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Assessing the Economic Impacts of Food Hubs to Regional Economies: a framework including opportunity cost

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Abstract

The number of food hubs ('local food' aggregation and distribution businesses) is growing, fueled in part by increasing public support. However, few data-driven economic impact assessments have evaluated these ventures. Using an input-output-based methodology and, a unique data set from a successful food hub operation, we measure the net and gross impacts from a policy supporting its development. We estimate a food hub gross output multiplier of 1.75, and employment multiplier of 2.14. However, utilizing customer surveys, we estimate that for every $1 increase in final demand for food hub products, a $0.11 offset in purchases occurs in other sectors.

Keywords: economic impact assessment, food hub, food policy, local food

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Introduction

As policymakers, researchers, and practitioners seek new opportunities to support rural communities and agri-businesses, interest in re-localized food systems continues to grow (Clancy 2010; Jensen 2010; King et al. 2010; Martinez et al. 2010; O'Hara and Pirog 2013; The National Research Committee 2010). The role of small- and medium-scale producers in developing local and regional food systems has also attracted renewed attention, as their importance in supplying these alternative food markets gains recognition (Low and Vogel 2011). Despite local food systems' purported potential to increase farm sales, particularly for small and mid-scale producers, and support rural economic development, the United States Department of Agriculture (USDA) acknowledges the "lack of distribution systems for moving local foods into mainstream markets" as a barrier to 'scaling up' local foods and meeting consumer demand (Martinez et al. 2010, iv).

Accessing markets that provide positive returns on investment is difficult for small- and mid-sized farms as supply chains become more vertically-integrated and consolidated. Large-scale supermarket retail and wholesale operations demand large volumes, low prices, and consistent quantities and qualities that meet increasingly strict safety standards. The procurement systems in such markets are often vertically and horizontally integrated, global in scale, and aim to maximize efficiency (King et al. 2010; Richards and Pofahl 2010; Sexton 2010; Tropp et al. 2008).

In an effort to support smaller-scale producers and foster opportunities for rural development, public agencies and private foundations are increasingly financing and promoting the development of 'food hubs', i.e., "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" (Barham et al. 2012, 4). For example, the Food Hub Collaboration, a public-private effort between the USDA, the Wallace Center at Winrock International, the National Good Food Network, the Farm Credit Council, and other organizations "works to ensure the success of existing and emerging food hubs in the United States by building capacity through connection, outreach, research, technical assistance and partnership" (NGFN 2010). Similarly, the USDA's Know Your Farmer, Know Your Food task force[1] has a Regional Food Hub Subcommittee, which prepared a list in 2011 of 15 agency programs that provide funding to support food hubs, including: Rural Development; Agricultural Marketing Service; the National Institute of Food and Agriculture; Farm Service; Natural Resources Conservation Services; and Risk Management (USDA KYF 2011). Some state governments have also utilized public funds to support food hub development. In February 2013, the New York State Governor announced $3.6 million in state funding to support four new food hubs (Cuomo 2013). As of 2013, there are more than 220 self-reported food hubs across the United States, an increase of over 68% since 2008 (USDA KYF 2013).

[1] The Know Your Farmer, Know Your Food task force is a USDA-wide effort to carry out President Obama's commitment to strengthening local and regional food systems (USDA KYF 2013).

Despite this growing interest in food hubs, as well as a burgeoning literature describing food hub development (e.g., Abatekassa and Peterson 2011; Barham 2011; Barham et al. 2011; Clancy and Ruhf 2010; Conner et al. 2011; Day-Farnsworth and Morales 2011; Diamond and Barham 2011; Feenstra et al. 2011; Hardesty et al. 2014; Jablonski et al. 2011; Schmidt et al. 2011; Stevenson and Pirog 2008), there have been no comprehensive, data-driven economic impact assessments completed to date. Nor is there an agreed upon methodology about how an economic impact assessment of food hubs should be conducted (O'Hara and Pirog 2013).

Economic impact assessments model and measure the economic activity associated with the sequential effects of linked purchases. An (exogenous) final demand driven change for food hub goods and services triggers changed production levels of other industry sectors throughout the entire economy. Of key importance for policy is the extent to which food hubs serve to increase overall demand for and consumption of locally-grown agricultural products, versus diverting farm sales from one existing local market to another (e.g., from a farmers' market to a food hub). Additionally, policymakers need to understand the percentage of the sales price retained by the farm through food hub sales compared to other market outlets. This is due to the fact that policymakers' primary interest in food hubs emanates from the potential of food hubs to support economic development, and particularly to increase the viability of the local farm sector.

This research specifically addresses whether increases in final demand for food hub goods and services divert sales from other industry sectors (like wholesale trade), thus resulting in a 'beggar-thy-neighbor' phenomenon taking place (Boys and Hughes 2013; Thilmany et al. 2005), or serves to increase farm profitability. Put differently, we explicitly take into account where businesses would have purchased products had the food hub not existed, or as we define it, the opportunity cost. Attention to this type of impact assessment can help to better inform public and private programs that support food hub initiatives.

Efforts to assess the impacts of local food system activities are often complicated by a lack of data necessary for complete evaluation. Frequently, these efforts suffer from insufficient data to identify the major inter-industry sales and purchase linkages of local food system participants. Data problems are exacerbated as data is not collected about a food hub industry sector per se, and thus food hub inter-industry linkages must be identified based on data of existing industry sectors in the economy.

The primary objective of this paper is to promote the utilization of a replicable methodology to evaluate the economic impact of an increase in final demand for food hub goods and services on their local economies and participating farms. This is accomplished by developing a data-driven empirical framework applicable to a variety of food hub structures. As the USDA distinguishes a food hub from other traditional food aggregators or distributors in part based on the fact that they purchase products "primarily from local and regional producers," their differential expenditure patterns can be modeled to determine the relative effects on the regional economy, including the impact on local agricultural sectors.

The framework developed is applied to a case study of a food hub located in New York State. There are significant limitations to generalizing the results of an individual case study to other food hubs. However, in contexts where food hubs exhibit similar attributes to our case study (i.e.,

performs similar types of business functions, serves the same number of farms or similarly scaled market), one may be able to utilize the adjusted expenditure patterns in constructing a similar analysis. However, where food hubs are more dissimilar in terms of their activities and purchasing and sales patterns, following the complete data collection procedure proposed is advised.

The secondary objective of this paper is to better understand the extent to which food hubs increase the overall demand for and consumption of local food products. We collect additional information on the nature of purchases of food hub output, and we analyze the extent to which these purchases represent increased demand for local goods and services, or if they instead represent substitutes of purchases from one local source for another (e.g., from a conventional wholesale distribution company to a food hub). The information collected from purchasers of food hub goods and services allows us to ascertain the direct value of food hub purchases, offsets in purchases from other sectors, and the potential in our case study for growing overall local food product demand.

We continue with a brief description of economic impact analysis to frame the paper's objectives, along with a discussion of previous literature analyzing the impacts of local food system infrastructure. Next we provide an analytical framework for our analysis and a detailed empirical methodology, including two alternative modeling approaches. A discussion of the case study application follows, including the interpretation of and policy implications from the particular results and a set of recommendations for replicating the methodology in alternative settings. We conclude with priorities for future research.

Local Food Economic Impact Assessments

Most local food economic impact assessments utilize social accounting matrix (SAM) models with data and software generated by the IMPLAN Group LLC (IMPLAN).[2] Among these assessments, there are a handful that measure the impacts of specific marketing channels, such as farmers' markets (e.g., Henneberry et al. 2009; Hughes et al. 2008; Myles and Hood 2010; Otto and Varner 2005; Sadler et al. 2013) or farm-to-school programs (Gunter and Thilmany 2012; Tuck et al. 2010), as well as key pieces of infrastructure such as smaller-scale meat processing facilities (Swenson 2011).

Throughout most of these studies, there are two main challenges that reflect the difficulty in meeting the data requirements to conduct rigorous economic impact assessments. The first is what O'Hara and Pirog (2013) refer to as an 'interpretation' challenge. Specifically, "stipulating how the 'opportunity cost'…is defined" (4). As they rightly point out, measuring opportunity cost is not straight-forward, and requires information about the extent to which increased consumer purchases of locally-grown food offsets other types of purchases, changes market prices and/or supply chain characteristics, or impacts land use. There are only a handful of local food economic impact assessments that explicitly acknowledge the need to consider opportunity cost (Conner et al. 2008; Hughes et al. 2008; Gunter and Thilmany 2012; Tuck et al. 2010; Swenson 2010). However, each of these studies makes assumptions about the sectors in which there are decreased purchases (or changes in land use) as a result of increases in local food

[2] A SAM is an accounting system that links the economic transactions within an economy among production sectors, labor and other factors of production, and government and other institutions (Miller and Blair 2009).

consumption–in other words, none collects the data necessary to more fully understand the opportunity costs of increased local purchases.[3]

The second challenge is that almost all of these studies reflect the implicit assumption that local food system participants have the same patterns of expenditure as the aggregate agricultural sector data available in IMPLAN. By default, the entire U.S. economy is currently represented by 440 sectors within IMPLAN. Each IMPLAN sector is represented by a single, static production function. The production functions for each sector reflect average purchase patterns across all firms in the sector, without the requisite information to be able to disaggregate them by any specific characteristic (i.e., scale of operation, or marketing channel) (Lazarus et al. 2002b; Liu and Warner 2009).[4] IMPLAN expenditure and sales data are more reflective of those firms that contribute a higher proportion of total output in the sector (typically the larger firms) (Lazarus et al. 2002a). Given that local food system participants tend to be smaller in scale, and represent a smaller overall portion of agricultural sector transactions (Low and Vogel 2011), the estimates of the impacts from increased local food sales based on existing IMPLAN data may be misleading if local food system participants have different patterns of input expenditures and/or they purchase a different proportion of their inputs from local sources. As one of the distinctive definitional attributes of food hubs is that they purchase more regional inputs, this would be expected to be the case, though to an unknown extent.[5]

There are a limited number of local food system impact assessment studies that disaggregate key sectors and augment the IMPLAN database with primary data collection on expenditure patterns. Gunter and Thilmany (2012) utilize a combination of survey data and National Agricultural Statistics Service data to create a customized farm-to-school farm sector within IMPLAN, reflecting the differential production function of farm-to-school producer participants. Schmit et al. (2013) collect detailed expenditure and sales data from farms in Upstate New York and show that small- and mid-scale farms participating in direct-to-consumer (D2C) markets have different spending patterns than depicted in the default agricultural sector data in IMPLAN. They conclude that local food economic impact assessments utilizing default IMPLAN agricultural sectors to estimate economy-wide impacts may underestimate labor income and value added impacts. Swenson's (2011) study is the only one of its kind to provide evidence that it is not just farms participating in local food supply chains that are not well represented by default IMPLAN sectors. His research on the small-scale meat processing sector in Iowa demonstrates differences in expenditure patterns based on the scale of operation, implying that utilizing default IMPLAN sector data to describe infrastructure required by local food system participants (likely smaller in scale than what is reflected in default IMPLAN data), may not reflect true impacts.

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[3] While computable general equilibrium (CGE) models provide an alternative approach to endogenously model changes in such things as prices or land use through assumed or estimated change parameters, the authors found no studies that utilize this approach to assess the impacts of local food systems developments. SAM models accommodate opportunity cost through more ad hoc analyses and assumptions that are external to the model itself.

[4] For an in-depth discussion of how production functions are constructed within IMPLAN, see Lazarus et al. (2002b).

[5] It is also worth noting that the IMPLAN agriculture sector data are themselves based on standard but incomplete existing data sources. While the agriculture sector data are estimated consistently from these sources, good regional measurements of the sector, if available, are probably superior. See: http://implan.com/index.php?option=com_content&view=article&id=638:638&catid=258:KB38

Empirical Framework

To conduct an impact assessment of food hubs using a SAM framework like IMPLAN, we must define the industry sectors of interest and their linkages with other industries. This is not straightforward as a separate 'food hub sector' and its transactions with other industries are not defined within traditional data sources (including IMPLAN). The implication for an impact assessment is that additional information must be collected to develop food hub transaction patterns in the economy.

Formally, we do not create a single aggregated food hub sector for the analysis. Instead, we model the impacts of the food hub sector through the allocation of food hub expenditures (associated with revenues resulting from final demand for its output) to food hub input suppliers (including regional farms), food hub employees, and food hub owners; this is an analytically equivalent alternative known as 'analysis-by-parts'.[6] Conceptually, the allocated expenditures represent the first round of indirect inter-industry purchases and payments to value added made by the food hub, each of which triggers additional indirect and induced effects. Defining the scope of a food hub within IMPLAN therefore requires detailed data on the food hub's annual outlays, including (*i*) purchases of input commodities by the food hub, along with the proportions of those expenditures that are purchased within the defined local economy, (*ii*) payments to the value added components, and (*iii*) other institutional purchases (e.g., payments to households or government purchases).

In addition, one should consider whether the default IMPLAN production functions (i.e., technical coefficients) associated with the sectors the food hub purchases from adequately represent the production technologies (input combinations) of firms with which the food hub interacts. If not, additional information will be required from firms representing these upstream sectors. This is perhaps most acute for the farm production sectors that supply food products to the food hub; i.e., are farms that sell to food hubs adequately represented using the default farm data contained within IMPLAN? In order to see if there are substantial differences, we construct two alternative impact assessment models–one that incorporates additional data collected from farms selling to the food hub and one that does not.

Expenditure categories from the food hub data must be mapped to appropriate industry, value added, and institutional sectors within IMPLAN. We start defining industries by utilizing the two-digit NAICS aggregation scheme provided within IMPLAN, but leave sectors of particular interest or importance to food hubs disaggregated. Importantly, we create a separate aggregated 'farm products' sector that only includes those sectors from which the food hub purchases food products.[7] Similarly, we separate from the 2-digit NAICS scheme processed food and beverage

[6] See IMPLAN's 'Case Study: Analysis-By-Parts' for more information: http://implan.com/v4/index.php?option=com_multicategories&view=article&id=730:case-study-analysis-by-parts&Itemid=71

[7] We define the 'farm products' sector to include oilseed farming, grain farming, vegetable and melon farming, fruit farming, greenhouse, nursery and floriculture farming, all other crop farming, cattle ranching and farming, dairy cattle and milk production, poultry and egg production, and all other animal production. For more information on IMPLAN's 440 sector scheme and NAICS bridge, see: https://implan.com/index.php?view=document&alias=110-440-implan-sector-scheme-2007-to-current&category_slug=implan-bridge-tables&layout=default&option=com_docman&Itemid=1370

products that food hubs purchase from nonfarm manufacturers for resale. We then consolidate them into a new 'manufactured food' sector.

Defining Farms that Sell to Food Hubs

Understanding how farms that sell product to food hubs (henceforth 'food hub farms') interact with other sectors of the economy is important in improving the precision of an impact assessment. While the same can be said of any input supplying sector, purchases from farms generally represent a relatively large share of total food hub expenses. Moreover, we are particularly interested in how food hub farms are impacted by food hubs given the role this interaction may play in rural/regional economic development. For these reasons, we devote special attention to the inter-industry linkages for farm suppliers.

Furthermore, for most of the nonfarm businesses from which food hubs purchase inputs, it is both sufficient for our purposes and consistent with standard practice to assume that the individual business' expenditure patterns reflect that of the entire industry sector. For example, a food hub is unlikely to purchase insurance from a specialty food hub insurance provider. As such, assuming that the food hub's insurance company has a similar production function to that of the region's 'insurance' sector within IMPLAN is a reasonable assumption given the difficulty and cost of collecting alternative data. By contrast there is growing evidence that farms participating in local food system outlets are oftentimes (but not exclusively) smaller in scale, and/or have different patterns of expenditures and labor requirements per unit of output than is reflected in IMPLAN's default agricultural sectors (Jablonski and Schmit 2014; Schmit et al. 2013).

Defining a separate food hub farm sector distinct from the total farm sector requires outlays data analogous to what is required from the food hub described above; i.e., the value and location of payments by the food hub farm to each industry sector and value added component.

Impact Analysis Considering Opportunity Cost

Once our SAM model is customized to reflect food hub expenditure patterns according to the framework explained above, we can perform the impact analysis. We consider a scenario in which an exogenous shock (for example, a federal incentive to local school districts to expand locally-grown food purchases) increases the final demand for food hub products and services. Given the absence of a discrete food hub sector, the increase in final demand is fully allocated according to the food hub's expenditure pattern. While the initial increase in final demand is the value of the direct effect, only a portion of expenditures to satisfy that increase occur locally, and thus only the expenditures that occur with local firms are included in the impact analysis (as first-round indirect effects).

In addition to a positive hypothetical shock assumed due to an increase in demand for food hub products, we need to consider possible negative impacts due to decreased spending in other sectors. We hypothesize that food hub purchases are likely to offset some local purchases that would otherwise be from existing distributors. At the same time, however, it is possible that these customers increase purchases of local products due to specialized food hub marketing efforts and the resulting availability of food hub products and services. Customers should have increased awareness of and access to a basket of goods that is differentiated from that available

from other types of distributors (i.e., they have more options to purchase local goods). While the net effect is indeterminate a priori, we can estimate the effect empirically.

In order to test this hypothesis and more fully reflect the impact that increased demand for food hub products has on other sectors, we require the following information from food hub customers: (*i)* the percentage of food hub customers who would have purchased product from other local sectors had the food hub outputs not been available; and (*ii*) of the customers who purchased less product from other sectors, the amount of reduced purchases as a result of purchases from food hubs.

Case Study Application

Given the heterogeneous structure of food hub operations and the detailed data needs required for an impact assessment, we utilize a case study approach. This is a preliminary case study and is not intended to provide definitive evidence of the economic impact of food hubs, but rather to: 1) test the framework developed herein; and 2) provide an initial case study with which future research can be compared.

Regional Access, LLC (RA) was chosen for our case study because they fit within the USDA's regional food hub definition as an aggregation and distribution business that is committed to supporting local farmers and preserving product's source-identification. In addition, RA's length of time in operation, the diversity of its customer base, and its operation size make it an interesting business to examine. RA was established in 1989. In 2011, it had over $6 million in sales, and operated with 32 employees. Utilizing 9 vehicles and a 25,000 square foot warehouse, RA aggregates and delivers products primarily throughout NYS. RA has over 3,400 product listings, including beverages, breads, cereals, flour, meats, produce, prepared foods, grains, and fruits and vegetables. RA purchases products directly from 96 farm vendors, 65 specialty food processors (nonfarm vendors), as well larger-scale foodservice distributors. The product is sold to over 600 customers, including: individual households, restaurants, institutions, other distributors, fraternities and sororities, buying clubs, retailers, manufacturers, and bakeries. RA also provides freight services to a range of businesses.

New York State (NYS) was chosen as our local region of analysis. We recognize that defining "local" is an important decision, and not a one size first all approach. RA works primarily with farms and customers across NYS; accordingly, the term 'local' will refer to NYS throughout the empirical application.

Deriving Food Hub Expenditure Pattern

RA provided a detailed 2011 profit and loss statement, along with estimates of the expenditures in each category that were local. Based on the data they provided and follow up discussions with RA personnel, the hub's expenditure categories were mapped to IMPLAN sectors, value added categories, and institutional components (see Appendix 1 for detailed sector aggregation and mapping scheme).

After accounting for the value of all hub outlays, relative expenditures by category are computed and disaggregated by their local versus nonlocal components. RA's six largest expenditure items are shown in Figure 1. The two largest expenditure items are manufactured food (44%) and farm

products (18%). Together, manufactured food and farm product expenditures represent what is commonly referred to as cost of goods sold (COGS). Interestingly, the COGS for RA is very similar to the average COGS reported by Fischer et al. (2013) from their national food hub survey (61%). The Farm Credit Council and Farm Credit East's Food Hub Benchmarking Study (2013) reported average COGS of 68%. By comparison, the Food Marketing Institute (2008) reports average COGS for food distributors at 71%.

The third largest expenditure item was employee compensation (16%). Similarly, the Farm Credit Council and Farm Credit East's (2013) Food Hub Benchmarking Study reported average labor costs as a percent of sales to be 17%. The Food Marketing Institute (2008) reports total payroll and employee benefits at 15% of total expenditures.

[Figure 1 here]

The extent to which these purchases are local is also important to consider. Figure 1 depicts RA's expenditures as percentage of total expenditures and divided into the local and nonlocal components. For RA, 54% of all expenditures are local. RA's largest local expenditures as a percentage of total expenditures are farm products (16%), employee compensation (16%), manufactured food (7%), finance and insurance (4%), proprietor income (3%), and automotive equipment rental and leasing (3%). As a point of comparison, Fischer et al. (2013) also asked food hubs about the percentage of their expenditures that were local. Though they do not provide an average for all expenditures, they found "no expenditure averaged less than 50% spent in-state" (34), with 85% of food and/or product purchases taking place within the state of the food hub's operation.

Food Hub Farms

In-person interviews were conducted with 30 farms that sell product to RA (out of 86 located in NYS, 35% response rate).[8] The farms were located in every region of NYS except New York City and Long Island.[9] Of the farms from which RA purchased product, 50% classified their operation as 'small' ($1,000-$249,999 in gross sales), 20% percent as 'medium' ($250,000-$500,000 in gross sales), and 30% as 'large' (over $500,000 in gross sales). When asked to classify their farms' primary production category, 37% percent identified meat and livestock, 30% fruit and vegetable, and 33% processed food products.[10]

Table 1 presents the average expenditure patterns of the food hub farms interviewed. The average total expenditure was $601,110 per farm, of which 80% was spent in the local economy ($483,741). The largest percentage of total expenditure is allocated to employee compensation (24%), followed by farm products (17%, representing intra-sector purchases of farm products from other farms), manufacturing (16%), and support activities for agriculture and forestry (9%).

[8] A copy of the interview protocol is available upon request.

[9] Regional location of firms follows from Empire State Development's delineation of ten regions throughout the state, including Western New York, Finger Lakes, Southern Tier, Central New York, Mohawk Valley, North Country, Capital District, Mid-Hudson, New York City, and Long Island. For more information, see: http://esd.ny.gov/RegionalOverviews.html.

[10] If a farm classified its primary production category as 'processed food products', it can be inferred that the farm grew/raised the raw commodity that it then processed. Examples of the processed food products include cheese, butter, yogurt, honey, maple syrup, wine and juice.

[Table 1 here]

IMPLAN Model Construction

Using 2011 IMPLAN data, two NYS models were constructed and aggregated according to the aggregation scheme presented in Appendix 1.[11] Both of the models utilize data collected from RA about their sales and expenses. Model 1 assumes that food hub farm's production function and local purchase coefficients are the same as the default IMPLAN agricultural sector (i.e., none of the food hub farm data are utilized in this model). Model 2 utilizes the food hub farm data to separate the default IMPLAN agricultural sector data (i.e., the farm products sector into two distinct sectors: the 'food hub farm' sector and the 'other farm' sector, see below).

In both models, RA expenditures are margined in IMPLAN's 'retail trade' and 'wholesale trade' sectors and the technical coefficients adjusted accordingly. Specifically in our aggregation scheme, RA has expenditures in three sectors that require margining: retail store-gasoline stations, wholesale trade, and other retail trade. To account for margining in the retail store-gasoline stations sector, we apply the retail trade-gasoline station margin (sector 326), of 14.5% (available within the IMPLAN database) such that only $54,438 is included in the retail stores-gasoline stations. The balance ($320,998) is mapped to the production sector (petroleum refineries, sector 115) and the local purchase percentage is taken from IMPLAN for that sector. The same approach was used for the other retail trade and wholesale trade purchases.[12] Once we have aggregated relevant sectors and accounted for margining, Model 1 is complete.

Model 2: Creating a Food Hub Farm Sector

For Model 2, the food hub farm data were utilized to apportion transactions in the farm products sector into two distinct sectors: the 'food hub farm' sector and the 'other farm' sector (i.e., everything in farm products other than the food hub farm sector). The first step in separating the food hub farm sector from the farm products sector is to determine the total size of the RA food hub farm sector in NYS—effectively calculating the total amount of a new expenditure column and a new sales row in the SAM. The average expenditure estimates from the interview data were multiplied by the total number of RA farm vendors in NYS; in other words, the average expenditure in each sector or value added component was multiplied by 86 to determine the total local inter-industry linkages of the food hub farm sector.

Food hub farm expenditure categories were then allocated to their corresponding IMPLAN sector (with margining), and the same amount was subtracted from the 'other farm' sector. Though we reallocated some of the inter-industry transactions from the 'other farm' sector to the 'food hub farm' sector, we do not adjust the technical coefficients of the 'other farm' sector based on the assumption that the remaining farms in the 'other farm' sector likely dominated the technical coefficients in the first place. This procedure also ensures that the overall economy remains the same, as we only reallocate total local expenditures into its two distinct sector

[11] After aggregating the models, the SAM IxI transactions matrix was exported from IMPLAN into Microsoft Excel 2010. Margining, disaggregation of the default agricultural sector, along with all of the computations that follow, were conducted in Excel. Though this work can be done within IMPLAN, we determined that completing the work within Excel is more transparent.

[12] IMPLAN retail and wholesale margining is based on national data, and varies by year, see: http://implan.com/index.php?option=com_multicategories&view=article&id=680:680&Itemid=71.

components. In addition to selling product to RA, food hub farms also identified purchases of goods and services from RA (e.g., transportation, warehousing and wholesaling). We divided these expenditures evenly between 'wholesale trade' and 'transportation and warehousing'. Additionally, we allocated the difference between the average sales and expense per farm ($601,110 - $569,167 = $31,913) as payments to owners (proprietor's income within IMPLAN).[13]

Just as expenditures of the food hub farms on their inputs were used to create a new sector with purchasing patterns that are distinct in relation to the overall farm products sector (i.e., using SAM column transactions), food hub farm sector output or sales must be similarly disaggregated into a vector of sales (i.e., using SAM row transactions). Average sales per farm ($601,110) were initially scaled up by the size of the sector (86 farms). Then, sales designated by the farm survey respondents as nonlocal were allocated to domestic trade (as regional exports). The balance of sales was divided between sales to other farms, sales to households (i.e., direct-to-consumer sales), intermediated sales not to RA (i.e., grocery stores, distributors, farm-to-school), intermediated sales to RA, and commodity sales (i.e., auction). Average sales by market outlet for food hub farms are presented in Table 2. All food hub farm direct-to-consumer sales were assigned to households (i.e., treated as sales directly to households, an average of $144,173/farm). Intermediated sales separate from those to RA were assigned to the aggregated manufactured food sector (an average of $279,701/farm). Sales to RA were apportioned to the sectors to which RA sells product, including: accommodation and food service; wholesale trade; education; manufactured food; retail trade; and health and social services. On average, food hub farms sold $37,200 to RA. Food hub farms reported an average of $37,152 in sales to commodity markets. These sales were allocated to IMPLAN's manufacturing sector. Non-local sales (an average of $52,355/farm) were allocated to exports (domestic trade). Finally, sales to other farms (an average of $102,884/farm) were assumed intra-industry sales and mapped to the food hub farm sector.

[Table 2 here]

Once we complete mapping of the food hub farms' expenditures and sales to the relevant IMPLAN sectors, we find our case study farms have very different patterns of expenditure than the default farm products sector within IMPLAN (see Table 3). Most importantly in terms of local economic impact, per dollar of output food hub farms spend $0.80 in the local economy versus the $0.65 in the original, aggregate farm products sector. Food hub farms' additional expenditure is in intermediate purchases where the sector spends $0.44 per dollar of output compared to the farm products sector $0.25. In total, the farm products sector has higher per dollar of output expenditure in value added components ($0.40, compared to $0.36 in the food hub farm sector). Food hub farms spend double as much on employee compensation as the default farm products sector per dollar of output ($0.24 compared to $0.12), although they allocate substantially less to proprietor income ($0.05 compared to $0.16). Another way of comparing these expenditure patterns is that per dollar of output, the total labor/owner direct income impact of food hub farms is $0.30 compared to $0.29 in the default IMPLAN data.[14]

[13] Within a SAM framework, there is an accounting identity in which the value of total outlays in each sector must equal the value of total outputs.

[14] Even nationally, the U.S. does not collect employment and earnings data on a commodity basis. The U.S. Bureau of Economic Analysis' (BEA) Regional Economic Accounts program estimates county-level employment and

Food hub farms spend $0.08 per dollar of output on support activities for agriculture and forestry, compared to just $0.02 in the default agriculture sector. And, food hub farms spend $0.16 per dollar of output on purchases from other local farms compared to $0.06 in the default farm sector.

[Table 3 here]

Customer Surveys

An online survey of RA's customers was used to better understand the extent to which purchases from RA increase the demand for locally-grown farm products and offset purchases from other sectors.[15] At the time of the survey, RA customers numbered 110 households and 547 businesses, of which 57 households and 186 businesses responded to the online survey. To improve the response rate for business customers, follow up phone interviews were attempted with those customers who did not respond online. An additional 62 surveys were completed, increasing the total number of responses received to 305 (46% response rate), with 80% from business customers and 20% from individual households.

RA's business customers are very diverse. They reported average annual gross sales of $5.7 million (median = $515,000, n=101), with a range from $3,000 to $414 million. On average, they have been in business 13 years (median = eight years), although this ranged from new to over 130 years in operation (n=151). The average number of fulltime employees was 15 (median = 4, n=145). Business customers were also asked to identify the function their business most often performs; accordingly, 2% identified themselves as distributors, 3% as grocery/meal delivery service providers, 9% as processors/manufacturers, 11% as wholesalers, 25% as restaurants, 34% as retailers, and 17% as other—including bakery, fraternity/sorority house, caterer, coffee shop, farmers' market vendor, and institutional cafeteria (n=245).

Impact Analysis

To understand the impact of an increase in final demand for RA food hub products and the extent of differential economy-wide impacts from the two models, we consider a scenario in which an exogenous shock increases final demand for food hub products and services by $1,000,000. The only difference between the allocation of the shock in Models 1 and 2 is that in Model 1 all local farm product purchases by RA are allocated to the aggregate farm products sector, whereas in Model 2, RA farm purchases are allocated to our new food hub farm sector.

In addition to the positive shock, we consider a simultaneous negative shock to the wholesale trade sector in order to account for the offsets, or opportunity cost. The customer survey results reveal that, on average, 49.4% of RA business customers decreased their purchases from other distributors due to their purchases from RA. Of those who reported decreasing purchases from

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income data, but these are farm totals, not differentiated by agricultural commodity. As a result, IMPLAN has developed procedures, using a combination of the USDA ERS farm count by commodity (as an indication of proprietors), employee compensation-to-output relationships from the BEA Benchmark I-O (to get a first estimate for wage and salary employment by commodity), and applying the resulting U.S. relationships to output to state outputs, to derive state employment numbers. Given the data challenges, we are wary about making too fine a point on the different value added component expenditures. For more information on the data challenges and IMPLAN's methodology, see:
http://implan.com/index.php?option=com_multicategories&view=article&id=638:638&Itemid=14

[15] A copy of the online customer survey is available upon request.

other distributors, the average decrease was 23.1%. Accordingly, a negative shock of $114,042 was applied to the wholesale trade sector (i.e., .494 * .231 * $1,000,000 = $114,042), in addition to the positive expenditures to this sector made by the food hub. The wholesale trade sector was chosen as business customers reported decreasing purchases from other distributors, which are included in IMPLAN's wholesale trade sector.

Results

Model 1: Multiplier, Employment, and Distributional Impacts

Model 1 results are shown in Table 4 illustrating the combined indirect plus induced output multiplier effects for the top affected industries,[16] the combined effects for the remaining industries, and the total effects across all industries. Without including opportunity costs, the combined output multiplier effects in Model 1 are $683,642. When adding in the direct effect of $1M, this implies a total output effect of $1,683,642, or a gross output multiplier of 1.68.[17] In other words, for every dollar increase in final demand for food hub products, an additional $0.68 is generated in backward linked industries. While not shown, the total indirect multiplier effect is $0.46 and the total induced multiplier effect is $0.22 indicating that most of the multiplier effect is due to the business-to-business transactions. The total employment effect is 9.65 jobs, 5.19 of which is the direct impact (calculated based on RA's current ratio of total employees/output, 32/$6,163,720, multiplied by the direct effect of $1M), 2.86 jobs from indirect impacts, and 1.60 jobs from induced impacts. Accordingly, the total employment multiplier is 1.86, of which 0.55 reflects indirect impacts and 0.31 induced impacts.[18] The sector receiving the largest employment impact from the exogenous shock is in the farm products sector (1.52, see Table 5).

[Tables 4 and 5 here]

Alternatively, consider the results for Model 1 when incorporating opportunity costs. Here, the additional negative shock to the wholesale trade sector results in total indirect and induced effects of $502,011, implying an output multiplier of 1.50. While still a relatively strong multiplier effect, this represents a 12% decrease in the total multiplier effect from that when opportunity costs are ignored. Similarly, the total employment multiplier declines by 12% to 1.66. The total employment impact is 8.61 jobs (2.12 of which represents the indirect impacts and 1.31 the induced impacts), reflecting, in part, a negative employment impact in the wholesale trade sector (-0.51). The distribution of the total employment impact to the farm products sector remains unchanged when incorporating opportunity cost (1.52, see Table 5).

Figure 2 supplements Table 4 by providing a visual representation of the industry effects, along with the component indirect and induced contributions. Since the relative distribution across industries is similar across versions of Model 1 (except for, obviously, the impact to wholesale

[16] Though not a top impacted industry sector in Model 1, we include support activities for agriculture and forestry for a point of comparison with Model 2.

[17] This result is similar to sectors that conduct activities that are, at least in part, similar to a food hub. For example, comparable output multipliers for wholesale trade, truck transportation, and warehousing and storage are 1.60, 1.69, and 1.73, respectively, for NYS.

[18] Note that the employment multiplier, calculated as the (direct+indirect+induced employment impacts / direct employment impact), was derived utilizing the default IMPLAN employment per dollar of output data by sector, multiplied by the RA's distribution of first round indirect impacts (as we are using analysis-by-parts). RA's total employment per dollar of output (5.19 per $1,000,000 of output) was assumed to be the direct employment impact.

trade), we restrict our attention to the model that explicitly accounts for opportunity costs. The farm products sector receives the largest positive impact ($180,606) from the change in final demand, almost entirely from indirect effects. The finance and insurance sector has the second largest positive impact, $55,952 of which is from indirect effects, the remaining $24,908 is a result of induced impacts. The manufactured food sector has the third largest total impact ($77,988), almost entirely due to indirect impacts. Real estate and rental has the fourth largest impact ($47,340), of which roughly one-third are due to indirect impacts and the other two-thirds due to induced impacts. The health and social services sector is next ($30,319) where almost all of the impacts to this sector are attributed to consumer spending and are thus induced impacts.

[Figure 2 here]

Model 2: Multiplier, Employment, and Distributional Impacts

Comparable results to Table 4 (Model 1) are shown for Model 2 in Table 6. Here, when opportunity costs are not considered, the combined indirect and induced effects are now $748,074. Considering the direct effect of $1M, this implies a gross output multiplier of 1.75, 4% higher than its counterpart in Model 1. The relative allocation to indirect effect (0.51) and induced effect (0.24) are similar to that for Model 1. Table 7 shows Model 2's indirect plus induced employment impacts. The total employment effect in Model 2 is 11.09 jobs, 4.16 of which result from indirect impacts, and 1.73 from induced. Accordingly, the total employment multiplier is 2.13, which represents an increase of 13% from Model 1. As in Model 1, the food products sector has the largest employment impact (2.11, see Table 7).

[Table 6 and 7 here]

The consideration of opportunity costs remains important to the impact results. Now, the additional negative shock to the wholesale trade sector results in reduced indirect and induced effects to $566,443, implying a net output multiplier of 1.56, and reflecting an 11% decrease when accounting for opportunity cost. Likewise, the employment impact declines to 10.05 jobs (3.42 from indirect impacts, 1.43 from induced), reflecting a 10% decrease from Model 2 without considering opportunity costs. Accordingly, the total employment multiplier declines by 10% to 1.94 (0.66 from indirect effects, 0.28 from induced impacts). The total employment impact to the farm products sector remains unchanged when incorporating opportunity cost (2.11, see Table 7).

As with Model 1, the relative distribution of effects is similar across versions of Model 2. We restrict our attention to the model that explicitly accounts for opportunity costs. Figure 3 provides a visual representation of the industry effects, along with the component indirect and induced contributions. The food hub farm sector receives the largest positive impact ($194,582) from the change in final demand, and is almost entirely from indirect effects. When we compare the farm-level impacts to Model 1, we see a 7% increase.

[Figure 3 here]

The ranking of the top five sector effects remain the same as that with Model 1. Notably, support activities for agriculture and forestry are considerably higher in Model 2 ($15,477) than Model 1 ($3,196), reflecting the higher industry linkages with this sector by food hub farms (Table 5).

Discussion and Conclusions

This paper provides a replicable empirical framework to conduct impact assessments for food hub organizations. By collecting detailed expenditure and sales information from food hubs, a SAM analysis-by-parts approach was used to estimate the multiplier effects of a change in final demand for food hub products. In addition, by collecting similar detailed information from food hub farms, the downward bias in using default agricultural production data can be lessened and result in more accurate assessments of a food hub's economic activity. Finally, by collecting detailed customer (downstream) information on purchasing patterns from food hubs, a better understanding of the important factors affecting opportunity costs associated with increases in food hub product purchases (i.e., offsets via decreases in purchases in other sectors) can be attained.

Our particular application considered RA, a food hub operating in NYS. Importantly, we demonstrate that the farms selling to the food hub have different production functions than those that are constructed using an aggregate NYS farm sector in IMPLAN – i.e., the SAM technical and regional purchase coefficients found in the default IMPLAN agricultural sectors do not accurately reflect activities of the food hub farms in our study. From the comparative modeling exercise, we show that the estimated multiplier effects on the farm sector are 7% lower when using the default data and, overall, the total output multiplier is biased downward by 4%. Additionally, using the default data underestimates the employment multiplier by over 13%. If the farms in our case study are shown to be typical in other studies, the impact of food hubs utilizing default IMPLAN agricultural sector data will likely under-estimate the true magnitude of the local economic impact, including undercounting the employment impact. Further, additional spending by the food hub farms per unit of output on employee compensation, other agricultural sectors, and support activities for agriculture and forestry, may be particularly important for rural economies – food hubs may have the ability to strengthen the interlinked network of business to business and business to customer sales within rural regions.

Results from the model incorporating food hub-farm specific data show a gross output multiplier of 1.75. However, using customer data, we estimate that for every $1 increase in final demand for food hub products, a $0.11 net offset in purchases from other sectors occur. After accounting for this offsetting negative shock, the output multiplier is 1.57, reducing the gross multiplier by 12%. Future impact assessments on food hubs should importantly consider opportunity costs.

Customer survey results provide evidence that there are opportunities for expansion within the food hub sector, primarily through improved logistics (e.g., lower minimum order sizes and increased frequency of deliveries) and expanded product offerings. Based on our findings, policies resulting in increased final demand for food hub products will have a positive community economic impact (even when opportunity costs are considered).

As discussed earlier in this paper, our results are based on one case study, and thus extending the results beyond the methodological recommendations may be problematic, particularly for food

hubs whose business model is considerably different (e.g., include food processing). Though we caution against generalizing the results of our case study to other food hubs, in the context where a food hub operates in a region with similar scale producers growing similar commodities, and performs similar functions, analysts without the resources to collect local food hub and farm data are likely to find the case study data preferable to IMPLAN farm sector default data. Further, given that Fischer, et al. (2013) estimate a very similar level of COGS, and the Farm Credit Council (2013) estimate similar expenditures on employee compensation, this may give some indication that RA, in some capacities, exhibits an expenditure pattern similar to an 'average' food hub. In any case, the data collection procedure described can be used by researchers interested in conducting similar studies of food hub operations.

Future Research

There are many areas for future research that emerged from this study. We fully support the recommendations of O'Hara and Pirog (2013) that "collective understanding of the relationship between local foods and economic development can be enhanced through improving data collection, undertaking studies on larger geographic scales…and forming a learning community to review and critique studies" (1). Our results provide evidence that economic impact assessments of food hubs will underestimate local impacts, as well as the distribution of impacts, if they depend on IMPLAN default data, and thus will benefit from data collection from farm participants. The challenge is that this type of data collection is time consuming and expensive; as presented, the data needs for this type of research are significant. The USDA Agricultural Resource Management Survey (ARMS) data provide a valuable source of information on farm expenditure patterns, but the sample size for local food system participants (not to mention those selling to food hubs) is extremely small. In addition, there is little useful information on *location* of expenditures. This information would be valuable, and facilitate more regular evaluation of these types of initiatives.

This study presents information based on one case study, and the broader application of its recommendations will clearly benefit from refinement via a learning community. For example, how do the economic impacts of food hubs change when a hub works only with fresh product producers (i.e., no value added products)? Further, our food hub farm survey was designed to correspond to IMPLAN sectors, rather than to farm profit and loss statements. There are merits and weaknesses to this approach, and as data of this sort continue to be collected, future research to determine more standardized data collection protocol is extremely important – particularly to compare the results across studies.

Finally, we recommend additional research that compares different models and structures for aggregating and moving locally-grown products into different types of market outlets. Conducting market channel assessment studies similar to those conducted by Hardesty and Leff (2010) and LeRoux et al. (2010) are recommended to better understand the net impact of food hubs on participating producers, particularly in comparison to other available market outlets.

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Appendix 1: Regional Access Sector Aggregation Scheme

Regional Access Expense	Model Sector	Original 2-digit NAICS sectors	Revised IMPLAN sectors
--	11 Ag Forestry Fishing and Hunting*	1-19	5, 7-9, 15-18
Food Sold – farm	Farm Products	--	1-4, 6, 10-14
--	Support activities for agriculture and forestry	--	19
--	21 Mining	20-30	20-30
Utilities – electric	22 Utilities	31-33	31-33
--	23 Construction	34-40	34-40
--	31-33 Manufacturing*	41-318	41, 42, 48, 49, 71-114, 116-318
Food Sold - Nonfarm	Manufactured Food	--	43-47 + 50-70
Fuel Expense	Petroleum Refineries	--	115
	42 Wholesale trade [a]	319	319
--	44-45 Retail trade* [a]	320-331	320-325, 327-331
Fuel Expense	Retail stores – Gasoline stations [a]	--	326
--	48-49 Transportation and Warehousing	332-340	332-340
--	51 Information	341-353	341-353
--	52 Finance and Insurance	354-359	354-359
--	53 Real estate and rental*	360-366	360, 361, 363-366
Rental truck expense; lease trucks	Automotive equipment rental and leasing	--	362
--	54 Professional-scientific and technical services	367-380	369-380
--	55 Management of companies	381	381
--	56 Administrative and waste services	382-390	382-390
--	61 Educational Services	391-393	391-393
--	62 Health and social services	394-401	394-401
--	71 Arts-entertainment and recreation	402-410	402-410
--	72 Accommodation and food service	411-413	411-413
--	81 Other services*	414-426, 433-436	415, 416, 418-421, 423-426, 433-436
Truck repairs and maintenance	Automotive repair and maintenance, except car washes; Commercial and industrial machinery and equipment repair and maintenance	--	414, 417
--	92 Government and Non NAICS	427-432, 437-440	427-432, 437-440

*Edited 2-digit NAICS sector
[a] Sector requires margining

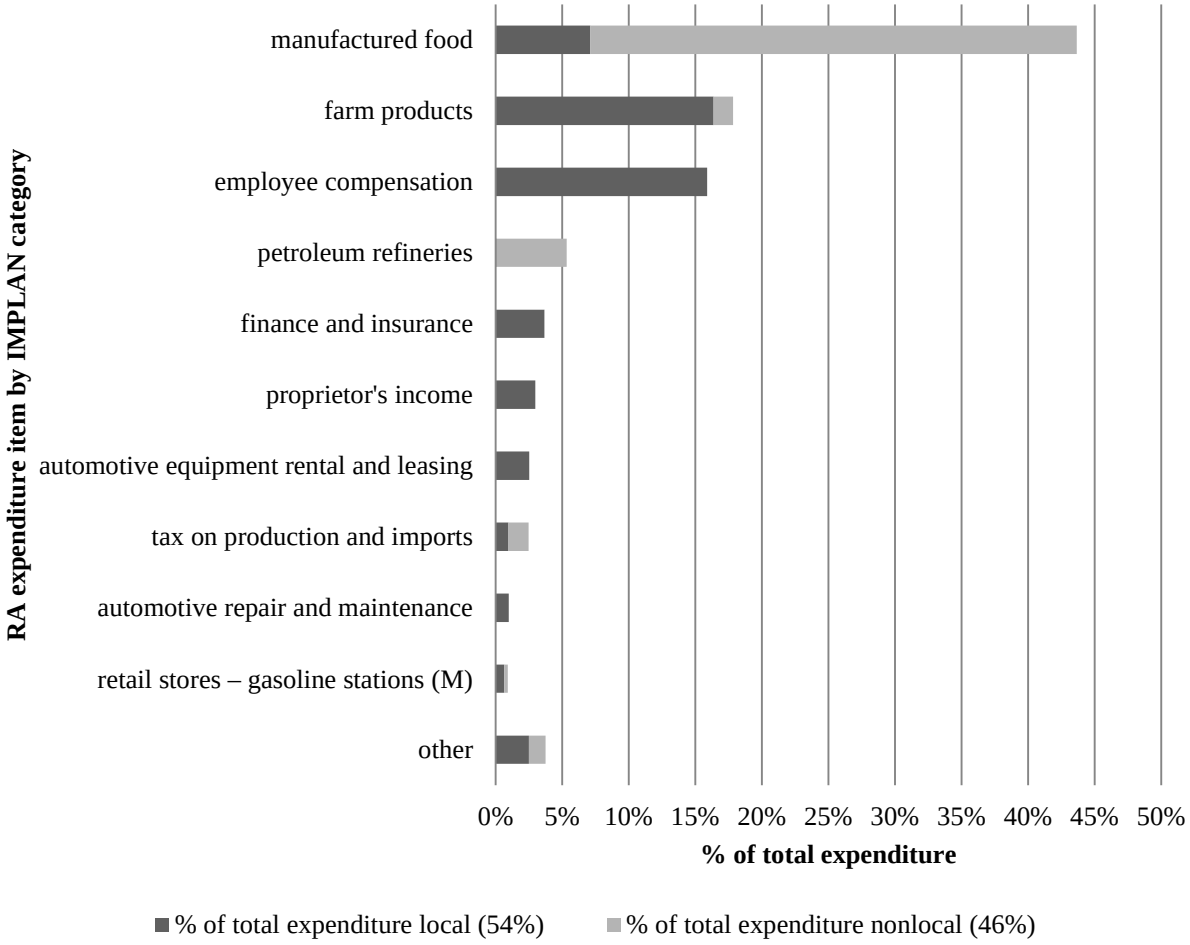

Figure 1. RA Expenditures as Percentage of Total, Local and Nonlocal (M) Margined Sector

Table 1. Food Hub Farm Average Expenditures by IMPLAN Sector and % Local

	Average Expenditure by Category		
Food hub farm expenditure by IMPLAN category	Local ($)	Local (%)	Total ($)
employee compensation	$ 141,644	100%	$ 141,644
farm products	$ 95,282	93%	$ 102,884
manufacturing*	$ 16,330	16%	$ 99,089
support activities for agriculture and forestry	$ 47,377	92%	$ 51,496
tax on production and imports [b]	$ 33,694	100%	$ 33,694
proprietor's income	$ 31,913	100%	$ 31,913
transportation and warehousing [a]	$ 19,821	80%	$ 24,755
wholesale trade (M) [a]	$ 9,349	53%	$ 17,768
finance and insurance	$ 13,106	85%	$ 15,403
other property type income	$ 11,467	80%	$ 14,334
Construction	$ 13,980	99%	$ 14,143
retail trade*(M)	$ 9,360	83%	$ 11,281
Utilities	$ 10,901	100%	$ 10,901
real estate and rental*	$ 8,604	100%	$ 8,604
manufactured food	$ 5,872	75%	$ 7,843
professional-scientific and technical services	$ 5,569	98%	$ 5,690
automotive repair and maintenance	$ 5,646	100%	$ 5,646
Information	$ 1,793	96%	$ 1,864
administrative and waste services	$ 1,217	100%	$ 1,217
other services*	$ 817	87%	$ 941
Total	$ 483,741	80% [b]	$ 601,110

*Edited 2-digit NAICS sector
(M) margined sector
[a] We asked food hub farms how much they purchased from Regional Access as a percentage of total expenses. On average, food hub farms reported spending $6,398 on products from RA, including freight service, other farm products (i.e., products for re-sale at a farm stand), and warehousing/storage. In this table we show these expenditures mapped evenly between 'wholesale trade' and 'transportation and warehousing'.

Table 2. Food Hub Farm Sales, Average and Percent Local

Food Hub Farm Sales by Outlet	Sales Average ($)	Local (%)
other farms	$102,884	93%
direct-to-consumer (households)	$144,173	100%
food hub (Regional Access)	$37,200	100%
other intermediated sales	$279,701	84%
commodity sales	$37,152	100%
Total	$601,110	91%

Table 3. Summary of Expenditure Patterns Per Dollar of Output for the Default Agricultural Sector (Farm Products) and the Food Hub Farm Sector

	Value of purchases per dollar of output	
Selected Industry Sector/Value Added Components	Farm Products (Default)	Food Hub Farm
farm products [a]	$0.06	NA
food hub farm [a]	NA	$0.16
other farm [a]	NA	$0.00
support activities for agriculture and forestry	$0.02	$0.08
Utilities	$0.02	$0.02
Construction	$0.00	$0.02
Manufacturing	$0.02	$0.03
wholesale trade	$0.01	$0.02
retail trade	$0.00	$0.02
transportation and warehousing	$0.01	$0.03
finance and insurance	$0.04	$0.02
real estate and rental	$0.05	$0.01
professional scientific and technical services	$0.01	$0.01
automotive and machinery repair and maintenance	$0.00	$0.01
other sector purchases	$0.01	$0.02
Total intermediate purchases	$0.25	$0.44
employee compensation	$0.12	$0.24
proprietor's income	$0.16	$0.05
other property type income [b]	$0.12	$0.02
tax on production and imports [b]	$0.00	$0.05
Total payments to value added	$0.40	$0.36
Intermediate imports	$0.35	$0.20

[a] This table reports results from Model 1 and Model 2. The default agricultural sector exists as the farm products sector in Model 1, and the food hub farm sector and the other farm sector exist in Model 2; i.e., Model 2 splits the default agricultural sector into two distinct sub-sectors based on the survey data.

[b] In our models, all of other property type income and tax on production and imports are rendered exogenous.

Table 4. Model 1 Output Results of a Million Dollar Increase in Food Hub Final Demand [a]

Industry Sectors	Indirect plus Induced Impacts	
	No Opportunity Cost	Opportunity Cost
farm products [b]	$180,742	$180,606
finance and insurance	$89,424	$80,860
manufactured food	$78,588	$77,988
real estate and rental	$57,853	$47,340
all other sectors	$54,412	$42,532
health and social services	$37,270	$30,319
automotive equipment rental and leasing	$25,854	$25,727
professional scientific and technical services	$23,894	$16,265
retail trade	$23,116	$18,903
utilities	$18,967	$17,261
information	$18,079	$14,435
accommodation and food service	$17,753	$15,264
wholesale trade	$17,534	-$100,236
manufacturing	$14,029	$12,246
automotive and machinery repair and maintenance	$11,705	$11,275
transportation and warehousing	$11,222	$8,032
support activities for agriculture and forestry	$3,199	$3,196
Total industry sectors	$683,642	$502,011

[a] The results of Model 1 utilize the agriculture sector as described below, prior to splitting the sector into the food hub farm sector and the other farm sector.

[b] The 'farm products' sector is defined to be an aggregation of production sectors in IMPLAN consistent with the types of commodities produced by the surveyed farms that sell products to food hubs. This includes oilseed farming, grain farming, vegetable and melon farming, fruit farming, greenhouse, nursery and floriculture farming, all other crop farming, cattle ranching and farming, dairy cattle and milk production, poultry and egg production, and all other animal production.

Table 5. Model 1 Indirect Plus Induced Employment Impacts of a Million Dollar Increase in Food Hub Final Demand [a]

Industry Sectors	Indirect plus Induced Impacts	
	No Opportunity Cost	Opportunity Cost
farm products [b]	1.52	1.52
health and social services	0.41	0.34
retail trade	0.30	0.24
finance and insurance	0.27	0.25
accommodation and food service	0.25	0.21
manufactured food	0.17	0.17
automotive and machinery repair and maintenance	0.15	0.15
real estate and rental	0.14	0.12
support activities for agriculture and forestry	0.13	0.13
professional scientific and technical services	0.13	0.09
automotive equipment rental and leasing	0.13	0.13
all other sectors	0.13	0.11
administrative and waste services	0.12	0.07
transportation and warehousing	0.10	0.07
wholesale trade	0.09	-0.51
other services	0.09	0.07
retail stores gasoline stations	0.09	0.09
educational services	0.08	0.06
government and nonNAICS	0.06	0.05
arts entertainment and recreation	0.06	0.05
information	0.05	0.04
Total industry sectors	4.46	3.42

[a] The results of Model 1 utilize the agriculture sector as described below, prior to splitting the sector into the food hub farm sector and the other farm sector.

[b] The 'farm products' sector is defined to be an aggregation of production sectors in IMPLAN consistent with the types of commodities produced by the surveyed farms that sell products to food hubs. This includes oilseed farming, grain farming, vegetable and melon farming, fruit farming, greenhouse, nursery and floriculture farming, all other crop farming, cattle ranching and farming, dairy cattle and milk production, poultry and egg production, and all other animal production.

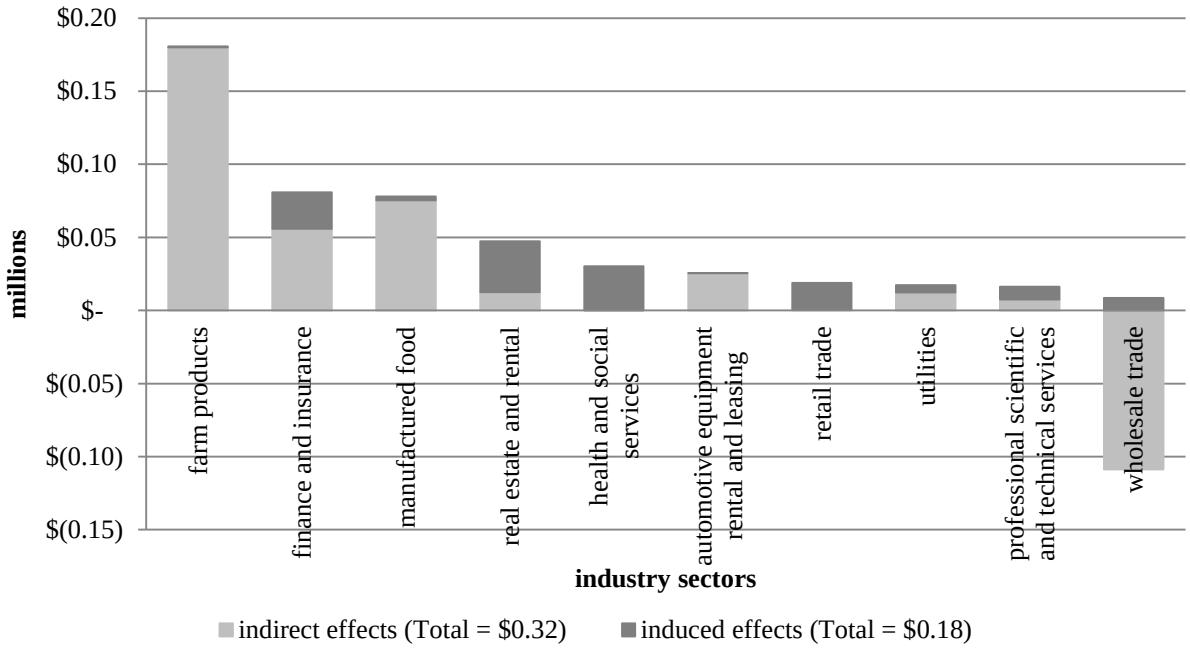

Figure 2. Indirect and Induced Effects Per $1,000,000 Increase in Final Demand (Top Impacted Industry Sectors), Model 1 Including Opportunity Cost

Table 6. Model 2 Impact Results [a]

Industry Sectors	Indirect plus Induced Impacts	
	No Opportunity Cost	Opportunity Cost
food hub farm [a]	$194,583	$194,582
finance and insurance	$89,695	$81,131
manufactured food	$80,513	$79,912
all other sectors	$60,408	$48,528
real estate and rental	$54,820	$44,308
health and social services	$40,224	$33,272
retail trade	$27,898	$23,684
professional scientific and technical services	$26,374	$18,745
automotive equipment rental and leasing	$25,801	$25,674
utilities	$20,477	$18,771
information	$19,527	$15,884
wholesale trade	$19,226	-$98,544
accommodation and food service	$18,614	$16,125
manufacturing	$16,657	$14,873
transportation and warehousing	$16,402	$13,212
support activities for agriculture and forestry	$15,481	$15,477
automotive and machinery repair and maintenance	$13,598	$13,168
other farm [a]	$7,775	$7,640
Total industry sectors	$748,074	$566,443

[a] The results of Model 1 include an aggregated agriculture sector defined as 'farm products' and is an aggregation of production sectors in IMPLAN consistent with the types of commodities produced by the surveyed farms that sell products to food hubs. This includes oilseed farming, grain farming, vegetable and melon farming, fruit farming, greenhouse, nursery and floriculture farming, all other crop farming, cattle ranching and farming, dairy cattle and milk production, poultry and egg production, and all other animal production. Model 2 splits this 'farm products' sector into the 'food hub farm' sector and the 'other farm' sector, such that the 'farm products' sector no longer exists.

Table 7. Model 2 Indirect Plus Induced Employment Impacts of a Million Dollar Increase in Food Hub Final Demand [a]

Industry Sectors	Indirect plus Induced Impacts	
	No Opportunity Cost	Opportunity Cost
food hub farm [a]	2.11	2.11
support activities for agriculture and forestry	0.65	0.65
health and social services	0.45	0.37
retail trade	0.36	0.30
finance and insurance	0.27	0.25
accommodation and food service	0.26	0.23
automotive and machinery repair and maintenance	0.18	0.17
manufactured food	0.17	0.17
professional scientific and technical services	0.15	0.10
transportation and warehousing	0.14	0.11
real estate and rental	0.13	0.11
administrative and waste services	0.13	0.09
automotive equipment rental and leasing	0.13	0.13
wholesale trade	0.10	-0.50
other services	0.09	0.07
retail stores gasoline stations	0.09	0.09
all other sectors	0.09	0.08
educational services	0.08	0.07
construction	0.07	0.07
arts entertainment and recreation	0.07	0.05
other farm [a]	0.07	0.06
government and nonNAICS	0.06	0.05
information	0.05	0.04
Total industry sectors	5.89	4.86

[a] The results of Model 1 include an aggregated agriculture sector defined as 'farm products' and is an aggregation of production sectors in IMPLAN consistent with the types of commodities produced by the surveyed farms that sell products to food hubs. This includes oilseed farming, grain farming, vegetable and melon farming, fruit farming, greenhouse, nursery and floriculture farming, all other crop farming, cattle ranching and farming, dairy cattle and milk production, poultry and egg production, and all other animal production. Model 2 splits this 'farm products' sector into the 'food hub farm' sector and the 'other farm' sector, such that the 'farm products' sector no longer exists.

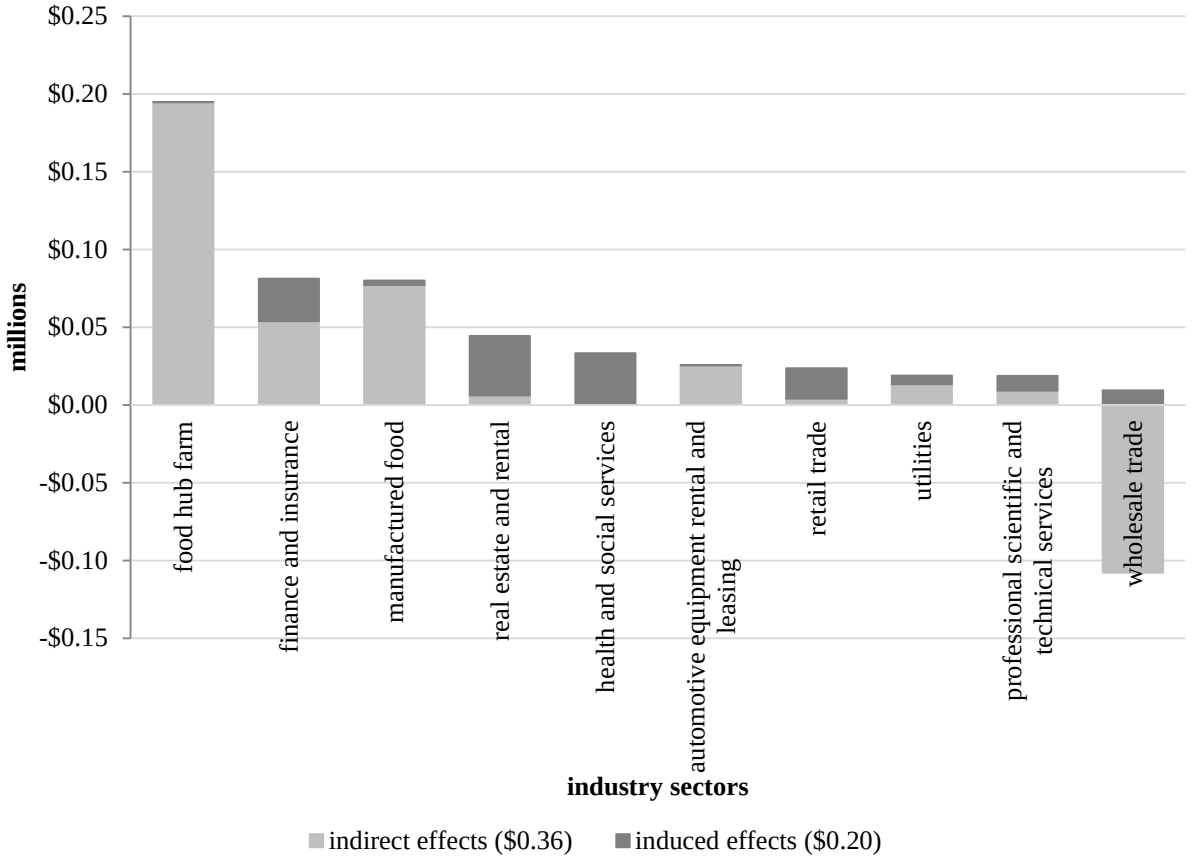

Figure 3. Indirect and Induced Effects Per $1,000,000 Increase in Final Demand (Top Impacted Industry Sectors), Model 2 Including Opportunity Cost

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