)	(658.09)	(924.93)	
Estimated with up to 2 establishments				
To support 1 establishment	101.81 ***	206.15 ***	218.95 ***	381.90 ***
	(10.29)	(34.74)	(39.13)	(138.46)
To support 2 establishments	182.15 ***	608.45 ***	603.08 ***	3534.62
	(31.42)	(171.62)	(184.06)	(7937.11)

Notes:

NB "*" indicates statistical difference at 10%; "**" at 5%; and "***" at 1%

a The food hub composite measure combines the number of NGFN food hubs and AMS food hubs in the following manner: by county, it takes the value of whichever is larger.

b Currently, the AMS data record only three counties with at least three hubs, which would render threshold estimates for three establishments questionable. Therefore, we only estimate thresholds using the AMS data alone for one and two establishments.

Sources:

1 County Business Patterns, NAICS Code "424480", 2012.

2 National Good Food Network, "US Food Hubs - Map." Downloaded from http://ngfn.org/resources/food-hubs/food-hubs#section-10 on August 31, 2016.

3 USDA, Agricultural Marketing Service, "Local Food Directories: Food Hub Directory". Downloaded from https://www.ams.usda.gov/local-food-directories/foodhubs on September 9, 2016.

Table 7. Ratios of Per Firm Population Thresholds

	Merchant Wholesalers[1]	Food Hub Composite[a]	NGFN Food Hubs[2]	AMS Food Hubs[b,3]
Estimated with up to 3 establishments				
2 establishments to 1	0.89 ***	1.38 ***	1.33 ***	
	(0.15)	(0.20)	(0.21)	
3 establishments to 2	1.21 ***	2.21 ***	2.45 ***	
	(0.07)	(0.51)	(0.80)	
Estimated with up to 2 establishments				
2 establishments to 1	0.89 ***	1.48 ***	1.38 ***	4.63
	(0.15)	(0.26)	(0.27)	(8.85)

Notes:

a The food hub composite measure combines the number of NGFN food hubs and AMS food hubs in the following manner: by county, it takes the value of whichever is larger.

b Currently, the AMS data record only three counties with at least three hubs, which would render threshold estimates for three establishments questionable. Therefore, we only estimate thresholds using the AMS data alone for one and two establishments.

Sources:

1 County Business Patterns, NAICS Code "424480", 2012.

2 National Good Food Network, "US Food Hubs - Map." Downloaded from http://ngfn.org/resources/food-hubs/food-hubs#section-10 on August 31, 2016.

3 USDA, Agricultural Marketing Service, "Local Food Directories: Food Hub Directory". Downloaded from https://www.ams.usda.gov/local-food-directories/foodhubs on September 9, 2016.

Table 8. Changes in Break-Even Population Thresholds (in 1,000's) Linked with Social Capital

	Merchant Wholesalers[1]	Food Hub Composite[a]	NGFN Food Hubs[2]	AMS Food Hubs[3]
Estimated with up to 3 establishments				
For 1 establishment	-0.59	-3.74 ***	-3.47 **	
	(0.78)	(1.35)	(1.44)	
For 2 establishments	-0.94	-10.84 **	-10.56 *	
	(1.41)	(5.14)	(5.45)	
For 3 establishments	-1.57	-57.89	-74.06	
	(2.78)	(50.23)	(77.39)	
Estimated with up to 2 establishments				
For 1 establishment	-0.12	-6.00 ***	-5.57 **	-12.49
	(0.83)	(2.18)	(2.26)	(9.53)
For 2 establishments	-0.35	-22.93 *	-21.08	-574.79
	(1.58)	(13.27)	(13.30)	(2613.52)

Notes:

a The food hub composite measure combines the number of NGFN food hubs and AMS food hubs in the following manner: by county, it takes the value of whichever is larger.

Sources:

1 County Business Patterns, NAICS Code "424480", 2012.

2 National Good Food Network, "US Food Hubs - Map." Downloaded from http://ngfn.org/resources/food-hubs/food-hubs#section-10 on August 31, 2016.

3 USDA, Agricultural Marketing Service, "Local Food Directories: Food Hub Directory". Downloaded from https://www.ams.usda.gov/local-food-directories/foodhubs on September 9, 2016.

Table 9. Changes in Break-Even Population Thresholds (in 1,000's) Linked With Local Business Presence[a]

	Supporting a Single Merchant Wholesaler			Supporting a Single Food Hub[b]		
Local business	**Average Size**	**Smallest Firm**	**Largest Firm**	**Average Size**	**Smallest Firm**	**Largest Firm**
Farms selling direct	-0.15 ***	-0.04	-2.85 ***	-0.70 ***	-0.71 ***	-0.49
	(0.06)	(0.06)	(1.02)	(0.21)	(0.22)	(1.32)
Grocery stores and supermarkets	-1.60 ***	-1.69 ***	-1.03 *	0.27	0.23	0.53
	(0.52)	(0.54)	(0.63)	(0.31)	(0.27)	(0.85)
Assisted living facilities for the ederly	0.48	0.54	-0.47	2.05 *	2.04 *	2.18 **
	(0.61)	(0.63)	(0.52)	(1.11)	(1.14)	(1.04)
Community food services	-1.66	-1.65	-3.72	-5.06	-5.11 *	4.38
	(1.55)	(1.56)	(4.08)	(3.07)	(3.09)	(7.18)
Full-service restaurants	-0.13	-0.12	-0.19	-0.44 **	-0.69 ***	2.02 **
	(0.11)	(0.14)	(0.63)	(0.18)	(0.26)	(0.90)
Mobile food services	-0.92	-0.93	-0.81	-15.35 **	-15.40 **	-12.05 **
	(2.70)	(2.71)	(2.37)	(6.25)	(6.27)	(5.11)

Notes:

a Changes in break-even population thresholds for more than one establishment are available upon request.

b Using the Food Hub Composite measure which combines the number of NGFN food hubs and AMS food hubs in the following manner: by county, it takes the value of whichever is larger.