The Economic Contribution of Agricultural and Food Production to the Ohio Economy

The Department of Agricultural, Environmental, and Development Economics Outreach Committee*

The Ohio State University

November 2017

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THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL, AND ENVIRONMENTAL SCIENCES

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The Committee appreciates the assistance of Ryan Brune who compiled a significant amount of data to develop this report. The Committee also appreciates comments provided by stakeholders during a June 29, 2017 seminar on the development of economic contribution analyses.

Finally, we thank Ms. Leah English from the Center for Agricultural and Rural Sustainability at the University of Arkansas and Dr. Jeff Reimer, Professor of Applied Economics at Oregon State University for their thorough peer reviews of this report.

Letter from the Vice President, for Agricultural Administration and Dean, College of Food, Agricultural, and Environmental Sciences

November 27, 2017

To Whom It May Concern,

The College of Food, Agricultural, and Environmental Sciences (CFAES) at The Ohio State University has a proven record of success addressing a wide array of issues pertinent to agricultural production, a safe food supply, long-term sustainability of the environment, and development of new products and technologies. We have broad research specialties, lead in student success, and continually engage with a broad audience of Ohioans around issues impacting our collective future.

Part of that engagement is providing tools to assist decision-making and translating research in ways that can be useful. I'm pleased to share a new report released by our Department of Agricultural, Environmental, and Development Economics confirming that Ohio farmers have been producing more and, on average, earning more too.

According to the *Economic Contribution of Agricultural and Food Production to the Ohio Economy* report, agricultural and food production in Ohio continues to grow despite decreasing employment and decreasing commodity prices. In 2015, Ohio's gross state product (GSP) was $617.4 billion. Ohio's agricultural and food production cluster with restaurants and bars directly account for $47 billion of gross state product and 900,000 jobs. That's $1 in every $13 of Ohio's GSP, and 1 in 8 jobs in Ohio.

Agricultural and food production continue to play a significant role in Ohio's economy, and the report outlines that contribution. This report examines the breadth of different sectors from forestry to food service separately allowing a greater understanding of the dynamics impacting the economy from the broad agricultural and food industry.

I want to thank CFAES' Department of Agricultural, Environmental, and Development Economics for its leadership and dedication in producing this valuable report. Thanks also goes out to our peer reviewers, Ohio State University Extension educators, and stakeholders for their input and feedback throughout the process.

Sincerely,

Cathann A. Kress
Vice President for Agricultural Administration and Dean
College of Food, Agricultural, and Environmental Sciences

Letter from the Chair of AEDE

With over 13% of the workforce employed in agricultural, food production and food service sectors, and many Ohio communities built upon these sectors, it is important for stakeholders and decision makers to understand the economic contribution of agriculture and food production to Ohio's economy. Beyond a simple understanding of the proportion of state income generated by these sectors, it is critical to the future of Ohio's rural communities to identify the trends that are driving not only the past, but also the future of these rural economies.

For over two decades, Dr. Tom Sporleder, in his position as Farm Income Enhancement Chair in the Department of Agricultural, Environmental, and Development Economics (AEDE) produced OHFOOD, a periodic report outlining the contribution of Ohio's food-related industries to the state economy. Upon Dr. Sporleder's retirement in 2012, the report lapsed. As a result of stakeholder desire for a continuation of estimates of the contribution of agriculture and food production to Ohio's economy, a team of AEDE economists, with over seventy years of combined experience in economic analysis in Ohio, stepped to the plate to provide a new look at the emergent trends in Ohio's agricultural and food economy. The result of their work is this report: The Economic Contribution of Agricultural and Food Production to the Ohio Economy.

The title of the report has changed from OHFOOD to highlight that this report is different, and should not be compared to past reports. While there are some similarities to the OHFOOD report (for example, the calculation and reporting of the value-added of food-related sectors to Ohio's economy), the current report focuses on identifying important trends and signals in the agricultural and food sectors that could impact thinking on issues of rural development in Ohio long into the future.

The authors of this new report were careful to ensure that the analysis follows the most up-to-date generally accepted practices for the calculation and reporting of economic contributions. Where appropriate, the authors follow the procedures and methods outlined by the U.S. Bureau of Economic Analysis. In circumstances where professional judgment is necessary, the authors rely on the consensus of recommendations provided by the academic, government and consulting communities that regularly produce economic contribution analyses around the United States.

The current report is the result of a rigorous and collaborative analysis and writing process that started with meetings of interested stakeholders in the spring of 2017 to assess interest in the report and to gather input on the types of information that would prove most valuable moving forward. In June, the authors held an educational forum on The Ohio State University campus and through webinar, to introduce the current state of thinking among national experts on the generally accepted methods for contribution analyses. In attendance were over forty representatives of stakeholder

groups, including commodity groups, other groups supporting Ohio's food and farm communities, and members of Ohio State University's Extension community. In addition to providing an educational opportunity, the authors provided an open forum for comments on the proposed report outline and content. A draft of the report completed in late July reflected consideration of these comments.

In August, national experts in contribution analysis reviewed the draft report. The peer-reviewers provided positive, but important critical feedback that validates the authors' choice of methods and the ensuing results. In mid-September, the draft report was sent to participants in the June workshop for comment. The final result of this review process is the report contained herein. As would be expected from a report outlining the contributions and trends of multiple sectors to a state economy, the authors find some good news and some areas of possible concern.

I would like to thank the leadership in the College of Food, Agricultural, and Environmental Sciences for their continuing support of the academic mission of AEDE. I would also like to thank all of our stakeholders for the passion, interest and critical eye they brought to this project. We have made a good faith effort to incorporate stakeholder comments while maintaining a commitment to adhere to generally accepted practices and provide an impartial and defensible analysis. Finally, I would like to thank the members of the AEDE Outreach Committee Dr. Brent Sohngen, Dr. Ian Sheldon, Dr. Zoë Plakias, Janice DiCarolis and Kelli Trinoskey for their work in further demonstrating AEDE's commitment to providing Ohio's agricultural and food production community the highest quality economic information needed to make informed decisions for the sustainability of Ohio's economy.

Sincerely,

Tim Haab
Professor and Chair

The Economic Conribution of Agricultural and Food Production to the Ohio Economy
is available at https://aede.osu.edu

Executive Summary

In 2015, Ohio was the 7th largest soybean producer and 8th largest corn producer nationally. Ohio is also the second largest producer of eggs, the 8th largest producer of hogs and pigs, and the 11th largest milk producer. State and federal investments in transportation infrastructure connecting farms in Ohio to markets throughout the U.S. and world, rising incomes, and a vibrant and growing consumer base, have all encouraged the growth of the agricultural and food production cluster.

Due to adoption of improved technology, rising crop yields, farmer ingenuity, and lower prices for farm inputs, productivity in Ohio agriculture, has increased 1.6% per year on average since the 1950s, mirroring national trends. Ohio's farmers are as productive at turning inputs into outputs as any of their peers in the U.S.

Productivity growth in the food processing and manufacturing sector has slowed nationally. In Ohio, the contribution of this sector to the state's economy has also declined. The decline has been heavily influenced by losses in the wood and paper manufacturing components of the sector, which has declined 60% since 1997. Output in the food, beverage and tobacco component has increased modestly, 2% in total, since 1997.

Combined, the agricultural and food production cluster employed 402,874 Ohioans in 2015 and contributed $33 billion in value added to Ohio's Gross State Product (GSP). The agricultural and food production cluster contributed an additional $20 billion to Ohio's economy through purchases of additional inputs from other sectors (thus contributing to the value added in those other sectors), and income used by employees to purchase additional goods and services. The total contribution of the agricultural and food production cluster to Ohio's economy in 2015 was $53 billion (a multiplier of 1.6 for every dollar of value added in the agricultural and food production cluster).

The farming sector has seen strong growth since 2005, with an increase in value added of 2.2% per year. Agricultural and food wholesaling and retailing have also grown over the same time period. However, consistent with national trends, the food processing sector in Ohio has seen a continual decline in direct value added since 2005. This may reflect a reduction in output in the sector, or it could reflect a lack of technological improvement in the sector. Further analysis is needed in order to understand the reasons for the decreasing contribution of the food processing sector to Ohio's and the national economy.

As would be expected, increasing productivity has resulted in decreased employment in agricultural and food production and decreasing commodity prices. Since 1994, employment has decreased by 23.5% in the farm input sector, 38.0% in agricultural production (farming), 16.9% in food processing, and 47.1% in food wholesaling/retailing.

Ohio's food services sector (restaurants and bars) has shown strong growth in employment and value added since 1994. Direct value added by restaurants and bars, driven by growth in population and consumer income, has increased from 1.9% to 2.4% of GSP. Restaurants and bars employ 496,342 Ohioans. This number has increased by 37.5% since 1994. The sector contributed $14.5 billion to Ohio's GSP in 2015.

Combined, Ohio's agricultural and food production cluster plus restaurants and bars accounts for $1 in every $13 of Ohio's GSP and 1 in 8 jobs in Ohio.

Despite strong growth in the farming and wholesaling/retailing sectors, we find decreasing employment, decreasing commodity prices, and decreasing relative contributions of these sectors to GSP. These results raise important questions about the impacts of changes in the agricultural and food production cluster on the health of and future development opportunities for Ohio's rural communities.

Key Findings

Purpose of the report: To document the contribution of Ohio's agricultural and food economy to Gross State Product (GSP) and describe emerging trends in the agricultural and food production sectors that could influence policy decisions that affect these sectors.

Key Findings: Ohio's agricultural and food production cluster plus restaurants and bars account for $1 in every $13 of Ohio's GSP and 1 in 8 jobs in Ohio.

Strong Growth, Decreasing Employment, and Decreasing Commodity Prices Observed in Ohio's Agricultural and Food Production Cluster

- The agricultural and food production cluster, employed 402,874 Ohioans in 2015 and contributed $33 billion in value added directly to Ohio's GSP.
- The agricultural and food production cluster contributed an additional $20 billion to Ohio's economy through purchases of additional inputs from other sectors outside the cluster and income used by employees to purchase additional goods and services in Ohio.
- The total contribution of the agricultural and food production cluster to Ohio's economy in 2015 was $53 billion (a multiplier of 1.6 for every dollar of value added in the agricultural and food production cluster).
- Since 1994, employment has decreased by 23.5% in the Ohio farm input sector, 38.0% in agricultural production (farming), 16.9% in food processing, and 47.1% in food wholesaling/retailing. These reductions are the direct result of increasing efficiency in the agricultural and food production cluster.
- There has been strong growth in the farming and wholesaling/retailing sectors, decreasing employment, decreasing commodity prices, and decreasing relative contributions of these sectors to GSP.

Important policy questions: What are the impacts of changes in the agricultural and food production cluster on income and employment opportunities in Ohio?

Efficiency Gains in On-Farm Production Lead to Strong Growth in Ohio's Farming Sector

- Due to adoption of improved technology, rising crop yields, farmer ingenuity, and lower prices for farm inputs, efficiency in Ohio's farming sector has increased 1.6% per year on average since the 1950s.
- Compared to the national average, Ohio farmers are extremely productive at turning inputs into outputs.
- The Ohio farming sector saw strong growth from 2005 to 2015, with an increase in value added of 2.2% per year. Agricultural and food wholesaling and retailing have also grown over the same time period.

Important policy questions: Will the farm sector see a slowdown in efficiency improvements as has occurred in the manufacturing sector in the past two decades?

Ohio's Restaurants and Bars are a Vibrant and Growing Contributor to Ohio's Economy

- As income has grown, Ohio's restaurants and bars have increased from 1.9% to 2.4% of GSP since 1994.
- Since 1994, employment in Ohio's restaurant and bars sector has increased by 37.4%.
- In 2015, Ohio restaurants and bars employed 496,342 Ohioans, and contributed $14.5 billion to Ohio's GSP.

Important Policy Questions: What are the contributions of Ohio's agricultural and food production sectors to restaurants and bars in Ohio?

Declines in Ohio's Food Processing Sector to Ohio's Economy Need Further Exploration

- The food processing sector in Ohio has seen a continual decline in value added since 2005.
- Productivity growth in the food processing sector has slowed nationally. In Ohio, the contribution of this sector to the state's economy has also declined. The decline has been heavily influenced by losses in the wood and paper manufacturing components of the sector, which has declined 60% since 1997.
- Output in the food, beverage and tobacco component has increased modestly, 2% in total, since 1997.
- Falling employment in food processing, wholesaling, and retail sectors likely result from wider use of labor saving technologies.

Important Policy Questions: What are the underlying state and national causes of declines in Ohio's food processing sector?

Glossary of Terms

Agricultural and Food Production Cluster: The cluster of sectors directly involved in the production portion of the agricultural and food value-chain in Ohio. The North American Industry Classification System (NAICS) sectors included in the agricultural and food production cluster are: Farm Inputs, Farming, Food/Forestry Processing, and Food and Wholesale/Retail.

Cluster: A grouping of sectors or subsectors, typically different from NAICS industry sectors (see Box 1).

Output: A measure of physical quantity of production (e.g., bushels of corn).

Restaurant and Bars Sector: The NAICS food service and drinking place sector (NAICS 722), relabeled to more clearly reflect the industries in that sector.

Sector: Industries as defined by the North American Industry Classification System (NAICS).

Total Sales (Total Output): The sum of the total dollars of output sold by each sector in a cluster. Total Sales are comparable at the sector level, but by summing together the total sales from each sector in a cluster, we double and triple count the value of inputs from previous stages. It is for this reason that adding sales across sectors does not result in a defensible measure of the total contribution of a cluster to an economy.

Value Added: The sum of sales minus input costs for each sector in a cluster. Value added is consistent with the measurement of Gross State Product (GSP) and is the preferred measure for economic contribution analysis of a cluster.

Introduction

This report examines the economic contribution of the agricultural and food production cluster to the economy of the state of Ohio and investigates emergent trends and signals in the agricultural and food production cluster that could affect thinking on issues of rural and regional development in Ohio. The agricultural and the food production cluster has maintained an important place in the state since its founding, and farming is still the largest land use in the state. In 2015, 49% of Ohio land was used as farmland (14 million acres), and 35% (10 million acres) was maintained in crop production. The two crops with the largest acreage in 2015 in Ohio were soybeans (5 million acres) and corn (3.4 million acres). The average market value of farmland and buildings was around $5,750 per acre (Turner and Morris, 2016), indicating that total farmland value in Ohio was around $80 billion.

Since the 1950s, corn yields in Ohio have tripled, and soybean yields have doubled. Multi- factor productivity, a measure of the overall profitability of the agricultural sector in Ohio has increased 2.5 times, or around 1.6% per year. This increase in productivity in the sector has occurred despite the general reduction in prices over the time period because farmers have become better at taking all of their inputs (such as seeds, fertilizers, tractors, and labor), and making them more productive. With increasing productivity and a relatively large portion of the state devoted to farming, Ohio has remained an important agricultural production state. In 2015, Ohio was the 7th largest soybean producer nationally and 8th largest corn producer. Ohio was also the second largest producer of eggs, the 8th largest producer of hogs and pigs, and the 11th largest milk producer (Turner and Morris, 2016).

Following past studies on the economic value of Ohio's 'food cluster' (OHFOOD), we report on a number of specific agriculture-related sectors together. This value-chain, referred to in our study as the 'agricultural and food production cluster', has emerged over the years in Ohio to take advantage of crop and livestock production potential, as well as Ohio's proximity to a significant portion of the US population. The cluster includes a large food processing and manufacturing sector (which includes forest products in this report) that adds value to the state's farm output, and food wholesaling and retailing subsectors that distribute food from farm to food processors, and from there to end consumers.

Farm production is of course one driver of the food processing industry in Ohio. State and federal investments in transportation infrastructure, which connect farms in Ohio to markets throughout the US and world, rising incomes, and a vibrant and growing consumer base have also encouraged

the growth of the food processing sector. These businesses are able to combine Ohio farm outputs with inputs from elsewhere in the region that can be quickly and easily transported into the state to produce food outputs consumed throughout the world.

The economic contribution of this cluster to the state economy is measured in several ways. First, we examine historical trends in agricultural and food production and illustrate how economic growth in the cluster is related to productivity growth. Because productivity growth has slowed in the manufacturing sector overall, a widely recognized national phenomenon (see Baily et al., 1988; Gordon, 2000; and Gordon, 2012), the food manufacturing sector in the state of Ohio, including the forest products manufacturing sector, has experienced slow or negative growth in the last 19 years.

Second, we calculate the value that this cluster contributes directly to the Gross State Product (GSP). GSP is also known as value added because it measures the aggregate value that each sector adds to the inputs it purchases. GSP is the correct way to measure economic value in a state, and it is the state equivalent of Gross Domestic Product (GDP) measured at the national level. Because many sectors must be added together to determine economic output at the state level, economists use GSP (value added) to avoid double-counting. GSP can be measured for a particular sector or a cluster of sectors, as is done in this report. It can also be measured at a more disaggregated level than the state, such as the county level.

Third, we measure employment in the agricultural and food production cluster.

Finally, we measure the indirect and induced economic contribution of the agricultural and food production cluster to the state's overall GSP. When economic activity occurs, the businesses engaging in that activity purchase inputs from other businesses. The value of these purchases, when made in-state, are part of the contribution of a sector such as agriculture to the state's economy. In addition, the income generated by a sector allows individuals receiving the income to purchase additional products, including either investments in new equipment through retained earnings, or expenditures on household items. The value of these purchases made in-state are also part of the economic contribution of the sector to the state.

The estimates in this report are derived from several sources. The US Department of Commerce Bureau of Economic Analysis and the US Census Bureau annually collect data on economic value by sector at the national, state and local levels. We report some of these data directly. The IMPLAN model uses these data to produce an economic input-output model for Ohio. This model is widely used to estimate the types of economic contributions that we study. The IMPLAN input-output model estimates value added for 536 separate sectors in Ohio, and can further be used to calculate the economic contribution of these sectors to the state's overall economy. The economic contributions are calculated using multipliers that account for the current interaction between sectors, and the effect of income generated within the agricultural and food production cluster on goods and services purchased from other sectors in Ohio. The data for this report are for the year 2015, the last year that complete data coverage is available from IMPLAN and the Bureau of Economic Analysis.

Many states use economic contribution methods to estimate the value of their agricultural sectors. A report by English (2016) describing the outcomes of a national assessment of state-level contribution

of agriculture analyses illustrates that most states use distinctly different approaches for making these estimates. Differences were especially notable in the selection of sectors to be included within the aggregate agriculture cluster. Despite the enormous interest in these estimates, no generally accepted set of practices has evolved for conducting these types of studies.

Given that, we have followed past practices in Ohio (OHFOOD) by calculating value generated by a broadly defined agricultural and food production cluster, which includes the food value- chain up to and including food distributors and grocery stores. We report restaurants and bars separately (sometimes referred to as the 'Food Service Sector') for two reasons. First, preliminary analyses show that around 8% of inputs to the Ohio restaurant and bar sector are purchased from the Ohio agricultural and food production cluster. As consumer income increases, food purchased at restaurants and bars increases, regardless of whether or not that food is produced within the boundaries of the state. Second, given the rise in direct marketing, and restaurants featuring locally grown products, the IMPLAN data do not accurately represent the direct link between Ohio agricultural producers and restaurants in the state.

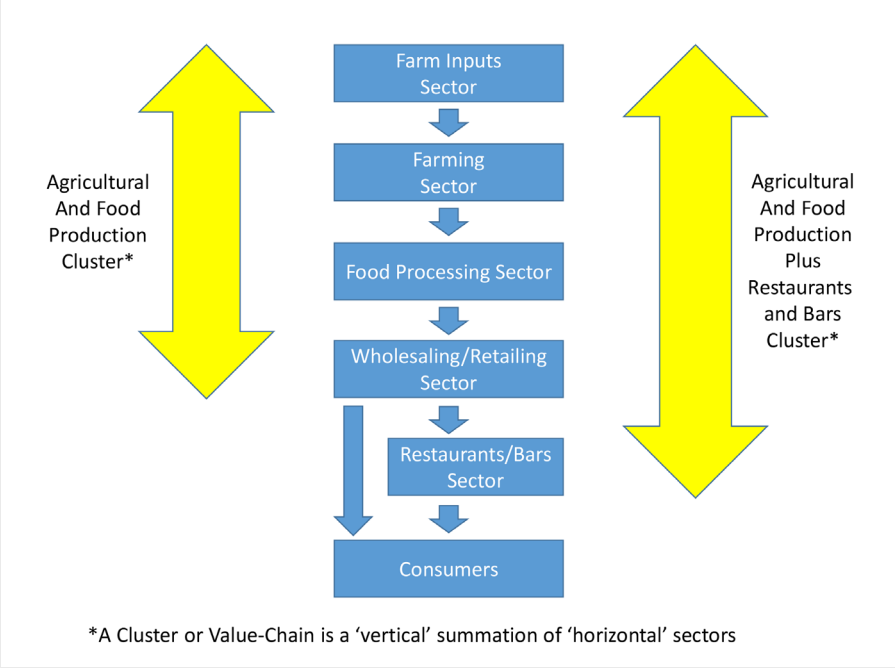
We report the restaurant and bar sector separately not to diminish the role of local producers in the supply of economic value to this sector, but rather to highlight the need for additional study into the role of Ohio producers in supplying Ohio inputs to Ohio food services. Additional data are needed to accurately categorize the size of direct marketing of farms to restaurants and bars to determine the impact of Ohio (local) food production in the restaurant and bar sector.

The remainder of this report is organized as follows. The following section provides a historical overview of productivity gains in the Ohio agricultural and food production sector, as well as sources of growth in other sectors of Ohio's economy. Next, the report provides basic data on direct value added and employment in the agricultural and food production cluster. The final section then reports on the indirect and induced economic contribution of the agricultural and food production cluster to the Ohio economy. An appendix describes the methods used to calculate economic contributions.

Box 1: Definition of the Agricultural, Food Production and Food Service Value-Chain

Figure 1 illustrates the Ohio agricultural, food production, and food service value chain. A grouping of sectors along this value chain is referred to as a cluster. The definition of a cluster used in this report is similar to the definition of the cluster used in OHFOOD reports. The idea of a cluster is that sectors are inter-related through a vertical value-chain. The agricultural and food production cluster in this study includes farm inputs, agricultural (farm) production, food processing/manufacturing, and food wholesale/retail. For the purposes of this study, as with OHFOOD reports, food processing/ manufacturing also includes forest manufacturing, including paper mills, lumber mills and other intermediate wood processing facilities. We do not include all end products in the wood processing sectors. We also report restaurants and bars separately in our reporting as separate investigation of this sector generates interesting insights. Where appropriate we report aggregates for the agricultural and food production cluster plus restaurants and bars. For the wholesaling and retailing sectors, note that we only include the components of these sectors that handle food products. The appendix describes how we determine this proportion.

Figure 1: The Agricultural and Food Production Cluster for Ohio.



Note: Figure 1 is intended to illustrate the grouping of sectors into clusters. We do not intend for this to be interpreted as a strict vertical value-chain at every step. The purpose of figure 1 is to simply illustrate the groupings of sectors in the studied clusters.

When considering the Ohio agricultural and food clusters, it is important also to note that many inputs into each sector are obtained from out of state (e.g., farm machinery or seeds are often produced elsewhere and only sold to farmers within the state's boundaries). At the same time, many of Ohio's agricultural and food processing outputs are sold outside of the state. So, for example, at the level of the farming sector, not all outputs from farms are purchased and used by Ohio food processors. The IMPLAN model that we use for much of our analysis accounts for these inter-state and international flows.

Historical Trends in Agricultural Production and Food Processing/Manufacturing

The Ohio economy has expanded slowly over the past 19 years, at an annual rate of 1.1% per year, in real terms, since 1997. This modest expansion includes the 2001 recession and 2008-2009 Great Recession periods during which economic output in Ohio declined. To get a sense for how different sectors contributed to the changes in economic activity that occurred, we can decompose Ohio GSP by sector in various ways using data from the US Bureau of Economic Analysis (USDOC BEA, 2017). In doing so, we focus separately on the agricultural production sectors and the food processing and manufacturing sectors.

Over the 19-year period from 1997 to 2016, value added in the two natural resource sectors in the state, mining and agriculture, expanded substantially. This change is shown in Figure 2, Panel A. In this same panel, the agricultural sector is composed only of the production of crops and livestock on farms and does not include the food processing or manufacturing components of the value-chain described in Figure 1. It also does not include the farm inputs. The increase in value added in the mining sector resulted from application of hydraulic fracturing technologies to extract natural gas from shale deposits in eastern Ohio. The increase in the agricultural sector resulted from the increase in commodity prices that occurred in the early 2000s through 2014. Other sources of growth in Ohio were information technology, finance and services. Manufacturing output did increase over the period 1997 to 2016, but the increases were relatively modest. In contrast government, utilities, and construction all contracted in real terms.

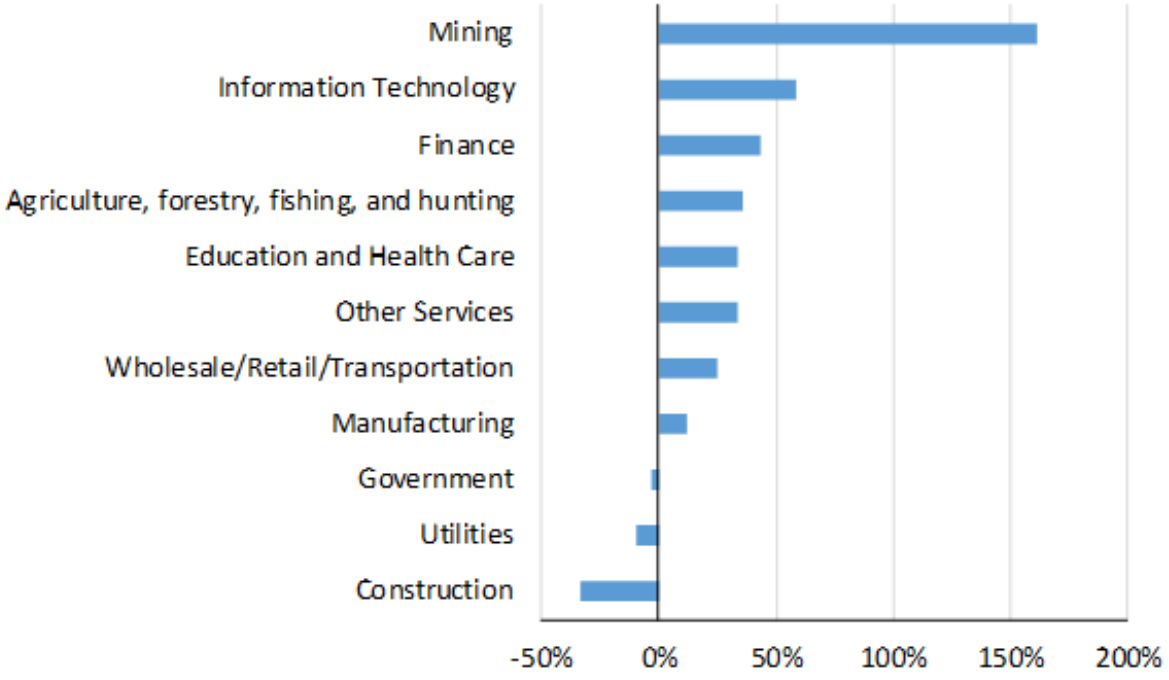
Panel B in Figure 2 decomposes the growth by accounting for the contribution of the individual sector to the aggregate change in Ohio GSP from 1997 to 2016. Thus, of the total growth in GSP in Ohio, growth in the financial sector contributed the largest share, nearly 30%. Other services, which includes health care, contributed 20% of the total growth, and mining contributed nearly 10%. Agricultural production contributed less than 1%.

As noted above, an important reason for the increase in agricultural output in the last 10-15 years has been an increase in crop prices during that time period. However, higher crop prices explain only part of the gains that have occurred in this sector. Other gains have been achieved through more efficient use of resources, and over time, the agricultural production sector has become significantly more successful and efficient at using inputs, including land, labor, capital, management, and purchased inputs from other sectors (e.g., fertilizer).

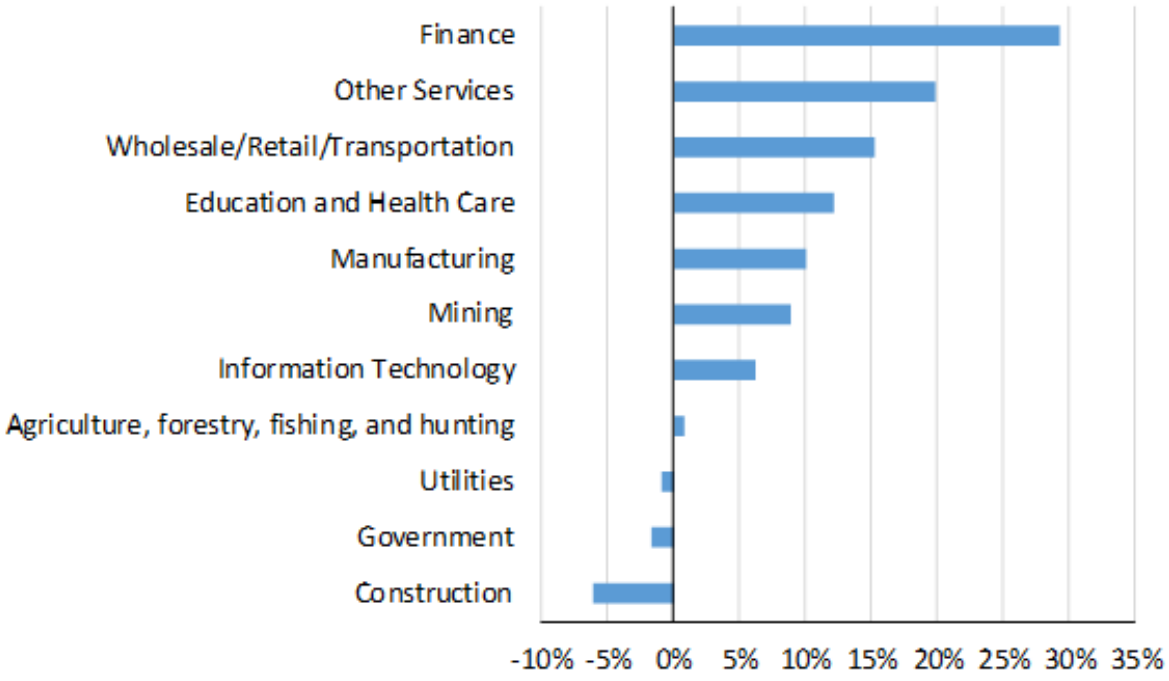
Figure 2: Sources of Economic Growth in Ohio, 1997-2016.

Data are based on changes in value added contribution to state economic activity. (USDOC BEA, 2017a).

Panel A: Total % change in Sectoral Value Added from 1997-2016

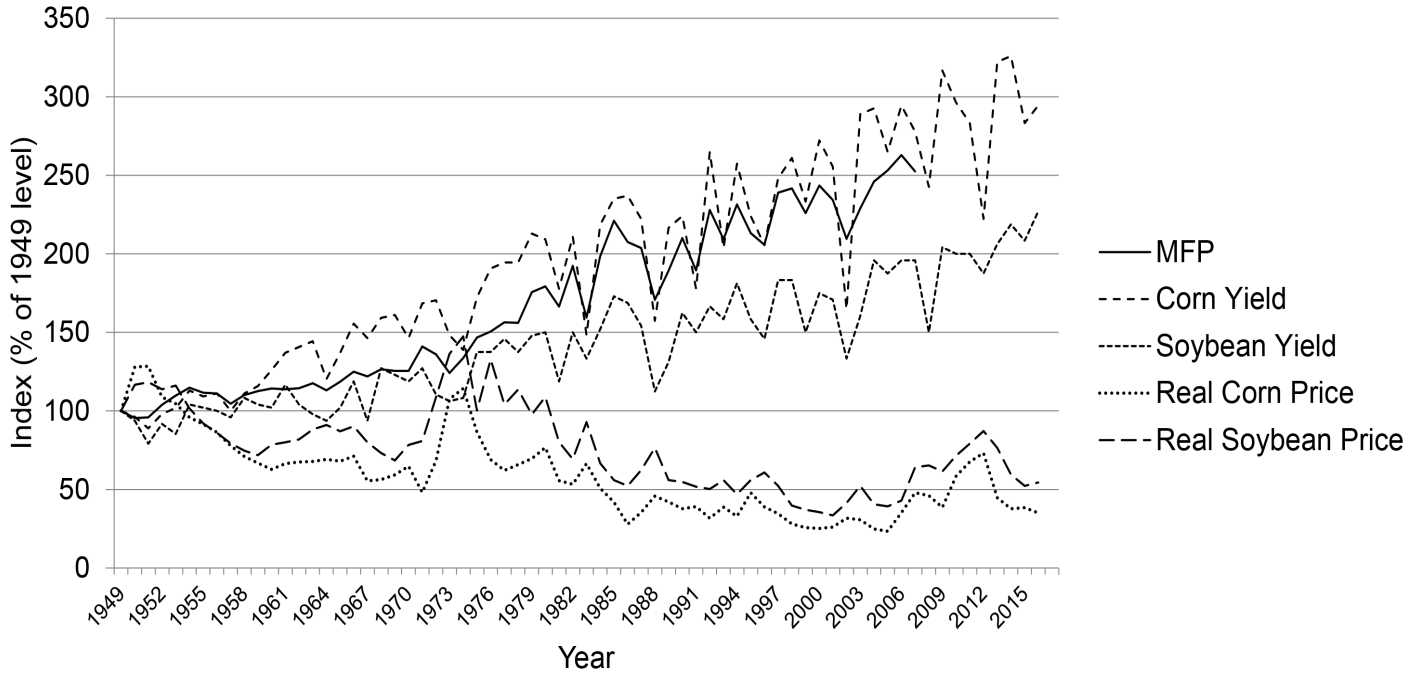


Panel B: Percentage contribution of sector to change in Ohio GSP (value-added), 1997-2016



One way to account for productivity changes is to use a measure called multifactor productivity (MFP; Figure 3). MFP represents the increase in output growth that cannot be accounted for by growth in input use. For the agricultural sectors included in the calculation of MFP in Figure 3, outputs include all farm production including crop, livestock, dairy, poultry, and egg production. Inputs include land, labor, capital equipment, and purchased inputs such as seed and fertilizer. As of 2007, agricultural productivity in Ohio was more than 2.5 times what it was in 1949, representing annual average increases of 1.6% per year.

Figure 3: Agricultural Productivity, Crop Yields and Crop Prices in Ohio, 1949-2016



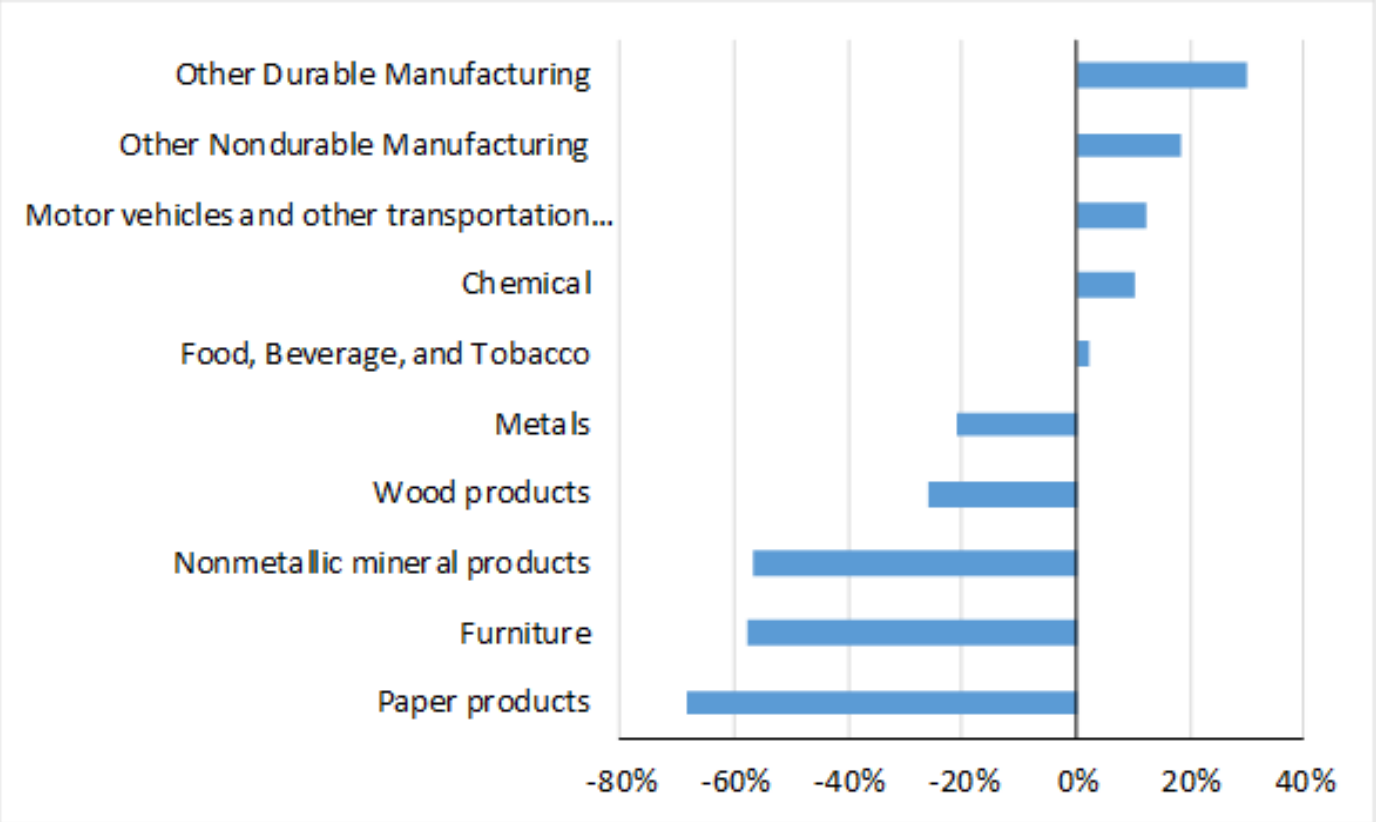
Sources: Pardey et al., 2014; USDA NASS, 2017; USDOC BEA, 2017b

There are many reasons for this increase in agricultural productivity in Ohio, including rising yields, farmer ingenuity and adoption of new technology, substitution of higher profit crops like soybeans for wheat, and declining input costs. Yields of most major crops have increased in Ohio since 1949. For example, corn yields in Ohio have tripled and soybean yields have more than doubled. As new technologies have emerged, Ohio farmers have adopted those technologies, and productivity has risen as a result. Input costs have also fallen over time. For instance, less labor is used now in farm production than in 1949, because tractors and other machines have become much more effective. The real prices of other inputs, like fertilizers, have also remained the same, or fallen.

Although crop prices were increasing from the early 2000s until recently, the longer-term trend is towards lower real prices. Since 1949, real prices for corn and soybeans have fallen by approximately 50%. This price trend is due in part to the substantial productivity gains in Ohio and elsewhere in the world that have allowed farmers to increase their production. The long-term downward real price trend is also due in part to rising incomes and shifts in the composition of food consumption as incomes rise.

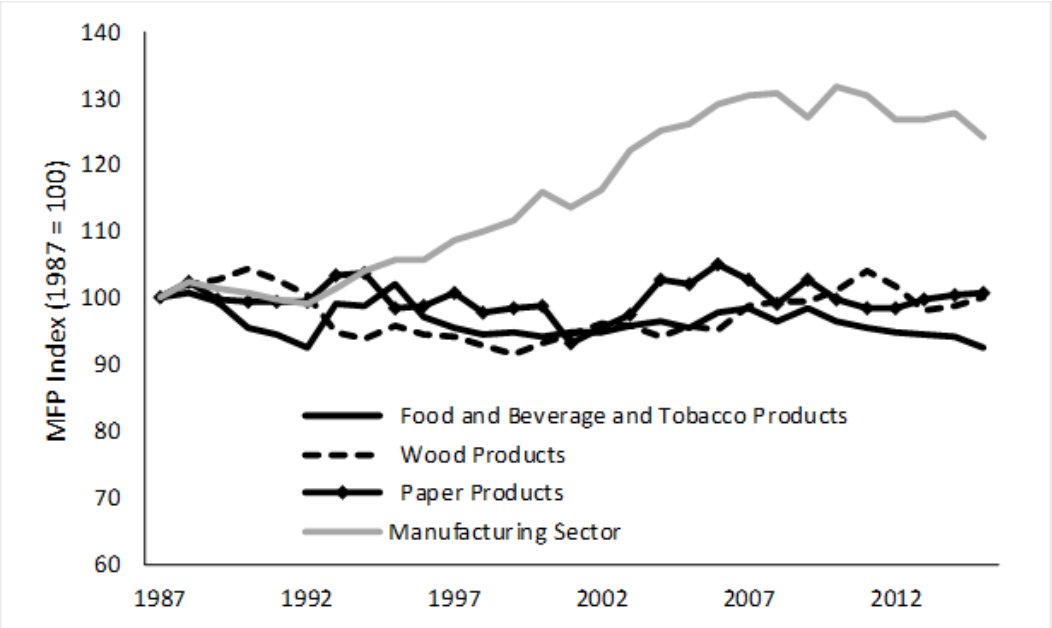
One important reason for slow growth in the overall Ohio economy has been the relatively slow pace of growth in the manufacturing sector in Ohio. Since 1997, value added in the manufacturing sector has grown by only 13% in total. This follows national trends, where manufacturing has been declining as a proportion of the overall U.S. economy. For the purposes of our analysis, the food processing and manufacturing sectors, as well lumber mills and paper manufacturing are part of the overall manufacturing sector, so it is important to assess how well those sectors have done in Ohio. The Food, Beverage, and Tobacco sector increased modestly, by 1% in total, from 1997 to 2015, but the wood product and paper manufacturing sectors declined over the period (Figure 4).

Figure 4: Sources of Economic Growth in Manufacturing in Ohio, measured as the total % change in sectoral value added from 1997-2016 (USDOC BEA, 2017)



MFP in these key sectors in our cluster has remained stable since 1987, despite a modest 0.8% per year increase in MFP in the overall manufacturing sector (Figure 5). The data we are able to obtain on MFP in manufacturing is only national level data, and we cannot disaggregate to the state level. But the data do suggest concerns with manufacturing overall and the food and forestry sectors in particular. Slowing growth in productivity in the manufacturing sector is not a new story in economics (Baily et al., 1988; Gordon, 2000; and Gordon, 2012), and this slowdown remains an important policy issue. It seems clear based on these data, however, that slowing productivity growth is particularly problematic in food and forest manufacturing and may have important consequences for key components of the Ohio agricultural and food production cluster.

Figure 5: National Multi-Factor Productivity for Manufacturing Sectors (USDOL BLS, 2017)



Value Added and Employment in the Ohio Agricultural, Food Production, and Food Services Clusters

The agricultural and food production cluster is a vertical set of interdependent sectors, forming a value-chain that produces, processes, and distributes food and forest products to consumers, restaurants, and bars (see Figure 1). This includes farms that produce crops, livestock, trees, and dairy, among other outputs, and the sectors that specifically serve those farms.In Ohio, there is also an historically vibrant food and forestry processing sector, ranging from grain milling to downstream food processing firms. To move food from farm to factory and on to the consumer, Ohio has built a strong food wholesaling and distribution network. All of these components are included in our definition of the agricultural and food production cluster (see Figure 1). We also include forestry and wood products manufacturing. For purposes of distinction and richness of investigation, we report separately on Ohio's restaurant and bars sector (sometimes referred to as the food services sector).

The value added of the agricultural and food production cluster to Ohio's economy was $33 billion in 2015 (Table 1). This amounts to 5.3% of Ohio GSP. This is comparable to the national agricultural and food production cluster contribution to national GDP of 5.1%. By sector:

- Food processing was the largest contributor, providing $15 billion in value added (2.4% of GSP in Ohio compared to 2.1% of national GDP).
- The wholesale and retail sectors followed with $12 billion (1.9% of GSP in Ohio compared to 1.0% of national GDP).
- Farming contributed another $4 billion (0.6% of GSP in Ohio compared to 1.0% of GDP nationally).

These sectors employed 402,874 individuals in 2015, amounting to 5.9% of total employment in the state, or 1 in 17 jobs.

Ohio's restaurant and bar sector accounted for:

- $14.5 billion in value added (2.4% of GSP in Ohio compared to 2.1% of GDP nationally)
- 496,342 employees (7.23% of total Ohio employment, or 1 in 14 jobs).

The restaurant and bar sector is a labor-intensive service sector with a large portion of the value added generated by labor-wages.

Combined, Ohio's agricultural and food production plus restaurants and bars cluster accounts for $47.5 billion in value-added, or $1 in every $13 of Ohio's GSP, and 1 in 8 jobs in Ohio.

Table 1: Direct Value Added and Employment in the Ohio Agricultural and Food Production Cluster

	Direct Value Added		Employment	
	$ millions	% Percentage of Ohio GSP	Jobs	% Percentage of Ohio Total
Farm Inputs, Equipment & Professional Services	$1,821	0.30%	24,470	0.36%
Agricultural Production				
Dairy Cattle & Milk Production	$545	0.09%	4,882	0.07%
Beef Cattle Production	$204	0.03%	12,302	0.18%
Poultry & Egg Production	$391	0.06%	4,162	0.06%
Hogs & Other Farm Animals	$439	0.07%	14,172	0.21%
Grain Production	$565	0.09%	13,114	0.19%
Soybeans & Other Oil Crops	$818	0.13%	6,685	0.10%
Misc. Crops, Hay, Sugar, Tobacco, & Nuts	$262	0.04%	16,996	0.25%
Fruit & Vegetable Production	$185	0.03%	2,353	0.03%
Greenhouse, Nursery & Floriculture Production	$316	0.05%	4,436	0.06%
Forestry, Hunting & Fishing	$176	0.03%	4,390	0.06%
Sum of Agricultural Production	$3,902	0.63%	83,491	1.22%
Agricultural and Food Processing				
Processed Meat, Fish, Poultry &Eggs	$1,098	0.18%	12,278	0.18%
Dairy Processing	$1,523	0.25%	7,054	0.10%
Processed Food & Kindred Products	$5,090	0.82%	41,417	0.60%
Grain Milling & Flour	$439	0.07%	1,207	0.02%
Fats & Oils Processing	$164	0.03%	615	0.01%
Beverage Processing	$3,569	0.58%	14,167	0.21%
Wood/Paper/Furniture Manufacturing	$3,103	0.50%	36,153	0.53%
Sum of Food Processing	$14,986	2.43%	112,890	1.64%
Food Wholesale/Retail				
Food and Forestry Wholesale	$6,225	1.01%	46,967	0.68%
Food and Forestry Retail	$5,631	0.91%	135,056	1.97%
Sum of Food Wholesale/Retail	$11,856	1.92%	182,022	2.65%
Total Agricultural and Food Production Cluster	$32,565	5.27%	402,874	5.87%
Restaurants and Bars	$14,489	2.35%	496,342	7.23%

To get a sense for how these numbers change over time, we utilize data from the Bureau of Economic Analysis (USDOC BEA, 2017) and present value added in the agricultural and food production cluster and restaurant and bars from 1997 to 2015 (Figures 7a-7c). Figure 7a presents the data in bar form, unadjusted for inflation, to highlight the relative contributions of each sector to total value added in each year. Figure 7b presents the same data in bar form, adjusted for inflation, to highlight the relative contributions of each sector to total value added in each year independent of changes in the general price level. It is clear from figures 7a and 7b that much of the growth in value added in the cluster in recent years can be attributed to changing prices over that period. Once general price inflation is accounted for, value added post-Great Recession is roughly equivalent to value added pre-Great Recession.

Figure 7c presents the same data in line graph form by sector to highlight trends in the sectoral data that might be difficult to discern in Figure 7b. It should be noted that the Bureau of Economic Analysis aggregates sectors differently from the IMPLAN data that we use for our main analysis, above so the data from Table 1 and Figure 7 cannot be compared on a one-to-one basis. The data from the Bureau of Economic Analysis, however, are provided consistently from year to year, and can, therefore, be used to construct a time series to make comparisons over time.

The farm sector itself has seen the strongest growth over the time period, with an increase in value added of 2.2% per year since 2005. This increase is not surprising given the strong growth in commodity prices that occurred relative to other prices. While price growth has slowed in recent years, sectoral value added has remained strong. Agricultural and food wholesale and retail have also grown over the time period, but they did decline substantially during the period 2007-2009. This decrease was primarily due to the reduction in disposable income associated with the recession. The food processing sector has seen a continual decline in value added over the time period of analysis. This reflects slower productivity growth in the sector nationally, but may also represent the implications of some Ohio-specific factors that drive up costs or reduce the value of outputs. Further investigation of the underlying causes is needed.

While the real dollar value added in Ohio's agricultural and food production cluster has shown growth over time, similar to national trends, the size of the cluster as a percentage of Ohio GSP continues to decline (Figure 8). Using past OHFOOD reports and the current report, we calculate that the agricultural and food production cluster plus the restaurant and bars sector has decreased from 11.4% of GSP in 1994 to 7.6% of GSP in 2015. Farm inputs have decreased from 1.2% to 0.3% of GSP, farming has decreased from 1.2% to 0.6% of GSP, food processing has decreased from 3.5% to 2.4%, and food wholesaling/retailing has decreased from 3.6% to 1.9% of GSP. Only the restaurant and bars sector, driven by population and consumer income growth, has increased as a percentage of GSP, from 1.9% to 2.4% of GSP.

In 2015, employment in the agricultural and food production cluster was 5.9% of total employment in Ohio. Since 1994, employment in the agricultural and food production cluster plus the restaurants and bars sector has decreased by 10.8%. By sector, employment has decreased by 23.5% in farm inputs, equipment & professional services, 38.0% in agricultural production, 16.9% in food processing, and 47.1% in food wholesale/retail. Employment in the restaurants and bars sector increased by 37.5% over that time period. Aggregating all sectors of the Ohio economy, employment increased by 10.2%.

Figure 7a: Ohio Agricultural and Food Production Cluster Value Added (Current $), 1997-2015

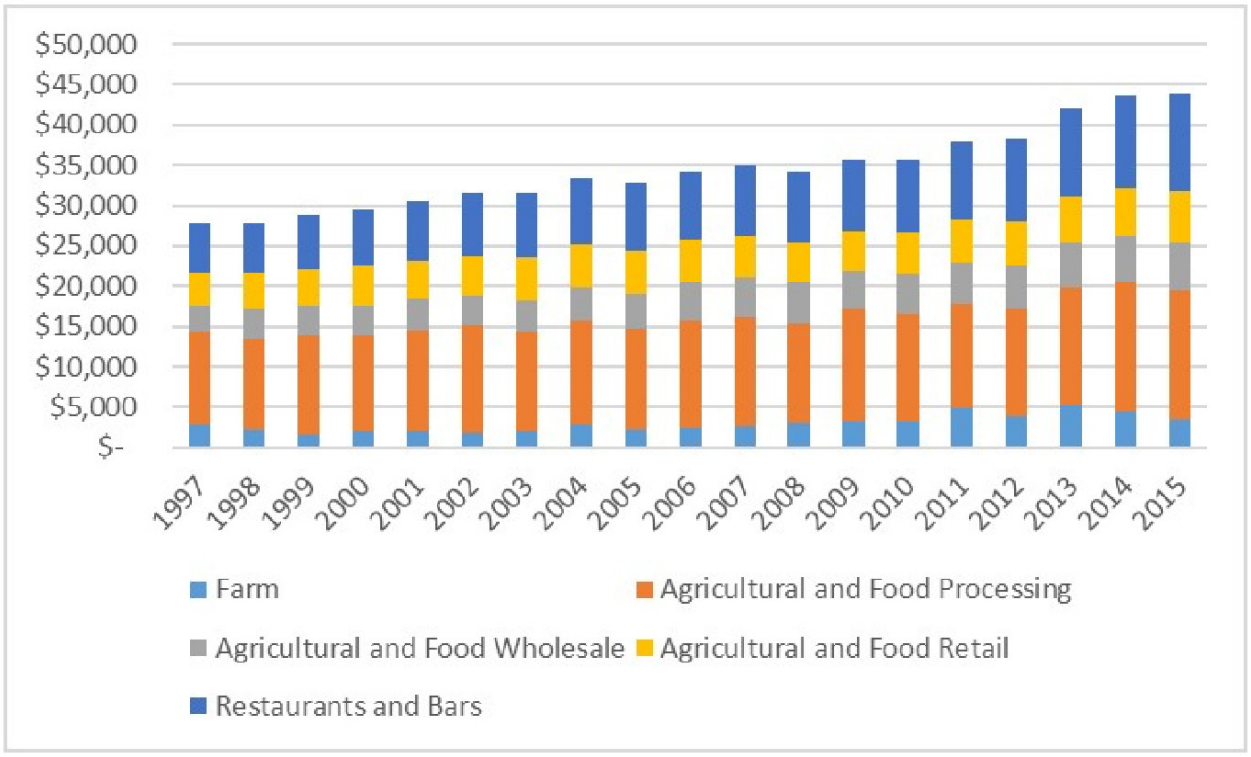
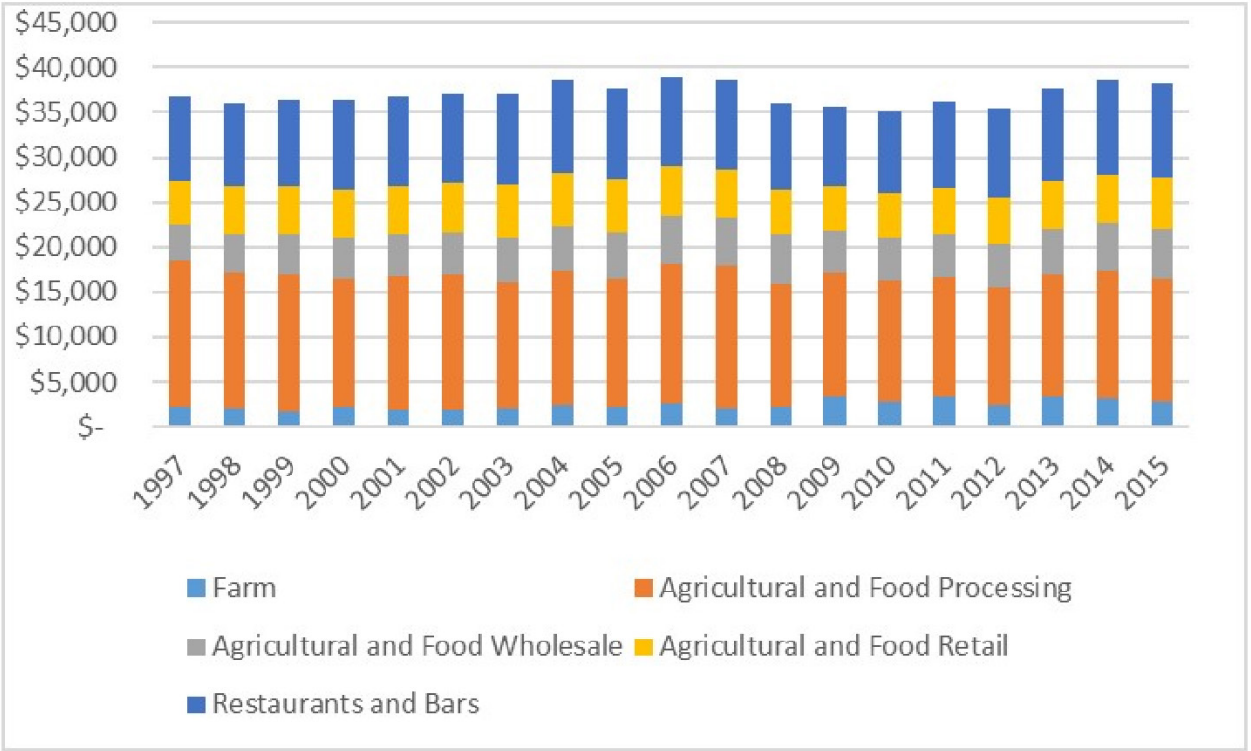
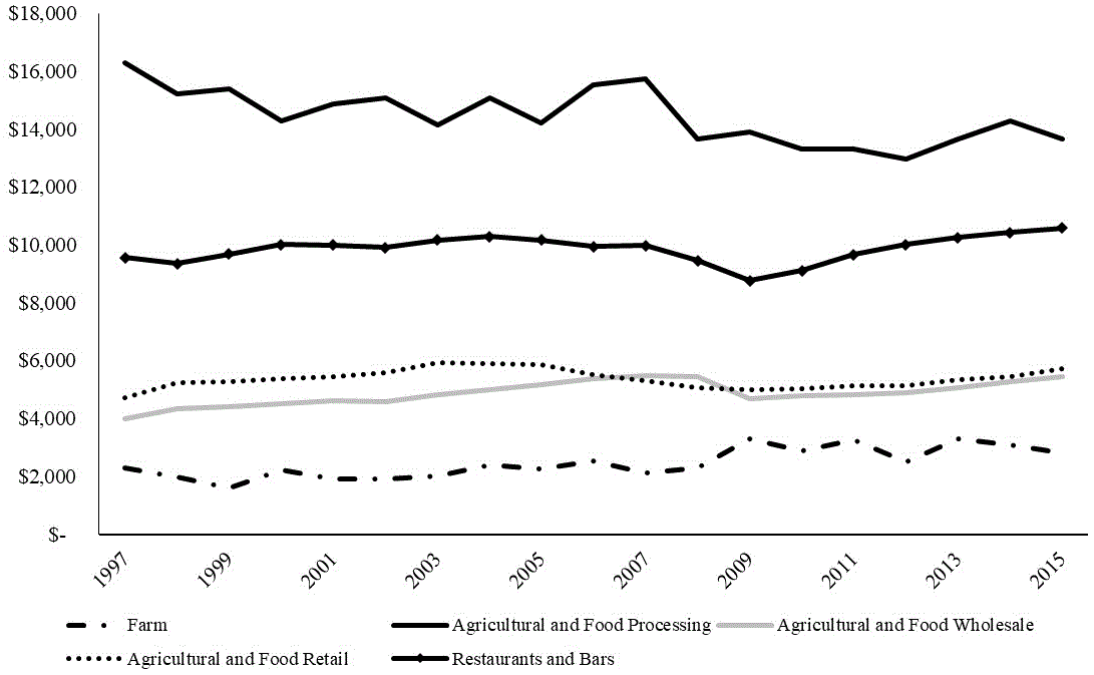


Figure 7b: Inflation Adjusted Ohio Agricultural and Food Production Cluster Value Added (Real Millions 2009$), 1997-2015



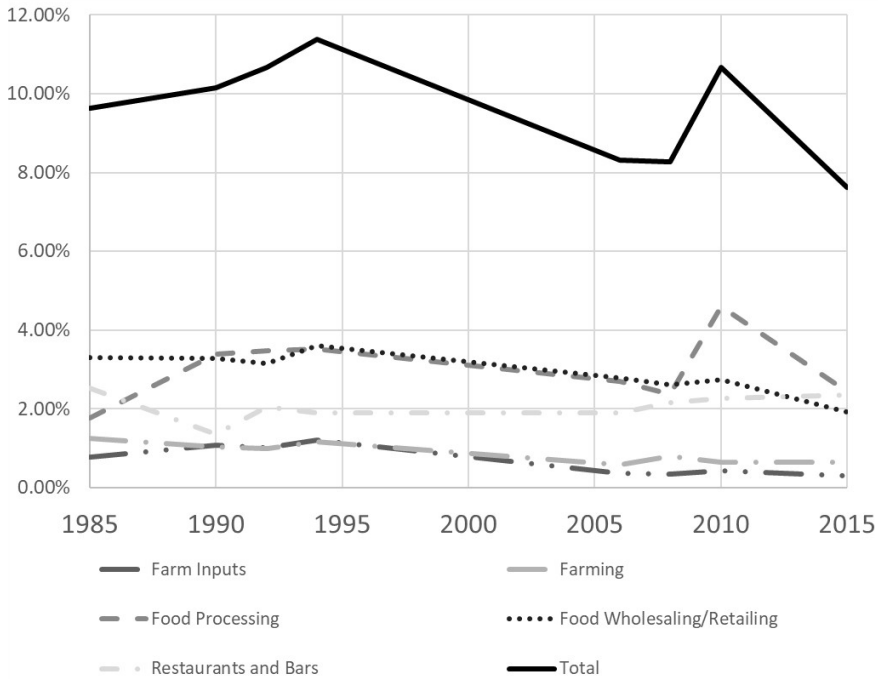
Source: USDOC BEA, 2017

Figure 7c: Inflation Adjusted Ohio Agricultural and Food Production Cluster Value Added Trends (Real Millions 2009$), 1997-2015



Source: USDOC BEA, 2017

Figure 8: Value Added by the Ohio Agricultural and Food Production Cluster plus Restaurants and Bars Sector as a Percentage of Ohio GSP, 1985-2015 (Sources: OHFOOD, Current Report)



Note: There appears to be an anomaly in the processing sector data from the OHFOOD report from 2010 resulting in the significant, but unexplainable, increase in value added in that sector, and overall, in 2010. Given the historic trend in all other sectors, and the consistent numbers for 2008 and 2015, we view the 2010 processing sector and cluster total data as outliers.

On the Use of Total Sales to Measure Value

Economic contribution analyses of food and agriculture sometimes report total sales (also referred to as total output) as a measure of 'value'. Table 2 presents total sales (output) by sector since 2006 drawn from various past OHFOOD reports. As outlined in Box 1, sales in an individual sector represents revenues (income) to that sector.

Sales in the farm inputs sector declined significantly (-30%) between 2010 and 2015. Sales in farm sales (+14%), food/forestry processing (+25%), food and forestry wholesale/retail (+5%), and restaurant and bars (+31%) sectors have increased. The decline in sales in the farm inputs sector needs to further exploration, and more data to understand if this is a long term trend or a short term blip. We caution that comparing sales year to year can lead to erroneous conclusions as the official reporting agencies sometimes change sectoral definitions and reporting requirements leading to data errors and incompatibility year over year.

Table 2: Total Sales by Sector 2006-2015 ($million, not adjusted for inflation)

	2006	2008	2010	2015
Farm Inputs	$ 6,715	$ 6,822	$ 7,916	$ 5,567
Farming	$ 6,393	$ 9,034	$ 8,809	$ 10,026
Food/Forestry Processing	$ 46,060	$ 51,563	$ 49,373	$ 61,634
Food and Forestry Wholesale/Retail	$ 19,295	$ 18,618	$ 18,086	$ 18,981
Restaurants and Bars	$ 19,759	$ 21,416	$ 21,022	$ 27,559

Subtracting input costs from sectoral sales gives a measure of value-added. Because value-added identifies the unique contribution of the sector to the value-chain after accounting for input costs, trends in value added can be different from trends in sales. For that reason we urge caution in drawing conclusions from trends in sales within a sector.

To understand the contribution of the full agricultural and food production plus restaurant and bars value-chain to Ohio's economy, it is tempting to add sales across sectors to get an aggregate sales [output] figure for the entire value-chain. Such a strategy would result in total sales of $98.2b, $107.5b, 105.2b, and $123.8b in 2006, 2008, 2010, and 2015 respectively.

However, we caution strongly against using sales as a measure of the economic contribution of a sector or value chain.

The primary reasons for this recommendation are two-fold:

- Aggregating total sales in a vertical value chain, or cluster, leads to double, triple and quadruple counting of sales. Failing to account for this multiple counting of sales along a value chain misrepresents the contribution of the value chain to the economy. Box 2 provides a detailed explanation of the differences between sales and value added, the double-counting issue and the reason total sales is not a useful or defensible measure of the economic contribution of a vertical value chain, or cluster.

- The sum of total sales in a vertical value chain does not represent the value chain's contribution to GSP. GSP is the accepted measure of aggregate income for a state. Adding GSP across all states results in Gross Domestic Product (GDP) for the nation. Summing total sales in a vertical value chain counts the same sales multiple times, and does not add up to the correct measure of the contribution of that vertical value-chain to Gross State Product (GSP). Value added correctly avoid double counting and is the correct measure to report.

Support for the recommendation to use value added as the appropriate measure of contribution comes from the academic community, consultants and the government agencies responsible for reporting economic data.

In November of 2016, the North American Regional Science Council (NARSC) hosted a workshop titled "Development of Standard Procedures for Contribution Analysis of Agriculture and Forestry." Participating in the workshop were academics from land grant universities (13), representatives from USDA and the US Forest Service (6), private consultants (5), and representatives from the software company IMPLAN (2). A portion of the workshop discussion focused on the question of reporting total sales versus value added. The workshop report summarizes the group's recommendation as follows: "Overall, the consensus appeared to suggest that value added was the preferred economic value for reporting, as it aligns closer to GDP. [Whether total sales or value added are reported], it's important to properly define the value being reported, or at least provide reference to a more comprehensive report where methodologies and results are accurately defined. Ultimately, it's important to have an understanding of what the numbers mean and to be able to properly communicate this to stakeholders" (English, 2016).

In making the recommendation to focus on value added, the NARSC workshop report states: "There is, however, some concern that it might be difficult for some researchers to transition from reporting Output [Sales] to Value added since this would inevitably result in lower reported values" (English, 2016). This is true—over time, value added and total sales track each other (albeit imperfectly), with total sales being roughly 2.4 times value added—but this is because total sales counts input expense at each subsequent stage of production.

The NARSC report recommendation echoes the Bureau of Economic Analysis in recommending against use of aggregated sales to represent the economic contribution of an industry to an economy: https://www.bea.gov/faq/index.cfm?faq_id=1034. The BEA concludes "While gross output [sales] is a useful measure of an individual industry's output, gross output for the economy as a whole double-counts sales between industries and is a less than reliable measure of aggregate business cycles or growth."

Value added is the correct measure of the contribution of Ohio's agricultural and food production cluster plus restaurants and bars to Ohio's economy.

We want to emphasize that the choice to report value added does not represent a choice to decrease the impact of the food and agricultural sector. Value added is not comparable to total sales, and such comparisons should not be made. Instead, as we have done throughout this report, we use value added to measure the contribution of Ohio's agricultural and food production cluster plus restaurants and bars to Ohio's economy.

Box 2: Value Added versus Total Sales (Total Output)

To understand the differences between total sales and value added, and the correct (and incorrect) use of value added and total sales, we spend some time here discussing each measure.

Total Sales is the sum of the total dollars of output sold by each sector.

Value Added is the sum of sales minus input costs for each sector in an industry.

Value added is the traditional and appropriate measure of value because it captures the increase in value that each stage of production provides.

To see why the distinction between total sales and value added is important, consider the example of a food production process illustrated in Figure 6 below. In this example, a farmer sells $1,000 worth of products to a processor. Assuming the farmer has $750 in input costs, the farmer contributes $250 to the state economy. The processor pays the farmer $1,000 for the farmer's products and in turn uses them as inputs in processing $1,500 worth of products for sale to a wholesaler. The processor has generated $1,500 in sales, but we have to remember to subtract the value of inputs purchased to calculate the value the processor has contributed to the production process, otherwise we double-count the value of those inputs. While the processor's sales are $1,500, their value added is $500 ($1,500 in sales minus $1,000 in inputs). If we add together the value of the initial inputs purchased by farmers ($750) and the value added of the farmer ($250) and the processor ($500), we get the value of the total sales of the processor ($1,500). This process continues at each stage of the supply chain so that the total sales of the final step of the supply chain (in this case the retailer) is equal to the sums of the value added at each of the previous stages of the supply chain.

Figure 6: Sales versus Value Added

	Farmer sells to Processor	Processor sells to Wholesaler	Wholesaler sells to Retailer	Retailer sells to Consumer	Total Value of Output
Value of Output	$1,000	$1,500	$2,200	$3,500	$9,700
Value of Inputs	$750	$1,000	$1,500	$2,200	Total Value Added
Contribution to GSP (Value Added)	$250	$500	$700	$1,300	$2,750

The sum of the value added in all sectors of an economy in a state is Gross State Product (GSP). The sum of GSPs for all 50 states is Gross Domestic Product (GDP) for the country.

Value added is a consistent measure of economic contribution from the industry to sector to state to national level.

The same cannot be said for total sales. By summing together the total sales from each sector, we double and triple count the value of inputs from previous stages. It is for this reason that adding sales across sectors does not result in a defensible measure of the total contribution of all sectors to an economy. Value added provides a defensible measure of the economic size of a sector or industry.

Value added is the correct value for measuring the contribution of a sector or cluster to an economy.

One question that can be asked about any economy relates to how efficiently inputs are converted into outputs. More efficient industries convert a smaller share of inputs into outputs. The ratio of value added to intermediate inputs can be used to assess the efficiency of an industry and compare across industries. A ratio of 1 indicates that each $1 of inputs provides $1 of value added. Table 3 presents the estimate of the ratio for the Ohio agricultural and food production cluster and restaurant and bars sectors, as well as the general service sectors in Ohio and the general manufacturing sectors in Ohio. The national ratios are also provided for comparison purposes.

The Ohio farming sector performs about as well as the national average, returning $0.65 in value added for each $1 of intermediate inputs. The food retail sector also performs at the national average. The food processing sector in Ohio performs less efficiently than the national average, returning only $0.33 for each $1 of intermediate inputs. Similarly, the general service and manufacturing sectors in Ohio perform poorly relative to the national average.

Table 3: Value Added versus Inputs for Food-Related Sectors and the Rest of Ohio's Economy in 2015. Data based on IMPLAN, 2017.

	Value Added	Intermediate	Ohio	National
	$ millions	Inputs $Millions	Ratio	Ratio
Farming	$3,902	$6,124	0.64	0.65
Agricultural and Food Processing	$11,883	$36,267	0.33	0.41
Agricultural and Food Wholesale	$6,225	$4,012	1.55	2.37
Agricultural and Food Retail	$5,631	$3,114	1.81	1.81
Restaurants and Bars	$14,489	$13,070	1.11	1.08
General Service Sectors	$365,719	$251,959	1.45	1.63
General Manufacturing	$136,110	$273,209	0.50	0.78

The Direct Contribution and Indirect Effects of the Agricultural and Food Cluster to Ohio's Economy

The value added in the previous section provides an estimate of the direct value produced by this cluster. This does not capture the full contribution of these sectors to the state. Income generated by a given sector is used to purchase additional inputs from other sectors (thus contributing to the value added by those other sectors), and income is used by employees to purchase additional goods and services. That is, a dollar of value added by a company has a multiplier effect throughout the economy.

Indirect effects occur when a company in the Ohio agricultural and food sector purchases inputs from other Ohio companies outside the agricultural and food sectors. For instance, suppose a farmer purchases accounting services from a local accountant. Accounting services are included in business professional and personal services, so they are already counted in the value added of that sector

of the Ohio economy. However, alternatively, they can be included as an indirect contribution of agriculture to the state's economy. This purchase contrasts with some other purchases farmers make from within the agricultural sector, such as seeds, or tractors. These input and equipment purchases are already included in the value added of the agricultural and food production cluster, and thus are not also included as indirect contributions of the cluster.

Induced effects of the agricultural sector occur when people who are employed in the sector make purchases with their income. The induced contributions include only purchases made outside of the food and agricultural sector but within the state of Ohio, such as leisure activities (e.g., golfing), housing services, or an automobile.

The analysis of indirect and induced effects is conducted with the IMPLAN model using data for 2015. For additional information on the analysis, please refer to the appendix. The results are provided for the agricultural production and food production sectors separately, as well as combined (Table 4). The total contributions of these sectors to Ohio value added was found to be $54 billion in 2015, with $33 billion in direct effects and $21.3 billion in induced and indirect effects. Total employment supported by these industries is 649,812, which is about 10% of the total workforce in the state.

Table 4: Economic Contributions of the Agricultural and Food Production Cluster to Ohio Employment and Value Added

	Employment	Total Value Added
	Jobs	$ millions
Agricultural Production/Farm Inputs, Equipment & Professional Services		
Direct Effect	107,962	$5,724
Indirect Effect	22,513	$2,859
Induced Effect	33,971	$2,747
Total	164,446	$11,330
Food Processing/Wholesale/Retail		
Direct Effect	294,912	$26,841
Indirect Effect	98,928	$8,750
Induced Effect	91,524	$6,917
Total	485,366	$42,509
Total Agricultural and Food Production Cluster		
Direct Effect	402,874	$32,565
Indirect Effect	121,441	$11,609
Induced Effect	125,495	$9,664
Total	649,812	$53,839

Appendix

To conduct the economic contribution analysis, we followed the steps recommended by IMPLAN. First, we needed to define the sectors we would include in our analysis. Second, because we include some sectors that are defined as 100% within the agricultural and food production cluster, and some sectors that are only partially part of the cluster (e.g., wholesaling and retailing), we needed to apply adjustment factors to three sectors to account for the proportion of those sectors that are allocated to the agricultural and food production cluster. Third, we assumed that the indirect and induced effects were proportional to these factors.

Sectoral Definitions and Allocations
The IMPLAN data categorizes economic activity into 536 distinct sectors. For Table 1 in the text, the first two general categories, “Farm Inputs, Equipment & Professional Services,” “Agricultural Production” are generally contained in the first 19 sectors in IMPLAN. These sectors are defined under the 2012 North American Industrial Classification System (NAICS) as industry 11. The IMPLAN number and sector names are described in Table A1 below along with the 2012 6-digit NAICS identifiers.

For the purposes of our analysis in Ohio, we include additional sectors from IMPLAN in “Support activities for agriculture and forestry,” sector 19. These additional sectors are noted in the last line of Table A1, including the 6-digit NAICS identifiers for the sectors.

The food processing sectors included in the Ohio Food Report are shown in Table A2 below, along with the corresponding IMPLAN sector numbers and the NAICS that apply. The food processing sector as noted above, includes wood processing and manufacturing sector, including paper manufacturing.

Food wholesale and food retail are not separately identified from other wholesale and retail subsectors in IMPLAN. To allocate the total sector value added and employment to the agricultural and food sectors, we used additional census data to allocate total value added and economic contribution to the agricultural and food production cluster. Those sectors that required additional decomposition are shown in Table A3.

For the wholesale sector, which is sector 42 in the 2012 NAICS 2-digit identifier, we identified seven subsectors at the 4-digit NAICS level that had agricultural and food processing components (Table A4). To determine the proportion of value added that is related to food, we obtained the County Business Profiles from the US Census (2017a). The County Business Profile is an annual series that provides subnational economic data by industry on number of establishments, employment during the week of March 12, and annual payroll. These data are provided at the 6-digit NAICS level. We then went through the 6-digit NAICS to determine which ones are agricultural and food sector related. Finally, we assumed the proportion of value added for the 4-digit NAICS is proportional to the annual payroll that is food related. The estimated proportions for each 4-digit NAICS are shown in in Table A4. The calculated proportion of payroll for the wholesale sector that is in the agricultural and food production cluster is 16.1%.

For the retail sector, which are sectors 44-45 in the NAICS, we needed to determine the proportion of sales that are food related. For instance, the retail trades sectors contain a wide range of types of stores, many of which may also sell food. To determine the proportion of total sales for all of these categories that is food related, we used the US Census of Retail Trade Survey (US Census, 2017b), which provides detailed state-level data on sales by type of establishment. With this, we were able to assign a proportion of food sales to each of the IMPLAN retail trades category. These proportions are shown in Table A3.

Similarly, for the warehousing sector, which is included in NAICS sector 49, we used the subsectors listed in Table A3 to determine the proportion of income in the state in the subsectors relative to the entire NAICS sector 49. This proportion is 11.8%, suggesting that 11.8% of the total food warehousing sector is devoted to warehousing agricultural and food products.

IMPLAN Economic Contribution Analysis

The contribution analysis is conducted four separate times for each of the components of the agricultural and food production cluster. We ran the analysis first for the 19 IMPLAN sectors that are involved in agricultural production and food processing. Then we ran the analysis for the three other subsectors separately (wholesale, retail, and warehousing). Then we added up the calculated contributions for each of the four subsectors assuming the proportions shown in Table A3.

When running this analysis, we followed the guidelines recommended by IMPLAN to avoid double counting. Thus, for each analysis, we modify commodity production so each of the sectors in our analysis only produces its primary commodity. We then modify the trade flows to use the IMPLAN national trade flows data and set the local use ratio to 0. These steps ensure that other sectors in our analysis are not purchasing from the sectors of interest. If we counted these purchases separately, then they would be counted twice since they also appear as value added for the individual sectors of interest (e.g. crop production).

The final analysis uses the proportions in Table A3 in each of the separate sectors to adjust the value added, indirect and induced effect for the proportion presumed to be in the Agricultural and food production cluster.

Table A1: Ohio Food Report Agricultural Production Sector, correspondence to IMPLAN sectors and to NAICS.

Ohio Food #	Ohio Food Report Sector Name	IMPLAN SECTORS	NAICS
1	Farm Inputs, Equipment & Professional Services	19,169-172,210,262	115111, 115112, 115113, 115114, 115115, 115116,115210, 115310, 325311, 325312, 325314, 325320, 327410, 333111, 541940
2	Dairy Cattle & Milk Production	12	112120
3	Beef Cattle Production	11	112111, 112112, 112130
4	Poultry & Egg Production	13	112310, 112320, 112330, 112340, 112390
5	Hogs & Other Farm Animals	14	112210, 112410, 112420, 112511, 112512, 112519, 112910, 112920, 112930, 112990
6	Grain Production	2	111130, 111140, 111150, 111160, 111191, 111199
7	Soybeans & Other Oil Crops	1	111110, 111120
8	Misc. Crops, Hay, Sugar, Tobacco, & Nuts	5,7,8,9,10	111335, 111910, 111920, 111930, 111991, 111940, 111992, 111998
9	Fruit & Vegetable Production	3,4	111211, 111219, 111310, 111320, 111331, 111332, 111333, 111334, 111336, 111339
10	Greenhouse, Nursery & Floriculture Production	6	111411, 111419, 111421, 111422
11	Forestry, Hunting & Fishing	15,16,17,18	113110, 113210, 113310, 114111, 114112, 114119, 114210

Table A2: Ohio Food Report Food Processing Sectors, correspondence to IMPLAN sectors and to NAICS.

Ohio Food #	Ohio Food Report Sector Name	IMPLAN SECTORS	NAICS
12	Processed Meat Fish Poultry & Eggs	89-93	311611, 311612, 311613, 311615, 311710
13	Dairy Processing	84-88	311511,311512,311513,311514, 311520
14	Processed Food & Kindred Products	65-66,74-83, 94-100,111	311111, 311119, 311313, 311314, 311340, 311351, 311352, 311411, 311412, 311421, 311422, 311423, 311811, 311812, 311813, 311821, 311824, 311830, 311911, 311919, 312230
15	Grain Milling &Flour	67-70,73	311211, 311212, 311213, 311221, 311230
16	Fats &Oils Processing	71-72	311224, 311225
17	Beverage Processing	101-110	311920, 311930, 311941, 311942, 311991, 311999, 312111, 312112, 312113, 312120, 312130, 312140
18	Wood/Paper/Furniture Manufacturing	134-153	321113, 321114, 321211, 321212, 321213, 321214, 321219, 321911, 321912, 321918, 321920, 321991, 321992, 321999, 322110, 322121, 322122, 322130, 322211, 322212, 322219, 322220, 322230, 322291, 322299

Table A3: Ohio Food Report Wholesale and Retails Trades Proportions included in Ohio Food Report, plus sectoral correspondence between IMPLAN and NAICS.

IMPLAN Sector #	Description	2012 NAICS codes	Percentage of sector income from food/ag
395	Wholesale trade	42	16.1%
396	Retail - Motor vehicle and parts dealers	441110, 441120, 441210, 441222, 441228, 441310, 441320	0.0%
397	Retail - Furniture and home furnishings stores	442110, 442210, 442291, 442299	1.0%
398	Retail - Electronics and appliance stores	443141, 443142	0.0%
399	Retail - Building material and garden equipment and supplies stores	444110, 444120, 444130, 444190, 444210, 444220	1.2%
400	Retail - Food and beverage stores	445110, 445120, 445210, 445220, 445230, 445291, 445292, 445299, 445310	70.7%
401	Retail - Health and personal care stores	446110, 446120, 446130, 446191, 446199	8.4%
402	Retail - Gasoline stores	447110, 447190	15.5%
403	Retail - Clothing and clothing accessories stores	448110, 448120, 448130, 448140, 448150, 448190, 448210, 448310, 448320	0.0%
404	Retail - Sporting goods, hobby, musical instrument and book stores	451110, 451120, 451130, 451140, 451211, 451212	0.7%
405	Retail - General merchandise stores	452111, 452112, 452910, 452990	31.4%
406	Retail - Miscellaneous store retailers	453110, 453210, 453220, 453310, 453910, 453920, 453930, 453991, 453998	25.6%
407	Retail - Nonstore retailers	454111, 454112, 454113, 454210, 454310, 454390	4.3%
416	Warehousing and storage	493110, 493120, 493130, 493190	11.8%

Table A4: Proportion of payroll in wholesale subsectors attributed to the ag and food production cluster (aggregate incorporated in line 1 in Table A3).

4-digit NAICS	Names of wholesale subsectors	Proportion of Payroll in the Ag. and Food Production Cluster
4232	Furniture and Home Furnishings	0.050
4233	Lumber & Other Construction Materials	0.050
4238	Machinery, Equipment and Supplies	0.693
4244	Groceries and Related Products	0.984
4245	Farm Product Raw Materials	0.997
4248	Beer, Wine, and Distilled Alcoholic Beverages	1.000
4249	Miscellaneous Nondurable Goods	0.507
	Agricultural and Food Component	0.161

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