Valuing Michigan's Local Food System:

A Replicable Model for Valuing Local Food

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Abstract

We use the underlying data of the IMPLAN Pro 3 regional economic simulation model to estimate the current economic contribution of Michigan's local food system and explore the chain of transactions giving rise to consumption of locally sourced goods from producer to processor to consumption. The model provides a replicable and consistent approach to estimating the value of local food systems within regional and state economies.

Introduction

This study describes the methodology used by the Center for Economic Analysis (CEA) at Michigan State University (MSU) to estimate the economic contribution of production and consumption of Michigan-grown food. The input-output framework for estimating the value of Michigan's local food system in this study utilizes three primary data sources and establishes a protocol for estimating the economic contribution of local foods. Estimates can be made for county, multi-county regions, and for state economies. Data sources consist of data readily provided by the USDA National Agricultural Statistics Service (NASS) and the IMPLAN modeling system. Finally, a survey of major Michigan food processors was conducted for comparison with IMPLAN data.

Economic development professionals are increasingly looking at local food systems as economic development opportunities (Marsden, Banks, and Bristow, 2000; Bellows and Hamm, Meter, 2008). This has led to several estimates of economic impacts of local food (NA, 2010; Otto, 2010; Shuman, n.d.; Sonntag, 2008; TXP Inc., 2013), including academic studies (Brown and Miller 2008, Bubinas, 2009; Hughes and Isengildina-Massa, 2013; Hughes, Brown, Miller, and McConnell, 2008; Myles and Hood, 2008; Swenson, 2009). A review of these studies reveals that there is wide variation in the estimates themselves as well as in the approaches (O'Hara and Pirog 2013). Along with direct impacts, most approaches employ some method of estimating secondary impacts of local food systems. These secondary impacts relate changes in direct expenditures to all expenditures within the defined economy. However, there is not a consensus as to how to measure secondary impacts, nor is there agreement as to what comprises "local" food (O'Hara and Pirog 2013).

Researchers suggest that the promotion of local food systems is an economic development proposition that places economic growth prospects within the control of the community (Campbell 1997; King, Gomez, DiGiacomo 2010). That is, policies promoting the development of local food systems may operate in conjunction with or compete with more traditional economic development strategies, such as industry attraction. This follows greater recognition of the failure of traditional economic development paradigms and increased interest in developing regional economies from within (Loveridge 1996, Nizalov and Loveridge 2005). Such strategies focus on expanding existing businesses and supporting the development of new businesses using existing human capital in the local region. The perception of such policies is that they facilitate greater local control over the economic development effort. This perception also contributes to the popularity among local policy makers of developing local food systems, especially within smaller and rural economies.[1]

The empirical research presented in this report measures the economic contribution of local foods to Michigan's economy. More specifically, we propose a method of measuring the economic contribution of local food systems using resources readily available by economic development researchers. The first

[1] The local food movement may provide new opportunities for rural entrepreneurial activity, and for many rural communities entrepreneurship has been pointed to as a pathway toward more sustained economic growth (Dabson, 2007; Hanham, Loveridge & Richardson, 1999). On the other hand, the local food movement is still in its youth and the impact from rural entrepreneurs' identification and exploitation of these new and potential opportunities is unclear.

section presents the input-output framework, especially as it relates to local economies. The second section describes the approach used to estimate the economic contribution of Michigan's local food system. This methodology may also be appropriate for measuring other state's local food systems or for measuring local foods at a smaller level of unit, e.g., county or MSA. For purposes of this report, "local food" is defined as food grown in Michigan that remains within the state for processing and for consumption. The data sources for this study and the use of the IMPLAN economic impact simulation system are discussed in greater detail in the methods sections. While the proposed methodology is intended to capture the full view of local foods systems, shortcomings of our approached are discussed in the forthcoming sections. The final section of this report summarizes the CEA's findings.

Input-Output framework as it relates to local economies

IMPLAN is a regional economic modeling system based on the work of Leontief in the late 1920s and early 1930s (Leontief 1951). Leontief's input-output modeling system is a double-entry accounting framework, where each purchase leads to an identical sale valued in dollars. While input-output economics is most often associated with impact estimation, its system of tracking transactions across the economy make it an ideal framework for understanding the transactions that make up the local food system. Hence, this framework is an ideal approach to measuring local food systems, as food marketing systems are complex due, in part, to the high number of small and part-time producers, and the large amount of diversity of value-added that occurs in the supply chain (Khohls and Uhl 2002).

A little bit of background in regional input-output models is needed to provide context. Regional input-output models are largely adopted from larger national models. More specifically, most regional input-output models start from a national system of accounts that track transactions across industries in the production of goods and services and track transactions between industries and institutions (made up of non-production segments of the economy). For the U.S., the U.S. Department of Commerce's Bureau of Economic Analysis is charged with developing and maintaining the Benchmark Input-Output Accounts (BEA, 2013). Because maintaining similar accounts for every region in the U.S. would be prohibitively expensive, regional models generally rely on regionalized versions of the national Benchmark Input-Output Accounts. This has led to considerable debate in academic circles about the role of regional input-output modeling in regional economic analysis (Isard et al., 1998; Miller and Blair, 2009, Pirog and O'Hara, 2013). Despite shortcomings to be discussed, input-output modeling has become a staple of regional economic analysis due to its intuitive framework and usefulness as a research tool.

Early input-output models relied on surveys of businesses to estimate the value of transactions across the region. However, these approaches are extremely expensive for generating and maintaining input-output accounts (Round 1983). Instead, regional transactions are generally derived from the national input-output table adjusted to reflect availability of local supply. That is, regional input-output models make the assumption that production and consumption in the modeling region largely reflect the same as that for the nation (Isard, 1953). This assumption is largely negated in regional economies, as the national economy has access to a greater breadth of goods and services than sub-regions (Richardson, 1972). For example, in the U.S., a sizable share of orange juice consumption is provided by domestic orange growers. However, in Michigan orange juice represents an import, as no oranges are grown in

locally. For this reason, national transactions are not sufficient to represent the values of sub-regional transactions. The national transactions table, while assuming the same consumption and trade patterns as the nation, must be adjusted to recognize domestic imports of goods and services where locally sourced options may be insufficient to meet local demand. Regional economists have invested extensive research on devising methods for estimating the local shares of commodity purchases within sub-national regions.

The method of estimating regional transactions has been described as the "Weakest Link" in the regional modeling system (Swanson, Morse, and Westeren, 1999). Estimates generally start from national estimates of the value of transactions stated in terms of shares, called a direct requirements coefficient. The direct requirements coefficient describes the proportion of the value of total commodity production made up of purchases from other industries within the region. Starting with the national direct requirements coefficient, a regionalized coefficient can be estimated by subtracting domestic imports' share from the national coefficient, as,

$$a_{ij}^{r} = a_{ij}^{n} - m_{ij}^{r}. \quad (1)$$

In equation 1, a_{ij} is the share of production of commodity *j* made up of inputs of commodity *i*, the superscripts "*n*" and "*r*" denote nation and region, respectively, and *m* adjusts the national direct requirements coefficient to reflect local availability. That is, the coefficient "*m*" measures the portion of commodity *i* in the production of commodity *j* that is imported from outside the region. Equation 1 simply says that the regional shares of purchases from local suppliers are equal to the U.S. share minus domestic imports of *i*. This explicitly assumes that local and national production of commodity *j* uses the same inputs, but that local purchases must be adjusted to reflect availability of locally sourced inputs. Equation 1 can be restated as,

$$a_{ij}^{r} = a_{ij}^{n}\left(S_{ij}^{r}\right), \quad (2)$$

where $S_{ij}^{r} = (1 - m_{ij}^{r})$ is the proportional share of commodity *i* supplied locally for the production of commodity *j*. Estimates of S_{ij}^{r} can be as daunting as building a direct requirements matrix by scratch, requiring $N \times N$ estimated coefficients. However, by assuming all users of commodity *i* consume locally supplied and imported values in fixed proportion, the number of share coefficients to estimate is reduced to *N* – the number of commodities. This assumption modifies equation 2 as,

$$a_{ij}^{r} = a_{ij}^{n}(S_{i}^{r}), \quad (3)$$

where S_{i}^{r} is known as the regional purchase coefficient (RPC) of commodity *i*. In equation 3, all uses of commodity *i* have the same proportional relationship between locally sourced to imported sources. The assumption of fixed proportion of regional supply over all purchasing segments *j* has far-reaching implications as will be discussed later.

With properly specified RPCs, the resulting regionalized direct requirement matrix has been shown to be mostly accurate (Lahr, 1998). For many regional economists, RPCs represent the most fallible

component of regional input-output analysis (Lahr, 1998),[2] and regional economists have been pre-occupied with methods of estimating RPCs since the 1950s, giving rise to a wealth of methods for estimation.[3] Most approaches share a common trait in that estimated RPCs compare expected regional demand to local supply. While a review of these approaches is beyond the scope of this study, the approaches are extensively covered in Miller and Blair (Miller and Blair, 2009), Richardson (1983) and Round (1983).

Despite improved methods of estimating RPCs, the use of a single value that describes the share of locally supplied inputs to all uses imposes a distinct weakness in building regional input-output tables. For example, locally sourced unprocessed foods make up the same share of sales to Michigan processors as it does of sales to households. As processors avoid shipping raw inputs over long distance in an effort to reduce operating costs, one should expect processors to actively seek local suppliers. Alternatively, shipping costs represent a lower share of total value of processed and package foods sold to households. Hence, the RPCs for food products may be expected to be higher for food processors than for households. In summary, accurate RPCs may fail to accurately assign transactions across all sectors of the economy, and will overstate transactions in some sectors and underestimate them in others. Unfortunately, economists have devised no practical means around this restrictive assumption of fixed shares across all uses.

Methods

IMPLAN Pro 3.0, using 2009 data for Michigan is used in this analysis to measure the value of local food in Michigan's economy. Additional data provided by the USDA National Agricultural Statistics Service is used for estimating total agricultural production. In addition, a survey of major local food processors is undertaken to augment and "ground truth" of IMPLAN estimates of regional trade in certain food sectors.

Two industry aggregates are created. The first industry aggregate, *Food Production*, is all food-related agricultural sectors. The second aggregate, *Food Processing*, is all food processing/manufacturing sectors. The remaining sectors were left un-aggregated to facilitate tracking purchases. The aggregation scheme is represented in Table 1. Aggregation is recommended for reducing the data requirements of this approach, though more detailed descriptions of the underlying transactions by commodity are possible without aggregation.

IMPLAN allows users to isolate commodities or aggregates of commodities and track downstream sales, including purchases for the production of other goods and services and purchases for final consumption.[4] At each step from production to consumption, IMPLAN reports which sectors within the

[2] Lazarus, Platas and Morse argue that the assumption of equal production technologies between the national and regional economy may be a larger source of misspecification than RPCs. See Lazarus, William F, Diego E Platas, and George W Morse. 2002. "IMPLAN's Weakest Link: Production Functions or Regional Purchase Coefficients?" *Journal of Regional Analysis and Policy*. 32 (1): 33–47.

[3] For a comprehensive exposé, see Isard, et al. 1998. *Methods of Interregional and Regional Analysis*. Ashgate Publishing Company, Brookfield, VT.

[4] The IMPLAN report described is the Commodity Balance Sheet reported under the Social Accounts section.

local economy purchase that commodity, indicate how much of a given commodity remains within the region, and how much is ultimately exported. Thus, the IMPLAN data allows the user to track the progress of commodities from production to final consumption and identify what share of output remains in the modeling region. Each transaction within the economy gives rise to added economic activity and a given commodity may be traded multiple times before final consumption. The value of commodities exported from the region ceases to generate further transactions within the region and therefore no longer contributes additional economic activity.

While all transactions in IMPLAN are recorded in dollar values of output,[5] values in terms of jobs and regional income can be derived. The standard approach to converting sales into employment and earnings in input-output modeling is to generate fixed ratios of employment and earnings, respectively, per dollar of sales. IMPLAN provides several measures derived from various government reporting agencies for making such ratios, including employment and three measures of earnings – employee wages, proprietary income, and non-employment income.

Food Production		**Food Processing**
3001: Oilseed farming		3041: Dog and cat food manufacturing
3002: Grain farming		3042: Other animal food manufacturing
3003: Vegetable and melon farming		3043: Flour milling and malt manufacturing
3004: Fruit farming		3044: Wet corn milling
3005: Tree nut farming		3045: Soybean and other oilseed processing
3006: Greenhouse, nursery, and floriculture production		3046: Fats and oils refining and blending
3009: Sugarcane and sugar beet farming		3047: Breakfast cereal manufacturing
3010: All other crop farming		3048: Sugar cane mills and refining
3011: Cattle ranching and farming		3049: Beet sugar manufacturing
3012: Dairy cattle and milk production		3050: Chocolate and confectionery manufacturing from cacao beans
3013: Poultry and egg production		3051: Confectionery manufacturing from purchased chocolate
3014: Animal production, except cattle and poultry and eggs		3052: Nonchocolate confectionery manufacturing
3017: Commercial Fishing		3053: Frozen food manufacturing
3018: Commercial hunting and trapping		3054: Fruit and vegetable canning, pickling, and drying
		3055: Fluid milk and butter manufacturing
		3056: Cheese manufacturing
		3057: Dry, condensed, and evaporated dairy product manufacturing
		3058: Ice cream and frozen dessert manufacturing
		3059: Animal (except poultry) slaughtering, rendering, and processing
		3060: Poultry processing
		3061: Seafood product preparation and packaging
		3062: Bread and bakery product manufacturing
		3063: Cookie, cracker, and pasta manufacturing
		3064: Tortilla manufacturing
		3065: Snack food manufacturing
		3066: Coffee and tea manufacturing
		3067: Flavoring syrup and concentrate manufacturing
		3068: Seasoning and dressing manufacturing
		3069: All other food manufacturing
		3070: Soft drink and ice manufacturing
		3071: Breweries
		3072: Wineries
		3073: Distilleries

Table 1: IMPLAN Commodity Aggregated Sectors

[5] Sales

For the purpose of this model, Michigan agricultural food production has two hypothetical channels from farm to consumption. The first channel is as unprocessed foods, comprised mostly of fruits, vegetables and tree nuts that are largely channeled to final consumption without further processing. These sales may arise as direct sales from farms to households through farmers' markets, community assisted agriculture (CSA) or through other means, or may be acquired through intermediation of retail facilities as fresh local produce. Unprocessed foods can take a second channel to consumers through commercial processors, where unprocessed foods are combined with other inputs such as packaging, heating and others. This larger channel makes up an often-overlooked aspect of local food consumption impacts, as local foods are commingled with imported foods in processing and then marketed globally, nationally, and/or locally. That is, challenges in measuring the share of processed food consumption supplied locally has likely contributed to the absence of studies on the economic impact of local foods. [6]

We break local consumption into three broad categories: households, food service, and institutions. Households represent at-home consumption of Michigan grown and processed foods purchased at consumer prices. Food service entails purchases of Michigan grown and processed foods at the price paid by the food service industry. It includes all food and drinking establishments, recreation establishments and accommodation services. The final consumption category is that of institutions, which entails local purchases at institutional purchase prices. This includes all local federal government expenditures for military and social programs, and state and local government expenditures (mostly comprised of social programming, primary and secondary education, and public hospital expenditures). Additionally, the institutions category includes purchases by private hospitals, residential care facilities and educational facilities as well as social services organizations. A complete breakout of consumption categories along with their respective IMPLAN sector codes are provided in Table 2.[7]

There is a material reason for using purchase prices as the basis of sales. Household prices represent final consumer prices. However, we end the local value chain for food service and institutional consumption at the point of acquisition by food service and institutions, rather than at the point of sale to the final consumer. For food service, our analysis does not posit that restaurant jobs serving local food are part of the local food value chain. For example, restaurants that serve locally-sourced foods add value to unprocessed food inputs, and sell the final product with markup. One can argue that the local food gave rise to the value added by the restaurant, and therefore should be considered part of the value chain of local food. Nonetheless, it would be difficult to share out what component of value added is attributed to the unprocessed food input from other value added activities. In addition, one has to be careful to separate out the value of the actual food from the value of the other services provided by the food service sector. Consider the IMPLAN output for amusement parks, for example, where food consumption is only one component of the total expenditures. We consider the value of the amusement park purchase for food commodities at prices paid by the park, not the price consumers pay

[6] Another potential reason this channel is frequently overlooked is that many local foods studies are focused on the consumption fresh fruits and vegetables, i.e., healthier food choices, compared to their processed counterparts. As a result, economic estimates of local foods programs only focused on direct farm-to-consumer transactions may underestimate the entire system.

[7] All other IMPLAN sectors remain disaggregated.

for it.[8] As a result, we elected to assume that the value chain ends when the commodity is sold to the food service provider.

Households
10001: Households LT10k
10002: Households 10-15k
10003: Households 15-25k
10004: Households 25-35k
10005: Households 35-50k
10006: Households 50-75k
10007: Households 75-100k
10008: Households 100-150k
10009: Households 150k+
Food Services
3007: Spectator sports companies
3007: Museums, historical sites, zoos, and parks
3007: Fitness and recreational sports centers
3007: Bowling centers
3007: Amusement parks, arcades, and gambling industries
3007: Other amusement and recreation industries
3007: Hotels and motels, including casino hotels
3007: Other accommodations
3007: Food services and drinking places
3320: Retail Stores - Motor vehicle and parts
3321: Retail Stores - Furniture and home furnishings
3322: Retail Stores - Electronics and appliances
3323: Retail Stores - Building material and garden supply
3324: Retail Stores - Food and beverage
3325: Retail Stores - Health and personal care
3326: Retail Stores - Gasoline stations
3327: Retail Stores - Clothing and clothing accessories
3328: Retail Stores - Sporting goods, hobby, book and music
3329: Retail Stores - General merchandise
3330: Retail Stores - Miscellaneous
3331: Retail Nonstores - Direct and electronic sales
Institutions
11001: Federal Government NonDefense
11002: Federal Government Defense
12001: State/Local Govt NonEducation
12002: State/Local Govt Education
3397: Private hospitals
3398: Nursing and residential care facilities
3391: Private elementary and secondary schools
3392: Private junior colleges, colleges, universities, and professional schools
3393: Other private educational services
3399: Child day care services
3400: Individual and family services
3401: Community food, housing and other relief services
3423: Religious organizations
3425: Civic, social, professional, and similar organizations

Table 2: Consumption Categories

[8] In essence, it would be difficult to estimate the value at the price consumers pay at amusement parks, as this would require estimating the share of total amusement park revenues arising from food sales.

Food Processor/Distributor Interviews

Interviews were conducted with ten Michigan food processor businesses in the spring of 2013. More specifically, of the 10 food processor businesses; 4 were classified as processors, 4 were packer shippers and 2 were distributors. Processors in this context are defined as businesses, which receive raw agricultural products, process them to canned or frozen products, or into packaged processed foods for sale to institutional buyers, food distributors or directly to consumers. Packers/shippers are described as businesses which receive agricultural products from various sources and sell the product to institutional buyers, food distributors, or directly to consumers. The business may package the raw product itself or receive packaged product that it sells on a commission. Distributors in this context are specifically described as businesses which purchase processed or packaged food items for sale to institutional buyers, food distributors, or directly to consumers.

Interview questions included annual gross sales of the business, annual expenses of the business, and the proportions of sales to national and state retailers and distributors, respectively. Interviewees were also asked to estimate what percentage of their product ultimately stayed in the state, the source of purchased food inputs by geography and the values of these purchases. The interviews did not collect data from businesses that traded with each other to avoid double counting of raw product in these measurements of the supply chain.

The interview included respondents with annual sales that ranged from just under $200,000 to $170,000,000. Interviewed establishments accounted for approximately 13.3 percent of the value of the total locally produced raw agriculture inputs produced in Michigan. Table 3 shows summary values from the survey mapped into IMPLAN categories used in this analysis. Only 11 of the food production and food processing sectors were represented in the survey. The first column indicates the proportion of inputs supplied by local sources, while the second column indicates the share of output that is expected to remain local for consumption.

Broad input category	% purchased locally	% available locally
Vegetable and melon farming	56.07%	10.68%
Fruit farming	58.60%	4.71%
Tree nut farming	100.00%	95.00%
Cattle ranching and farming	87.00%	13.85%
Dairy cattle and milk production	99.00%	98.01%
Poultry and egg production	20.34%	18.34%
Animal production, except cattle and poultry and eggs	75.00%	15.26%
Frozen food manufacturing	99.00%	98.01%
Fruit and vegetable canning, pickling, and drying	100.00%	15.00%
Cheese manufacturing	29.13%	27.25%
Snack food manufacturing	99.00%	98.01%

Table 3. Summary statistics of food processors survey

Findings

We use the IMPLAN Commodity Balance reports for the two industry aggregates, Food Production and Food Processing. The flow from agricultural production to consumption, as modeled in the IMPLAN data is shown in Figure 1. Starting with the Food Production aggregate made up entirely of food-related agricultural sectors, IMPLAN reports that in 2009 total state level of agricultural output was $5.67 billion.[9] About $3.13 billion was directly exported out of the state, while $2.51 billion remained local. For the $2.51 billion worth of unprocessed agricultural foods $1.54 billion was sold to processors and $645.9 million was sold to households, food service industries or institutions charged with providing food services. The remaining $328.7 million where sold through other channels without knowing where final consumption took place.

The unprocessed channel consists of consumption of unprocessed foods including direct household consumption, food service purchases and institutional purchases. Households purchase unprocessed food through direct purchases from farms through farmers markets, community supported agriculture (CSA) and roadside stands, but also through intermediated purchases at retail outlets where unprocessed produce is sold. IMPLAN reports, that in 2009, about $560 million dollars of household expenditures for unprocessed foods came from Michigan agricultural producers. Food service purchases of locally-sourced-unprocessed food totaled $67 million. This is measured in the price food service businesses paid, rather than the value they sold to their customers. Finally, institutional purchases totaled $19 million in 2009.

Unprocessed foods channeled through food processers are subject to price markups before final purchase for consumption. This markup represents payments to labor, capital owners, indirect business taxes, as well as the value of inputs that go into processing foods, including energy, packaging, other food imports and others required to process unprocessed foods to final goods for delivery to retail establishments or direct sales for household consumption, food service, and institutional purchases. IMPLAN's commodity balance sheet is once again used to generate the value of statewide transactions of processed foods. However, because a sizeable portion of Michigan processed foods come from imported raw foods, only the proportion made up of locally sourced inputs should be used. In this, an assumption is made that the contribution of the value of locally processed food items is equal to proportion of food inputs made up of locally sourced unprocessed food.

While food processors purchase $1.54 billion in Michigan-supplied unprocessed food, IMPLAN estimated that total sales of Michigan processed food was $36.6 billion in 2009. This includes sales to other food processors, service providers, households and for export. However, we are only concerned with those sales made up of locally sourced inputs and sold locally. Hence, processed foods that are eventually exported are excluded. IMPLAN's estimated RPC suggests that about 35.7 percent of Michigan's unprocessed agricultural food product demand was sourced from Michigan producers in 2009. Alternatively, the RPC for processed food (share of purchases from local processors) was estimated at 34.9 percent. This suggests that about 12.5 (=0.357*0.349*100) percent of final consumption of

[9] This compares favorably with USDA, ERS estimates of 2009 Michigan food agriculture output of $5.79 billion which includes home consumption and the value of inventory adjustment for goods not sold by December 31.

processed food in Michigan is made up of locally sourced food. As discussed above, this ratio is constant over all sales, whether they are made to households, food service, institutions or other processers.

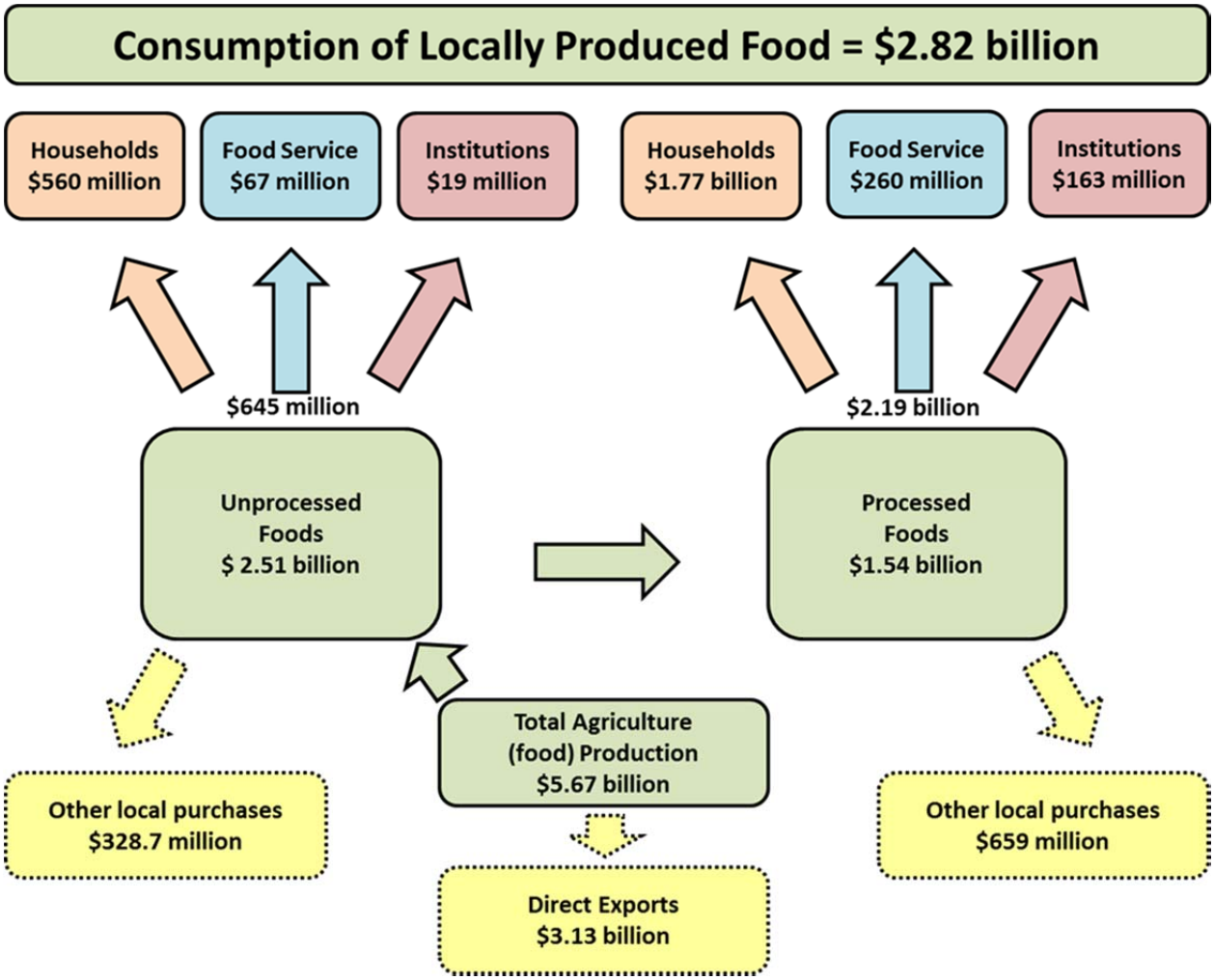

Figure 1: 2009 Sales Value of Michigan Local Food Chain

Source: Authors' calculations based on IMPLAN 2009 Michigan data

Returning back to Figure 1, the second channel to consumption indicates that $1.54 billion in Michigan-sourced, unprocessed food products went to Michigan processors. Raw inputs are combined with value added processing before being sold as processed foods. Only Michigan sales arising from locally sourced raw inputs processed by local processors are counted toward the total value of local food sales. As depicted in Figure 1, household purchases of local processed foods generated $1.77 billion in total sales. For food service and institutional purchases, the values of locally-sourced processed foods total $260 million and $163 million, respectively. Similar to the discussion around unprocessed foods, the value of food service and institution sales is set at the point of sale from the processor so as not to count the value added of food preparation at restaurants or institutions. In total, locally sourced foods totaled about $2.20 billion in Michigan sales for consumption in 2009. Other in-state transactions for processed

foods were observed that totaled $659 million, but these transactions do not fall into the consumption categories shown in Table 2 and the nature of these transactions put into question their role in the local food chain. They are therefore excluded from the final calculations.

Combining processed and unprocessed food consumption in Michigan, locally sourced food comprised about $2.82 billion dollars in 2009 according to IMPLAN data sources. While food production agricultural sales totaled about $5.67 billion in 2009, approximately 55.7 percent was exported, while the remaining 44.3 percent, or $2.51 billion, was delivered within the state. Using IMPLAN, our best estimate is that in 2009 sales for consumption of Michigan sourced unprocessed foods totaled $645.9 million, and sales for consumption of Michigan sourced and processed foods totaled $2.2 billion. This values 2009 local food sales at $2.84 billion.

Interviews with processors provided comparisons with IMPLAN's estimated RPCs. These interviews accounted for approximately 13.3 percent of total Michigan agricultural production. Accordingly, Michigan food processors estimate that about 58.5 percent of agricultural inputs come from Michigan agriculture. This compares to 35.7 percent estimate provided by IMPLAN. Similarly, processors anticipate that about 6.3 percent of their sales remain in Michigan, compared to 12.5 percent estimates provided by IMPLAN. While we do not speculate on which measures are more reliable, IMPLAN or the processor interviews, the comparisons suggest that precision in estimating local shares is uncertain. Several issues are relevant. First, as discussed, IMPLAN treats the share of local supply for all uses of inputs equally, though there may exist valid reasons to suspect different proportions for different uses – especially across purchases for processing and purchases for household consumption. Second, interviews with processors necessarily provide incomplete accounting for flows of local foods within the economy. Processors can only account for where they purchase inputs from when processing foods. They cannot account for household consumption shares of local foods. IMPLAN calculates an average over both processors and household purchases.

The estimates presented in Figure 1 provide an estimate of the share of Michigan agricultural output that remains in the state economy through to consumption. As shown in Table 4, unprocessed foods make up about $0.65 billion in total local food sales, while processed foods make up about $2.20 billion. Hence, unprocessed foods make up about 23 percent of total local food sales, while processed foods make up about 77 percent. IMPLAN estimates that about 35.7 percent of the Michigan's agricultural production sales remain in the state, while processors purchase 34.9 percent of their agricultural inputs from suppliers within the state. When combining unprocessed and processed foods for local consumption, about 17.7 percent[10] of Michigan's food consumption arises strictly through local supplies. A similar estimate arising from processor interviews suggests that about 18.2 percent of Michigan's food consumption arise from the Michigan local food chain.

[10] Calculated as the weighted average of local share with percent of total local food sales as weights.

				Regional Purchase Shares[a]	
	$ Billions	% of Total Local Food Sales	IMPLAN RPC	Based on IMPLAN[¥]	Based on Survey of Processors
Processed Food	$2.20	77%	34.9%	12.5%	6.3%
Unprocessed Food	$0.65	23%	35.7%	35.7%	58.5%
Totals	$2.84				
Weighted Average Share				17.7%	18.2%

*a. calculated as the RPC * (Regional Sourced Input)*

Table 4. Estimated Local Share of Michigan Food Purchases

The estimates provided in this paper can also be used to estimate the economic impact of local foods for other years. If the structure of transactions largely remains unchanged over time, estimates can be extrapolated based on the fixed ratios. Assuming RPCs remain constant from the 2009 benchmark year, the value of local food system can be updated with 2011 USDA Michigan food agriculture output estimates. This assumption is most likely to hold within short intervals from the benchmark year, but may result in biased estimates under certain conditions. If exports are considered a residual secondary market such that local markets are satisfied before exporting, extrapolation to other years may lead to unbiased estimates. This is the general tenant of traditional approaches to estimating RPCs. However, if local demand is considered the residual market and exports as the primary market, this assumption will inflate the expected impact if agricultural output increases, and understate the impact if it declines. The logic follows. If production increases to meet export demand only, then the local food chain should not be affected by the increase in output. This assumption can be tested with consecutive models and interviews with processers to assess how RPCs respond to changes in agricultural output.

Table 5 shows the estimated values of locally sourced, processed and consumed foods in Michigan in 2011 by using 2011 USDA output estimates. This is based on agricultural food production output of $9.03 billion (Economic Research Service 2013). The structure of Table 5 follows that of Figure 1, breaking out unprocessed foods from processed foods. However, it also adds estimates in terms of employment and earnings based on IMPLAN's estimated employment and earnings ratios to output. In total, it is estimated that the local food system generated $4.53 billion in total Michigan output, supporting 18,627 jobs with total earnings of $680.5 million.

Michigan Local Food Consumption							
Sales/Output	$4,526,239,495						
Employment	18,627						
Earnings	$680,467,182						
	Households	Food Service	Institutions		Households	Food Service	Institutions
Sales/Output	$891,904,238	$105,964,965	$30,745,879		$2,824,061,688	$413,443,122	$260,119,604
Employment	10,580	1,257	365		5,187	759	478
Earnings	$328,029,392	$38,972,371	$11,307,887		$243,968,880	$35,717,086	$22,471,566
	↑	↑	↑		↑	↑	↑
	Unprocessed Foods			→	Processed Foods		
	$4,000,598,082				$2,448,470,191		

Table 5: Economic Value of Michigan Locally Produced, Processed and Consumed Foods

Summary

Michigan has a vibrant local food system, a system that is comprised of Michigan grown unprocessed food as well as in-state processing and consumption by Michigan residents. We use available tools and a survey of major food processors in Michigan to estimate the total economic contribution of Michigan's local food system. While, we estimate that in 2011, the local food system generated $4.53 billion, employed nearly 19,000 and contributed to just over $680 million in state earnings, the methods underlying the data used in this analysis calls for further research.

While many studies have attempted to measure the economic value of such local food systems, the approaches have been constrained by lack of data and no implementable modeling approaches useful in documenting transactions associated with local food systems. The resulting estimates are largely inconsistent or focus on smaller, measurable attributes of local food systems.

This study explored IMPLAN as a tool for estimating the full extent of the local food chain starting with agricultural output and ending with household at-home consumption and food service and institutional purchases of locally grown and processed foods. Theoretically, input-output models track all the relevant data necessary to generate an estimate of the size of the local food sector. Survey-based approaches may be the most effective way of estimating detailed transactions, but is generally prohibitively expensive to implement. In this study, the data generated from a survey of local food processors, supports the results of the IMPLAN model.

To make these systems more affordable, economists have devised non-survey approaches to regionalize national transactions to be representative of those in the region. The methods underlying the data call into question the accuracy of such estimates. Regional input-output models largely derive their transactions share by commodity through national transactions estimates. The transactions are then scaled to reflect local availability assuming that each region shares the same disposition of purchases. The scaling is also one-way, in that the share of any commodity, regardless of its final use, is the same for all purchases. These overly restrictive assumptions are most apt to bias estimates of usage than to impact aggregate estimates. That is, it may bias the estimate of locally sourced foods used in restaurants without biasing the estimates of total consumption of locally sourced foods. Minimal surveys have been applied to modify, or augment transactions coefficients in non-survey input-output tables.[11] Such was used in this research to test the coefficients provided by IMPLAN. Such surveys can also better tune estimates of transactions based on national data to better represent the transactions and region in study. . Iowa's Regional Food Systems Workgroup recently was successful in agreeing on shared measurement systems and used surveys to collect local food sales data across multi-county networks from farmers and institutions (Bregendahl and Enderson, 2013). The low cost of collecting the data ($400 per network) shows that it is indeed possible to develop the collaboration infrastructure to collect meaningful local food data, which could improve the efficacy of future modeling of economic impacts of local foods.

[11] For a comprehensive overview, see Round (1983)

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