ALLEN ECONOMIC DEVELOPMENT GROUP
ALLENCOUNTY®
REAL AMERICAN STRENGTH™

future→iQ
PARTNERS

COMPREHENSIVE GAP ANALYSIS

PART 2 - SUPPLY CHAIN ANALYSIS

Greater Lima Region, Ohio, USA

August 2016

COMPREHENSIVE GAP ANALYSIS

PART 2 - SUPPLY CHAIN ANALYSIS

Greater Lima Region, Ohio, USA

August 2016

This report examines the regional supply chains associated with the Greater Lima Region. This report has been produced as part of the development of a Collaborative Growth Plan for the region.

PREPARED BY:

future→iQ PARTNERS

ALLEN COUNTY DEFENSE INITIATIVE HOSTED BY:

ALLENCOUNTY® REAL AMERICAN STRENGTH™

This report was prepared under contract with Allen County Commissioners, with financial support from the Office of Economic Adjustment, Department of Defense. The content reflects the views of Future iQ Partners, and does not necessarily reflect the views of the Office of Economic Adjustment or the Department of Defense.

TABLE OF CONTENTS

1.0 INTRODUCTION

There are a number of essential factors that determine the success of a manufacturing firm. The firm must have a plant and the physical assets to produce goods. The firm must also have access to the workforce or human capital to support the production process and all other technical and administrative functions. The plant must be located with good access to needed natural resources, such as fresh water, and utilities including a reliable electrical source and other technology services. The location must also be close to a market or within access to these markets through freight or other distribution solutions. Each of these factors play a key role in where a firm decides to locate and are largely within each firm's control.

One critical factor remains, however. Few firms have the capacity to either produce or source all of the materials needed to produce any manufactured or processed good. Rather, the growth of manufacturing globally has been fueled by the creation and proliferation of a series of robust and integrated supply chains. Firms establish relationships with local, national, and international vendors to provide a variety of goods and services ranging from cleaning services to hardware to equipment. These same vendors engage in their own relationships as every supply chain begins to resemble a spider's web rather than a straight line. The complexity and magnitude of these relationships have expanded globally over the past sixty years, taking the customer relationship from the shop next door to one an ocean away. This has also greatly reduced the sense of control that a single firm could assert on its supply chain while also increasing the interdependencies of firms.

The growing complexity of global supply chains have not been without their dangers. The growth of a global supply chain has enabled many firms to both diversify their supplier base while reducing production costs. At the same time, manufacturers in a number of industry sectors have recently expressed concern regarding both the availability and quality of key inputs, ranging from access to raw materials in response to decreasing global supply to the reliability of distributor and customer service networks. These concerns, coupled with a growing trend of co-locating manufacturing plants close to markets has refocused industry attention on supply chain development.

The importance of supplier collaboration, materials costs, and reliable sourcing are cited time and again by global manufacturing executives in surveys such as one recently commissioned by *IndustryWeek* and *Kronos* (*The Future of Manufacturing: 2020 and Beyond*). Material costs and transportation costs rank among the top five market challenges and the development of enhanced collaboration with suppliers and customers is recognized as a high-growth strategy. Results of this type have become increasingly common since the global recession of 2007-2009.

Similar concerns have been raised by a number of manufacturers in the Allen County, Ohio region, an eight-county region consisting of Allen, Auglaize, Hancock, Harding, Mercer, Paulding, Putnam, and Van Wert County. This region, located on the I-75 corridor in West Central Ohio has a strong history of manufacturing success and innovation in the energy, machinery, automotive, and transportation equipment industries. Where the region once boasted a series of strong ties between vendors and end customers, comparatively fewer such relationships now exist. These ties have been weakened by the expansion of global supply chains and the consolidation of purchasing and ownership of many of the region's largest manufacturers. This has created an environment where needed supplies and services are reliably acquired, but are most likely sourced from firms outside of the region.

The current state of supply chain relationships and activity within the Greater Lima Region will serve as the basis of the current analysis and is of particular concern to the U.S. Department of Defense Office of Economic Adjustment. The Office has frequently pointed to the resilience of a regional defense industry supply chain as one of the primary objectives of funding in their Defense Industry Adjustment grant program. It is strongly suggested that any region that is home to a large defense contractor or facility, as the Greater Lima Region is with the presence of the Joint Systems Manufacturing Center and General Dynamics Land Systems, must have a vibrant and nimble manufacturing supply chain that has the capacity to increase production to meet changing defense needs while also being flexible enough to diversify when procurement lessens. The

presence of a number of large, albeit unrelated firms in the automotive, energy, and machinery manufacturing sectors points to the potential of a diversified and highly integrated regional supplier base that can quickly respond to the changing needs of each sector. The intent of this analysis, in part, is to assess the degree to which this structure exists.

More importantly, the focus of this analysis is to identify and attempt to measure the magnitude of any gaps that may exist within the region's manufacturing supply chains. The analysis will first attempt to map discrete supply chains across a variety of prominent manufacturing sectors by tracking the flow of goods between firms and across the region. Second, the analysis will identify the linkages across these networks. Finally, the analysis will identify those supplies or commodities that are predominately sourced outside of the region.

This gap analysis will serve two purposes. First, it will allow economic developers and industry leaders in the region to identify whether local firms may already exist to meet these needs and diagnose whether further assistance may be needed to increase their capacity. Second, the analysis will also identify markets that may be appropriate for either new entrepreneurs to enter or for the region to attract producers or distributors from elsewhere. Each of these potential solutions carries a common value proposition. It is assumed that a number of significant supply chain gaps currently exists in the region. We can further assume that the development of solutions to fill these gaps will lead to increased productivity and reliability and decreased supply costs among the region's largest firms and most prominent vendors. This will increase the level of economic prosperity shared across a number of industry sectors throughout the region.

The analysis that follows proceeds in eight parts. It begins with a definition of the concept of a supply chain and discusses why supply chain development is vital to the Future of Manufacturing. This is followed by a general overview of the region's manufacturing economy. Next, the analysis describes an analytical model which uses a survey of commodity flows to identify linkages among and across industry sectors in the Greater Lima Region and beyond. The following two sections presents an analysis of locally and regionally traded commodities and firms. These findings are then validated through the analysis of a survey of regional manufacturers developed and administered by Future iQ with the Allen Economic Development Group. The penultimate section of the analysis considers the implications of the identified supply chain gaps. The analysis concludes with a series of recommendations for further supply chain development throughout the Greater Lima Region.

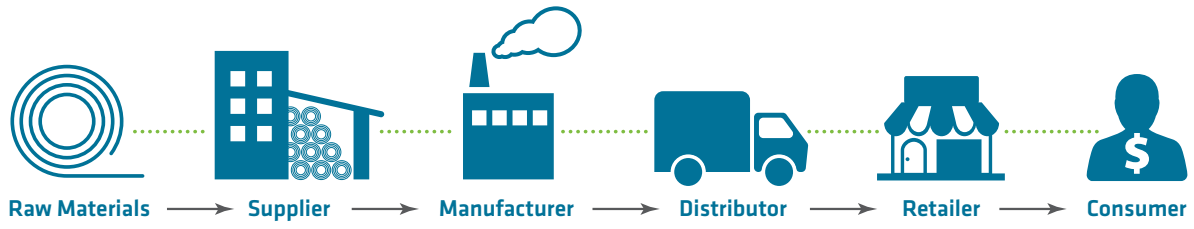
2.0 THE ROLE OF SUPPLY CHAIN DEVELOPMENT IN THE FUTURE OF MANUFACTURING

Future iQ Partners published a foresight analysis of new and emerging disruptive trends in the manufacturing sector entitled *The Future of Manufacturing: Building the Future Through Innovation and Agility* in May 2016. This analysis summarizes our perspectives on a number of trends related to products, processes, and people. Among the most pressing concerns referenced in the report is the evolution of the global supply chain from a means of supplying parts and materials to one that stresses the added value of innovation and process. This is reflected in the shifting discussion of what is meant when one refers to a supply chain versus a value chain.

2.1 WHAT IS A SUPPLY CHAIN?

The classic supply chain model utilized by a number of firms and taught in most industrial organization courses stresses the connection of firms as vendors and customers. A supply chain understood in this context refers to a series of relationships between a manufacturer of a finished product, such as an automobile, and the producers of those parts or components that are needed to assemble the finished good, such as tires, engine blocks, and windshield wipers. The firms engaged in this supply chain model may either be independents of or subsidiaries of the end producer.

Figure 1: Example of Classic Supply Chain Model



The Figure 1 infographic presents a simplified representation of this type of supply chain and expands it somewhat. The textbook model of a supply chain begins with the sourcing of raw materials, such as the cotton used to produce the shirt in this example. The supply chain then includes the distribution of this raw material, the processing of it first into yarn and then weaving into a shirt. It also includes the distribution of the finished good first to a series of retailers and finally to an end consumer. For our purposes, we shall largely focus on the intermediate processes of the model, specifically the supplier, manufacturer, and distributor relationships. This focus is intentional as most of the added value of a good occurs during these steps.

The majority of manufacturing firms in the Greater Lima Region are either involved in the production of intermediate goods such as components or parts used in finished products or in unique processes such as metal forming, finishing, or painting. There are also a number of original equipment manufacturers, or OEM's, including General Dynamics Land Systems, Potash, and Procter and Gamble. These firms provide the most direct link between the production process and end consumer.

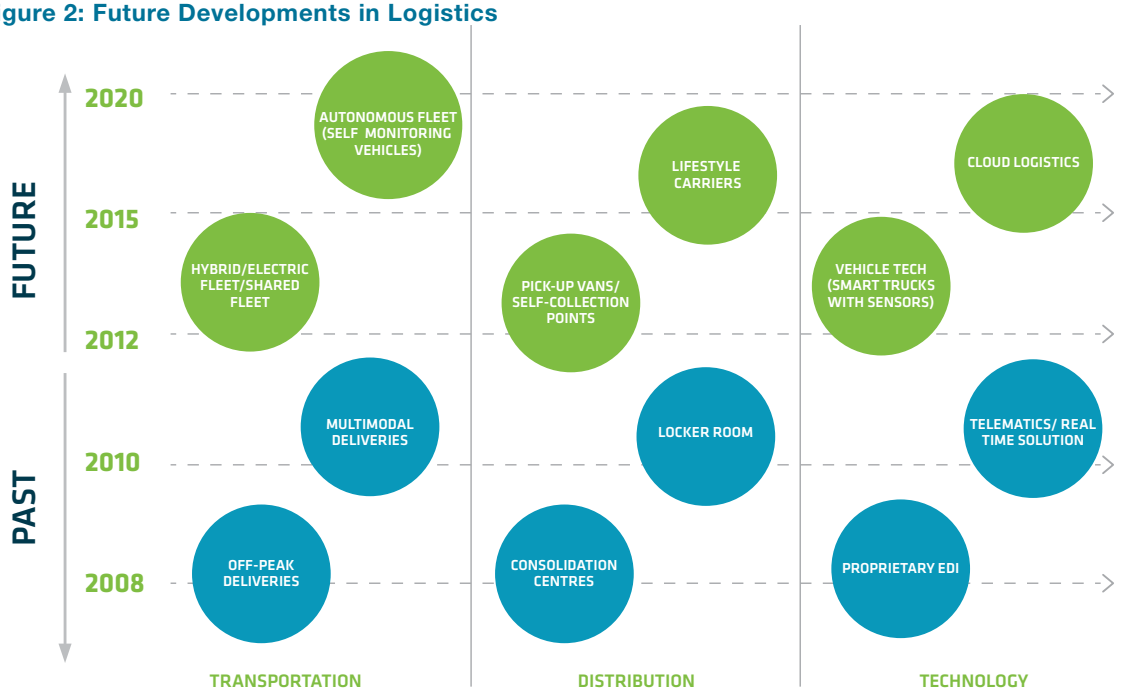
2.2 SUPPLY CHAINS AND VALUE CHAINS IN THE FUTURE OF MANUFACTURING

In the *Future of Manufacturing*, it is proposed firms throughout supply chains will be required to more rapidly respond to changing customer needs due to the growing expectation of just-in-time production. This has been accompanied by a significant reduction in the role that goods held in inventory play in the production process.

Lean practices dictate that firms plan production schedules around materials and parts that are on-hand rather than to hold large volumes of materials in inventory. Inventories for durable goods manufacturers as a share of all unfilled orders has consistently decreased by more than 2 percent annually since 2009 while total sales have increased by between 1.5 and 1.8 annually over the same period according to the U.S. Census Bureau.

This movement towards lean production requires firms throughout the supply chain to become significantly more responsive to production fluctuations within short time frames. This flexibility is being facilitated by a number of new technologies, including additive manufacturing and the increased use of data analytics and the Internet of Things to anticipate ordering activity and proactively prepare goods for shipment. The rapid and responsive production of materials and goods is only one part of the way in which supply chain needs are changing. Significant changes are also occurring in how goods are transported along the supply chain.

Figure 2: Future Developments in Logistics



Source: Tristan Wiggill. 2015. Global Megatrends and The Future of Urban Logistics.

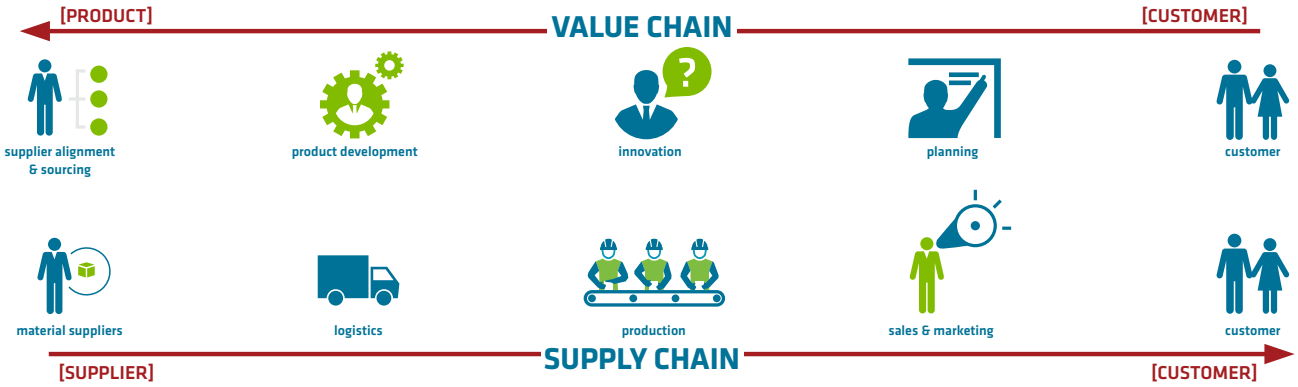
A second component of the innovations that are reshaping the role of supply chains in the Future of Manufacturing is the emergence of multimodal distribution as the dominant means by which goods come to market. In the past, the method of shipment of goods was generally determined both by the type and volume of goods produced as well as the distance between the point of production and the destination market. This led to the segmentation of truck, rail, air, and water transportation as distinct and disconnected. In reality, the movement of goods in a global market has become increasingly more complex and interconnected.

The movement of any good in a global supply chain will frequently depend on two or three modes of transport, beginning in transport to a large harbor, overseas shipment on a large container vessel, and ending in further transport by rail or truck to the final destination. The future of multimodal logistics calls for the siting of distribution facilities that connect multiple means of transport, such as a semi-truck loading dock being located along a rail siding. This practice is becoming increasingly more common in most major markets. The Greater Lima Region has a small number of such facilities. Future supply chain development will depend, in part, on the further development of multimodal options.

Multimodal logistics have been the subject of significant innovation in the past decade, ranging from the real-time tracking of shipments through the use of RFiD technology (similar to the UPC codes found on many consumer products) to the use of semi-autonomous robots and drone technologies to manage warehouse inventories and engage in final delivery. While some goods and markets may be better suited for the use of these technologies than others, we predict that greater utilization of multimodal innovations will occur in the Greater Lima Region in the next decade.

The final innovation that is vital to the success of the Greater Lima Region in the Future of Manufacturing is the evolution of our traditional understanding of supply chains

Figure 3: Value Chain versus Supply Chain



Source: T. Weiner. 2015. How to Develop an Efficient Value Chain. Manufacturing Extension Partnership (MEP) Supply Chain Optimization Initiative and California Manufacturing Technology Consulting.

to one that embraces the possibility implied in the concept of value chains. In the future, supply chains will evolve into value chains where firms involved in both production and service activities will be connected as vital linkages in the primary process flow, and feedback comes from all parts of the chain from suppliers through to customers. The move to a value chain model also offers development opportunities for a number of regions that excel in providing services such as design or distribution but have few domestic manufacturing industries. The value chain model will also introduce a number of core dependencies between unrelated firms, changing cost structures and spurring further competition between niche service firms.

There is some evidence of a growing value chain in the Greater Lima Region among a number of prominent manufacturing sectors, including food processing and transportation equipment manufacturing. These value chains include design, engineering, marketing, and logistics services. The scope of these value chains extend well beyond the borders of the region, however, as there are few local providers of the highly technical services required by many firms. This points to a potential vulnerability and opportunity for the region as growth in technical services firms such as engineering, prototyping, and automation specialists may accelerate the growth of advanced manufacturing firms in the region. Many of these issues are addressed in more detail in the Greater Lima Region Workforce Needs Analysis.

2.3 KEY IMPLICATIONS

The Future of Manufacturing presents a number of possible lessons for supply chain development in the Greater Lima Region, including:

- The introduction of lean practices, fueled by customized manufacturing technologies and data science is changing our understanding of traditional supply chains and the role that inventories play in manufacturing practice. This will enable many manufacturers to produce goods with fewer materials and to hold less product in stock.
- The emergence of new models of multimodal transportation have improved both the time to market for most materials and commodities and access to global markets. They have also increased the importance of reliable sources of many of these materials and placed increased pressure on suppliers to deliver within narrowing timeframes. The Greater Lima Region has some potential for further development in this area, though significant rail access issues remain persistent.
- The evolution of global supply chains to value chains has increased the importance of value-added processes and practices. This has also increased the value of innovation in most regions as those regions that have a comparative advantage in some process or product, such as metal finishing play substantial roles in these new models. The Greater Lima Region is home to a number of firms with this level of customized knowledge. Significant potential exists in connecting these firms to new global customers.

3.0 REGIONAL MANUFACTURING INDUSTRY PROFILE

Manufacturing dominates the Greater Lima Region landscape. Driving along any highway in the region takes us past small fabrication shops and large finished goods manufacturers. Those same highways are shared by semi-tractor trucks filled with parts and goods, traveling between vendor and customer. Allen County's economic history has also been written to a great extent by the works of manufacturers. This dominant position is typical of most regions in the Midwestern and Northeastern United States or the area referred to as the Rust Belt. We can consider a number of metrics that measure the level of manufacturing activity to give a sense of its current and future standing. This is especially important in the process of supply chain development as any supply chain depends on the presence of a large and diverse customer base.

3.1 MANUFACTURING INDUSTRY REVENUE

Manufacturing revenue accounts for 42.4 percent of regional Gross Domestic Product (GDP) in 2014. The next largest regional industry sector is the Health Care and Social Assistance sector, which contributes 11.6% of GDP. Manufacturing revenue was $2.44 billion in 2014, representing 3.2 percent growth from the previous year. Manufacturing revenue averaged $1.9 billion over the past decade and increased by an average of 6.1 percent annually. The most recent annual growth rate is slightly lower than the national growth rate of four percent, but the decade average is significantly higher. This suggests an industry sector that remains vibrant, but whose growth has slowed over the past three years.

Examining the region's manufacturing revenue more closely, we see that durable goods revenue, accounts for 12.3 percent of total revenue, or $608.6 million. Regional revenue in this sector is dominated by two industry sectors – motor vehicles, bodies, and trailers, and parts manufacturing ($201.7 million) and other transportation equipment manufacturing ($117 million). These two market segments combine to contribute 6.7 percent of total revenue. The region has had a long history of automotive and transportation manufacturing, given its location on the I-75 corridor and close proximity to industry leadership in Detroit. A majority of the revenue in the other transportation equipment manufacturing sector is related in some manner to the activities of the Joint Systems Manufacturing Center and defense-related spending.

Outside observers may be surprised to note that the nondurable goods manufacturing sector provides the lion's share of manufacturing revenue (26.2 percent of total GDP) for the region. The sector accounted for $1.9 billion in revenue in 2014, or an average of $1.2 billion annually over the past decade. A majority of revenue in this market segment is produced by petroleum production and related activities, such as chemical production ($452 million). Industry data for a majority of sectors in this segment is not available due to confidentiality concerns, restating the significance of the presence of a smaller number of industry leading firms. Nondurable goods revenue has increased by 3.6 percent in the past year, and 11.6 percent annually over the past decade.

The stark division between durable goods and nondurable goods manufacturing revenue may seem somewhat counterintuitive given the prominent standing of a number of large manufacturers in the transportation, metals, and machinery markets. However, it is also important to note that the Greater Lima Region has had a strong historical presence in the energy, food processing, and petroleum markets. Paper production and printing also plays an important secondary role. As such, the region's nondurable goods base may play a prominent role even in the absence of a large number of consumer-focused industries outside of the food processing and personal care space.

3.2 MANUFACTURING EMPLOYMENT PATTERNS

The state of manufacturing employment in the Greater Lima Region has been previously discussed at some length in the Greater Lima Region Workforce Needs Analysis (Future iQ, August 2016). Manufacturing employment in the region has largely ebbed and flowed in response to national economic cycles. Total manufacturing employment has generally recovered since the recession of 2007-2009 to a present level of 31,346 employees. This represents 21.2 percent of total employment and is more than twice the national average of 9.6 percent. This further cements the region as being dominated by manufacturing activities.

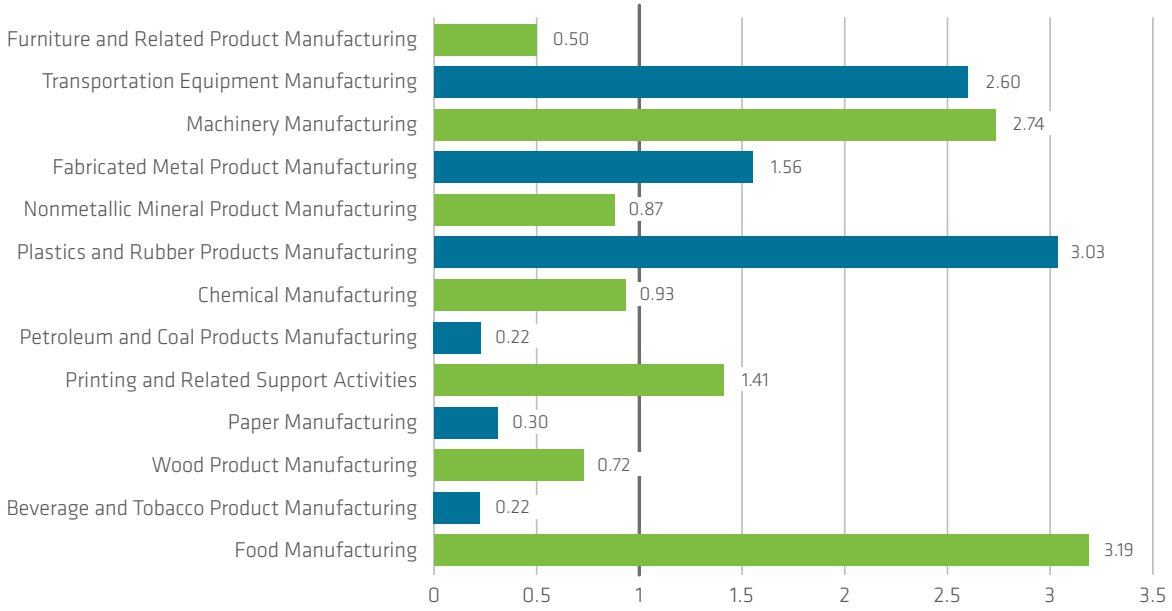
There are a number of aspects of the manufacturing workforce that warrants mention here. First, we know that the Greater Lima Region's manufacturing base is concentrated in a number of prominent industry sectors. We have already discussed in passing the influence of the food processing, machinery equipment, and automotive industries on the region's manufacturing base. These are a few of the region's prominent sectors, but they are not alone. We can measure the relative dominance of certain manufacturing sectors compared to state and national patterns by calculation location quotients. A location quotient is simply the ratio of the percentage of employment in a given industry sector in one region to the percentage of employment in the same industry sector in another reference area.

The chart in Figure 4 presents the location quotients for all manufacturing sectors for which employment data is available, as measured in the third quarter of 2015. Please note that all industry employment has been estimated at the three-digit NAICS industry sector level. Location quotients are measured against state employment to illustrate local prominent industries. For reference, any industry sector with a location quotient above one is considered to be prominent.

It is readily apparent that there are four industry sectors that hold prominent positions in the region's manufacturing sector – food manufacturing, machinery manufacturing, plastics and rubber products manufacturing, and transportation equipment manufacturing. Other industry sectors such as fabricated metal product manufacturing and printing and related support activities also have employment concentrations that exceed state averages. The importance of many of these industry sectors persist even when compared against national employment patterns, with food manufacturing and transportation equipment manufacturing actually increasing to represent between three and four times the national average level of employment.

Each of these industry sectors represent traditional strengths with many sectors relatively evenly spread throughout the region and others, such as printing and support activities and transportation equipment manufacturing having the majority of their employment based in a smaller number

Figure 4: Location Quotients of Manufacturing Sectors – Greater Lima Region Q3:2015



Source: Quarterly Workforce Indicators, U.S. Census Bureau and Author's Calculations

of counties. We should also note that these prominent industry sectors also drive much of the supply chain activity in the Greater Lima Region. This is also true when considering local exporting activity.

3.3 MANUFACTURING EXPORT TRENDS

Manufacturers in the Greater Lima Region engage in a significant level of export activity across the majority of market segments. The region is home to a number of multinational and foreign-owned firms that are engaged in the global supply chain such as Husky Energy, Potash, and Procter and Gamble. The region has strong ties to export markets in both finished goods and raw commodities, including agricultural produce and petroleum products. The table in Figure 5 presents the most recent export activity for the Lima, Ohio Metropolitan Statistical Area.

Total export revenue accounts for nearly one-fifth of all regional manufacturing revenue. This places the region slightly behind the national average (28 percent) for advanced manufacturing regions, according to research by the Brookings Institution. This suggests that some potential exists for future growth in developed and emerging markets.

Taken as a whole, we see that the Greater Lima Region's manufacturing base plays a prominent and diversified role in the regional economy. It also surpasses national and statewide benchmarks in a number of measures while lagging behind industry measures in others. This naturally leads us to consider the business dynamics that exist within the Greater Lima Region. The analysis that follows will attempt to bridge this gap by assessing supply chain and commodities trading behavior throughout the region.

Figure 5: Manufacturing Export Revenue 2005-2014

Industry Sector	2014 Export Activity	2005-2014 Average Annual Activity	2005-2014 Percent Change	Percent of Total
Transportation Equipment Manufacturing	$338,797,457	$266,016,564	288.2%	48.1%
Chemical Manufacturing	$62,027,000	$65,758,358	-21.4%	11.9%
Food Manufacturing	$30,683,709	$23,646,002	153.8%	4.3%
Machinery Manufacturing	$28,128,108	$27,356,402	22.1%	4.9%
Plastics and Rubber Products Manufacturing	$7,428,942	$13,596,170	-62.6%	2.5%
All Products	**$485,405,537**	**$552,931,131**	**91.2%**	

Source: Manufacturing and International Trade Report, 2014, U.S. Census Bureau

We first see that transportation equipment manufacturing exports account for nearly three-quarters of regional export revenue. Exports in this sector have also nearly tripled in the past decade. This can be attributed both to increases in automotive parts exports and a growth in General Dynamics Land Systems' foreign government sales volume over this period. Chemical exports are also quite important to the region, but revenue has decreased, along with the plastics and rubber products sector over the past decade. This may be due to the sharp decline of petroleum prices over the same period, opening producers in the region up to increased global competition. Finally, food products exports have increased by nearly 1.5 times over the course of the past ten years as regional producers have expanded their export activity to new markets in a number of developing regions.

3.4 IMPLICATIONS

The high-level review of the Greater Lima Region's manufacturing profile reveals a number of key findings, including:

- The region's manufacturing sector dominates the region's Gross Domestic Product (GDP), accounting for 42.4 percent of all revenue. This means that the region's economic fate is generally tied to the general success of the sector.
- The manufacturing sector has been insulated, to some extent, from national economic cycles in the past due to the high level of defense production and historical stability of petroleum markets. There has been significantly more uncertainty observed in these markets in the past decade, prompting increasing demands for industry diversification.
- The region's manufacturing landscape is dominated by food processing, chemical and plastic product manufacturing, and transportation equipment production. Each of these industry sectors is especially sensitive to the impacts of changing market attitudes towards the use of petroleum products. Similarly, the food processing sector may be affected by climate change in the future. Firms in these sectors must be especially proactive and innovative.
- The region's manufacturing exports, while prominent, can still experience significantly more growth as access to new markets increases.

4.0 DATA SOURCES AND ANALYTICAL METHODOLOGY

The principal objective of the current analysis is to measure and depict supply chain activity in the Greater Lima Region. This analysis will utilize a number of methods in order to understand the nature of the region's business patterns. We will begin with a macro-level analysis of commodity spending and shipment throughout and outside of the region. In subsequent sections, we will review the results of a detailed survey instrument administered by the Allen Economic Development Group and other regional partners. Each of these analyses provides greater context to the central argument that the Greater Lima Region's manufacturing base is both dynamic and diverse yet possesses a number of significant needs.

4.1 THE DIFFICULTY OF ANALYSIS

It is frequently quite difficult to quantitatively model supply chain activity at the industry or firm level. This can be traced to a number of potential causes, beginning with the lack of reliable data. Firms are frequently reticent to share vendor or purchasing activity information as its public disclosure may be seen as the sharing of proprietary or trade information. This concern is generally voiced in terms of the disclosure of specific vendor and pricing information may cause competitors to seek to either use the same vendor, or negotiate more favorable terms with other vendors.

Similarly, the supply chain of most manufacturers is a complex system. A single product line may be comprised of tens or hundreds of individual components and processed that may be sourced from multiple vendors in multiple locations. This is made even more complex by firms with multiple product lines or those who produce different products at different times of year. It is very rare to find any manufacturer who fully produces a good from raw material to finished good, or firms who have a controlling interest in all of their suppliers.

As a means of illustrating this complexity, consider two examples from General Dynamics Land Systems. Figure 7 presents the services or commodities sourced from vendors throughout the Greater Lima Region.

As we can see, General Dynamics Land Systems sources a wide variety of goods and services from regional vendors. Many of these contracts are directly related to the firm's production activities, ranging from tools and equipment contracts to finishing and maintenance services. Other vendors provide maintenance or support to the facilities at the Joint Systems Manufacturing Center. However, few of these vendors are responsible for the production of parts used in the firm's military platforms.

We can get a sense of the complexity of the firm's expanded supply chain by considering those contracted relationships

Figure 6: Sample Supply Chain Visualization

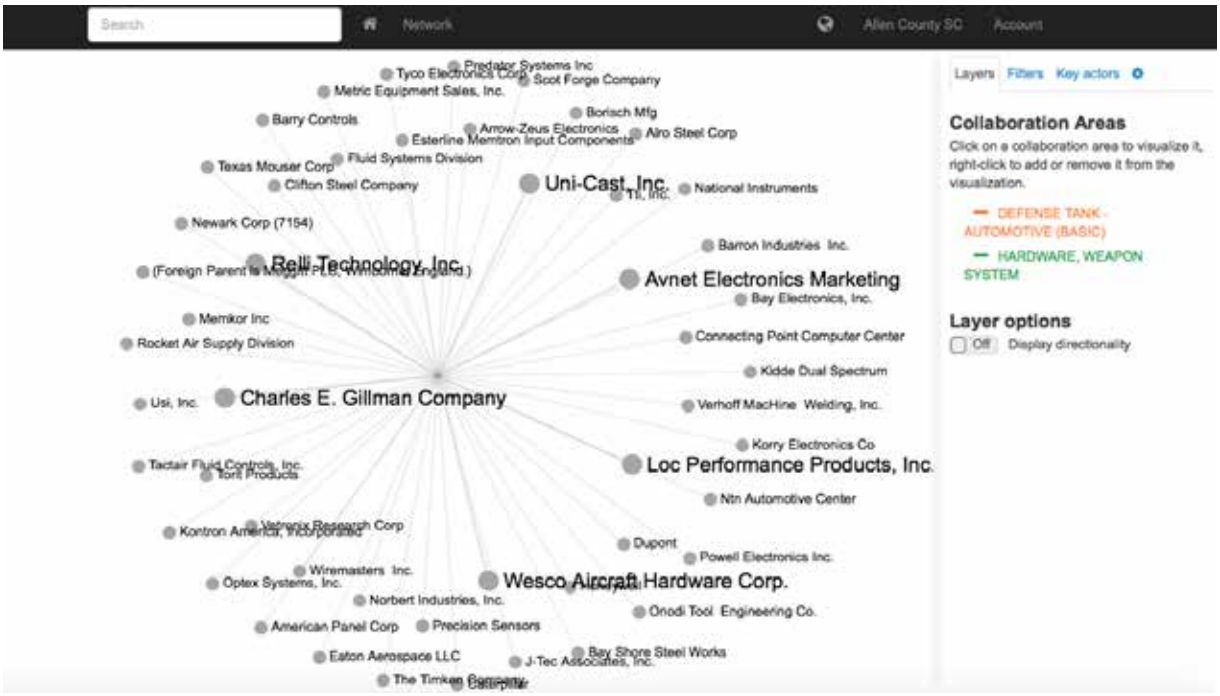


Figure 7: Partial General Dynamics Land Systems Procurement Activity

ZIP Code	Site Reference	Commodity or Service
45801	517183-LIMA	Warehouse Services
45801	505451-LIMA	LUBRICANTS & COOLANTs
45801	504141-LIMA	Bearings/Hydraulics
45801	512015-LIMA	Welding Accessories
45801	505323-LIMA	Engineering consultation for high-voltage infrastructure system
45801	517145-LIMA	Switches & Relays
45801	505289-LIMA	Radio Equipment & Batteries
45801	512989-LIMA	Security Controls Equipment
45801	508730-LIMA	Office Furniture & Equipments
45801	506077-LIMA	CHEMICALS & COMPOUNDS
45801	505851-LIMA	Building supplies
45801	516677-LIMA	Water Service Treatment
45801	506353-LIMA	Hardware
45801	508671-LIMA	Tubing & Piping
45801	505414-LIMA	Building supplies
45801	517354-LIMA	Machine & Fabrication
45801	505759-LIMA	Shredding Services
45801	505881-LIMA	MRO Tools & Equipment
45801	505560-LIMA	MRO Tools & Equipment
45801	507444-LIMA	Paint Supplies
45801	508749-LIMA	Building Fire Protection
45801	506060-LIMA-1	Signs & Graphics
45801	506060-LIMA	Signs & Graphics
45801	509440-LIMA	Printing Services
45801	506554-LIMA	Environmental Services
45801	505692-LIMA	Electrical Supplies
45802	506203-LIMA	Electrical Supplies
45802	509976-LIMA	Building Equipment
45802	505692-LIMA	Electrical Supplies
45802	505405-LIMA	Water Piping Systems
45802	506204-LIMA	Recycling Services
45804	513814-LIMA	Industrial Tools & Hardware
45804	513523-LIMA	Welding Accessories
45804	506147-LIMA	Steel
45804	505386-LIMA	Building Equipment
45804	505744-LIMA	Plumbing & Pipe Supply
45804	506210-LIMA	Environmental Services
45804	505581-LIMA	Concrete
45804	507987-LIMA	Plumbing & Pipe Supply
45804	505634-LIMA	Cranes
45804	506210-LIMA-1	Environmental Services
45804	*506673-LIMA*	*Building Equipment*
45804	*516554-LIMA*	*Batteries*
45804	*505485-LIMA*	*CHEMICALS & COMPOUNDS*
45804	*511554-LIMA*	*Batteries*
45804	*506204-LIMA-AP1*	*Recycling Services*
45804	*506213-LIMA*	*MRO Tools & Equipment*
45804	*509673-LIMA*	*MRO Tools & Equipment*
45804	*504354-LIMA*	*MRO Tools & Equipment*
45804	*505796-LIMA*	*Heat Treating Services*
45804	*510003-LIMA*	*MRO Tools & Equipment*
45804	*507358-LIMA*	*MRO Tools & Equipment*
45805	*505728-LIMA*	*Lumber*
45805	*505848-LIMA*	*Air Compressors*
45805	*505754-LIMA*	*Plumbing & Pipe Supply*
45805	*505955-LIMA*	*MRO Tools & Equipment*
45806	*505741-LIMA*	*Motors*
45807	*505495-ELIDA*	*Cutter Grind Services*
45807	*505730-ELIDA*	*Sandblast/Cleaning Services*
45807	*506302-LIMA*	*Building supplies*
45807	*517423-LIMA*	*Carpet Cleaning*
45817	*516934-BLUFFTON*	*Concrete*
45820	*506392-CAIRO*	*Railroad Repair Services*
45833	*516409-DELPHOS*	*Heater*

Source: General Dynamics Land Systems

directly related to defense-production activities. The visualization in Figure 6 presents a high-level overview of vendor and contract information collected and reported as part of the 2005 Base Alignment and Closure review. This serves as a sample of the data visualization platform developed to accompany the regional supply chain analysis.

We see that General Dynamics Land Systems maintains discrete supply chains in two commodity groups – defense tank and weapon systems – across a wide array of vendors. The size of the various dots and names indicate the size of the contract by dollar value. The vendors are geographically dispersed, based in nineteen states with few vendors local to the State of Ohio. The diversity and spread of the supply chains visualized here is driven by the specialized nature of production of many key components and further illustrates the complexity of analyzing supply chain activity.

4.2 SUPPLY CHAIN ANALYSIS METHODOLOGY

In order to provide a macro-level analysis of manufacturing activity within the Greater Lima Region and to overcome some of the common difficulties in analysis, an alternative review of longitudinal survey data has been completed. There are a number of public data sources that allow us to imply certain things about the region's manufacturing base. We know that it employs a significant number of people and generates a dominant share of the regional revenue. We also have a sense of the types of products produced by manufacturers in the region among those who deal in finished goods.

The analysis presented here depends on another public data source, collected through a partnership of the U.S. Census Bureau and U.S. Department of Transportation Bureau of Transportation Statistics. The Commodity Flow Survey (CFS) is administered every five years as part of the Census Bureau's Economic Census. According to the Census Bureau,

"The CFS produces data on the movement of goods in the United States. It provides information on commodities shipped, their value, weight, and mode of transportation, as well as the origin and destination of shipments of commodities from manufacturing, mining, wholesale, and selected retail and services establishments."

It is the only public source of commodities shipment data available in the United States and one of the few known public sources globally.

The Commodity Flow Survey data is collected by a random sample survey of employers by Census Region in the manufacturing, mining, wholesale, business-to-business retail, and professional services sectors. The specific focus of activity in these sectors naturally excludes a number of significant areas, including agricultural production. The voluntary nature of the survey instrument also introduces potential bias, though the Census Bureau takes steps to mathematically impute comparable data to ensure that each industry and commodity segment is appropriately covered.

One additional restriction limits the potential utility of this dataset. The survey instrument and resulting data was designed in the early 1970's to primarily measure the volume of freight being transported along the nation's highway system. As such, only that freight which is transported by truck or delivery vehicle is considered. This does not specifically preclude freight transported by other means such as air, rail, or water. Rather, shipments are measured at the point of destination, with greater importance placed on the "last mile." The survey data also precludes any data on commodities transported by other means, such as petroleum or gasoline transported by pipeline, for example. As such, a number of regional commodity volumes may be artificially depreciated.

A final restriction that limits its utility for most researchers is that the data is only publicly available at the state and Metropolitan Statistical Area (MSA) level. This is especially problematic for the Greater Lima Region as limited data is publicly available for the Lima MSA, which consists of Allen County but no other data is published for the surrounding counties. Future iQ Partners requested and received a partially unpublished data series from the U.S. Census Bureau containing all available activity from throughout

the eight-county region. As such, data is presented for the entire region so as to ensure the confidentiality of individual records.

The geographic restriction, while not presenting any issue for the acquisition of the dataset used in this analysis presents a secondary challenge. We shall see that the commodity flow data presented depicts the shipment of commodities between industry sectors and across regions. As such, while we can measure the volume of goods flowing from the Greater Lima Region to the Detroit area, for example, we cannot map relationships between specific firms in these regions nor can we identify a more specific location than a general region.

4.3 DATA COMPOSITION

The Commodity Flow Survey data compiled for this analysis consists of two datasets. One measures the inflow of commodities from other regions into the Greater Lima Region. The second dataset contains information on all shipments that originated in the Greater Lima Region and headed elsewhere. Intra-region flows can also be imputed through each of these datasets.

The inflow data series contains 16,692 records and measures commodity flows worth more than $2 billion of total value. The outflow data series contains 25,712 records and measures commodity flows worth more than $1.875 billion of total value. The reader may notice a disconnect in the number of records in each data set. This is both because the data sets have been estimated independently and that many of the region's manufacturers are engaged in a series of complex and global supply chains. This is also a consequence of the total size of the region's manufacturing base. This yields more volume flowing into the region to fuel production processes that is flowing out.

This disparity is also explained, to some extent by the primary focus on freight traveling by road. Many of the finished goods that leave the region travel by rail or pipeline given the commodity volume or weight. As such, the outflow measures are underestimated here.

The data series contains a number of measures related to the characteristics of each commodity shipment, including:

- Region of Origin
- Destination Region
- Originating and Target Industry Sector
- Commodity by Class
- Value of Shipment
- Volume of Shipment
- Quarter When Shipment Was Made
- Means of Transport
- Average Distance of Travel
- Special Characteristics (Export Shipment, Temperature-Controlled, Hazardous Material

Each record also contains a weighting factor that represents the relative significance of each record in the estimate of industry or commodity totals. This is used to ensure that each record is representative of a given share of total shipment activity.

The current analysis is primarily concerned with the first five data measures. These allow us to consider the flow of manufacturing activity throughout the region. The data also contains both a spatial and value dimension that allows us to measure direction and magnitude.

4.4 ANALYTIC METHOD

The results presented in the following two sessions represent the findings of an extensive spatial and factor loading analysis of the commodity flow data sets. The data was first subjected to a matching algorithm that assigned both a point of origin and point of destination for each shipment. These assignments were validated against the average distance of travel to ensure that no location codes were incorrectly assigned. This validation resulted in the correction of 2,103 incorrect destination assignments.

The two data sets were next subjected to a spatial validation process where each record was matched against every other record to ensure that that a shipment leaving the region was reported as received in the destination region. This further ensured that the data set represents a reasonably accurate depiction of commodity flows within the region.

The final step of the commodity flow analysis involved the imputation of updated commodity value and volume data in a number of industry sectors, including food processing and transportation equipment manufacturing. This was deemed necessary as an analysis of industry revenue patterns between 2012 and 2016 indicated that significant changes had occurred in these sectors, with industries in both sectors increasing by between 18 and 32 percent over the period. Partial imputation was further justified by the volume and value of commodity flows precipitated by each of these sectors.

In order to impute partially updated values in each of these industry sectors, a subset of advance 2017 survey data was reviewed and compared against the 2012 baseline. Commodity flow measures were inflated by 3.3 percent for food processing and 2.6 percent for transportation equipment as a result. These increases were applied across all commodity classes and shipment records since insufficient data existed to determine in what commodity classes or to what markets activity had increased.

The results that follow examine aggregate measures of commodity inflow and outflow activity. Further detail of commodity flows to and from every region is available and will be referenced where appropriate. A full dataset of all results will be made available to the Allen Economic Development Group upon final publication of this analysis.

5.0 AN ANALYSIS OF COMMODITY INFLOWS

The commodity inflow results are aggregated in two tables, one grouped by commodity type and another by industry sector. We will begin our discussion with a review of commodity activity.

5.1 COMMODITY INFLOWS BY COMMODITY TYPE

Figure 8 presents the aggregated regional inflow of commodities by mining operations, manufacturers, and wholesale distributors. This accounts for $2 billion in total volume.

At first glance, we see that most of the commodities sourced by manufacturers in the region are used to support many of the most prominent industry sectors. The single largest class of commodities, machinery is common among many large manufacturing regions and is widely dispersed among a number of industry sectors. It is also important to note that more than $32 million in machinery sales are made among firms in the Greater Lima Region annually.

The second significant finding is that the region brings in significant volumes of food and agricultural products annually. Food commodities account for an estimated $219 million in volume, or 10.7 percent of all commodities traded. We will also see that a large volume of food commodities flows out of the Greater Lima Region each year. This suggests the presence of a robust supply chain where unprocessed commodities are brought into the region, are processed into finished goods, and then sent to final markets. Food commodities flow into the region from 129 national markets, with the majority of products sourced from Illinois, Indiana, Iowa, Michigan, and throughout Ohio. The majority of processed produce comes from Alabama and California.

A third significant finding points to the role that the Greater Lima Region plays in the nation's transportation supply chain. We will see this more significantly when reviewing inflow activity by industry. However, we see that transportation-related commodities account for more than $200 million of activity annually. While the survey data set does not define motor vehicle parts as a discrete category, independent calculations have estimated that parts shipments account for 65 percent of all commodities in this sector.

Figure 8: Commodity Inflow by Commodity Type

Commodity Type	Commodity Value
Machinery	$458,991,650
Motorized and Other Vehicles (includes parts)	$173,374,700
Base Metal in Primary or Semi-Finished Forms and in Finished Basic Shapes	$152,312,220
Mixed Freight	$139,788,880
Meat, Poultry, Fish, Seafood, and Their Preparations	$126,540,090
Other Prepared Foodstuffs, and Fats and Oils	$108,296,860
Plastics and Rubber	$96,299,520
Electronic and Other Electrical Equipment and Components, and Office Equipment	$80,409,360
Gasoline, Aviation Turbine Fuel, and Ethanol (includes Kerosene, and Fuel Alcohols)	$69,170,600
Fuel Oils (includes Diesel, Bunker C, and Biodiesel)	$55,194,620
Coal	$51,139,980
Other Chemical Products and Preparations	$47,142,160
Articles of Base Metal	$45,323,950
Basic Chemicals	$41,503,190
Miscellaneous Manufactured Products	$38,233,730
Textiles, Leather, and Articles of Textiles or Leather	$35,949,140
Wood Products	$30,013,040
Transportation Equipment, not elsewhere classified	$27,597,710
Paper or Paperboard Articles	$27,529,430
Agricultural Products (excludes Animal Feed, Cereal Grains, and Forage Products)	$26,092,910
Pulp, Newsprint, Paper, and Paperboard	$23,933,340
Animal Feed, Eggs, Honey, and Other Products of Animal Origin	$22,706,720
Cereal Grains (includes seed)	$21,846,730
Non-Metallic Mineral Products	$21,440,200
Milled Grain Products and Preparations, and Bakery Products	$21,372,570
Furniture, Mattresses and Mattress Supports, Lamps, Lighting Fittings, and Illuminated Signs	$20,928,560
Printed Products	$19,020,730
Other Coal and Petroleum Products, not elsewhere classified	$13,988,920
Precision Instruments and Apparatus	$13,076,340
Pharmaceutical Products	$11,343,220
Alcoholic Beverages and Denatured Alcohol	$7,775,410
Tobacco Products	$5,769,590
Not Classified	$5,278,300
Fertilizers	$4,733,130
Waste and Scrap (excludes of agriculture or food, see 041xx)	$3,444,530
Other Non-Metallic Minerals not elsewhere classified	$1,440,420
Gravel and Crushed Stone (excludes Dolomite and Slate)	$1,320,900
Metallic Ores and Concentrates	$1,024,290
Natural Sands	$449,280
Animals and Fish (live)	$271,880
Monumental or Building Stone	$176,700
Logs and Other Wood in the Rough	$126,520
Grand Total	**$2,052,372,020**

Source: Commodity Flow Survey, U.S. Census Bureau

A final technical note is warranted here as it pertains to one discrete category. Mixed freight shipments account for $140 million of all commodity inflow in the region. This relates to shipments comprised of two or more types of goods with no single good accounting for more than 50 percent of total value and volume. This freight arrangement is fairly common among regional carriers. It is also an arrangement that is growing in the era of multi-modalism. These shipments are attributed among the industry segments that we will discuss below, giving us some insight as to how they are composed.

It is also important to note here that the commodities inflow data includes wholesale activity. This has some impact on the volume of transportation commodities flowing into the region and accounts for a significant share of all finished vehicles flowing into the region. However, this data does not include vehicles and parts sourced in a retail environment. This would significantly increase the inflow volume in this commodity class.

5.2 COMMODITY INFLOW BY INDUSTRY

We can now turn our attention to analyzing industry inflow patterns. These are presented in Figure 9. Please note that the totals match the commodities volume as the estimates were produced from the same data set.

The estimates presented here continue the narrative that has been established throughout this analysis. The Greater Lima Region's manufacturing market is dominated by a group of five industry sectors – chemical manufacturing, food manufacturing, machinery manufacturing, and transportation equipment manufacturing. These five sectors account for $936 million of shipments annually or 45 percent of total inflow.

A number of other aggregations are possible and point to the potential arrangement of another dominant industry sector. The Greater Lima Region has a long history of production and innovation in petroleum-related goods ranging from chemicals to gasoline to plastics. Industries in this sector account for more than $333 million of commodity inflow. We shall see that this sector, along with the other dominant regional sectors plays a vital role in the processing and outflow of finished products in a global supply chain.

The warehousing and storage sector accounts for $133 million in commodity inflow in the region. This relates specifically to goods held in storage either by manufacturers or distributors throughout the region. These are most likely goods held in long term storage as goods held in storage for less than sixty days are traced back to the producer of origin.

Figure 9: Commodity Inflow Data by Industry Sector

Industry Sector	Industry Activity
Transportation equipment manufacturing	$399,668,200
Food manufacturing	$234,594,650
Machinery manufacturing	$169,154,800
Warehousing and storage	$132,718,800
Chemical manufacturing	$122,948,240
Primary metal manufacturing	$102,637,690
Petroleum and coal products manufacturing	$83,049,580
Fabricated metal product manufacturing	$65,800,840
Plastics and rubber products manufacturing	$65,635,660
Electrical equipment, appliance, and component manufacturing	$58,517,810
Machinery, equipment, and supplies merchant wholesalers	$58,176,900
Grocery and related product merchant wholesalers	$57,734,420
Mining (except oil and gas)	$53,968,510
Petroleum and petroleum products merchant wholesalers	$51,385,920
Paper manufacturing	$50,650,050
Farm product raw material merchant wholesalers	$45,612,570
Metal and mineral (except petroleum) merchant wholesalers	$30,697,320
Computer and electronic product manufacturing	$20,384,390
Corporate, subsidiary, and regional managing offices	$19,454,640
Miscellaneous manufacturing	$18,823,510
Beverage and tobacco product manufacturing	$18,588,320
Wood product manufacturing	$18,410,310
Printing and related support activities	$17,074,010
Furniture and related product manufacturing	$15,901,990
Miscellaneous nondurable goods merchant wholesalers	$13,359,110
Nonmetallic mineral product manufacturing	$12,314,650
Apparel, piece goods, and notions merchant wholesalers	$11,244,210
Lumber and other construction materials merchant wholesalers	$10,818,300
Electrical and electronic goods merchant wholesalers	$10,430,330
Textile mills	$10,397,390
Chemical and allied products merchant wholesalers	$10,030,020
Motor vehicle and parts merchant wholesalers	$8,512,260
Furniture and home furnishing merchant wholesalers	$7,729,530
Miscellaneous durable goods merchant wholesalers	$7,312,210
Paper and paper product merchant wholesalers	$6,995,350
Commercial equip. merchant wholesalers	$6,968,490
Hardware and plumbing merchant wholesalers	$6,774,520
Drugs and druggists' sundries merchant wholesalers	$4,181,700
Textile product mills	$3,987,640
Newspaper, periodical, book, and directory publishers	$3,266,390
Leather and allied product manufacturing	$2,593,430
Beer, wine, and distilled alcoholic beverage merchant wholesalers	$1,555,420
Electronic shopping and mail-order houses	$1,370,320
Apparel manufacturing	$941,620
Grand Total	**$2,052,372,020**

Source: Commodity Flow Survey, U.S. Census Bureau

6.0 AN ANALYSIS OF COMMODITY OUTFLOWS

Now that we have established the volume and composition of goods flowing into the Greater Lima Region, we must turn our attention to the volume of goods flowing out of the Greater Lima Region. In many instances, the process of inflow and outflow of commodities within a region defines the level of value added to those commodities by firms in the region.

6.1 COMMODITY OUTFLOW BY COMMODITY TYPE

Again, it is important to note that the volume of commodity outflow presented here -- $1.875 billion is less than the volume of commodity inflow that was previously estimated and discussed. This disparity may be the result of a number of factors. First, and most significantly we know that the commodity flows measured in this analysis only account for goods transported over the road rather than by other means. This excludes the value of goods transported by rail, for example. We know that a number of companies, ranging from Dana Manufacturing to Ford and General Dynamics Land Systems transport significant volumes of finished goods by rail. These are not accounted for among finished products.

Second, the disparity is also accounted for, in part, by the fact that both inflows and outflows only measure the exchange of commodities between manufacturers and wholesalers. As a consequence, goods that are prepared for retail sale are excluded. This depreciates the volume of commodities flowing from the food processing and transportation sectors, for example.

It is important to note that a number of commodities that flow into the Greater Lima Region do not flow out of the region. If we compare the list of inflow commodities and outflow commodity classes, we see that the following gaps exist:

- Animals and Fish (live)
- Coal
- Logs and Other Wood in the Rough
- Meat, Poultry, Fish, Seafood, and Their Preparations
- Metallic Ores and Concentrates
- Monumental or Building Stone

Figure 10: Commodity Outflow by Commodity Type

Commodity Type	Commodity Value
Mixed Freight	$385,134,418
Machinery	$184,631,101
Plastics and Rubber	$178,959,207
Other Prepared Foodstuffs, and Fats and Oils	$129,761,095
Motorized and Other Vehicles (includes parts)	$119,410,492
Base Metal in Primary or Semi-Finished Forms and in Finished Basic Shapes	$110,462,228
Pulp, Newsprint, Paper, and Paperboard	$76,997,721
Other Chemical Products and Preparations	$74,131,379
Cereal Grains (includes seed)	$67,708,320
Basic Chemicals	$57,637,085
Wood Products	$44,340,997
Transportation Equipment, not elsewhere classified	$41,239,705
Milled Grain Products and Preparations, and Bakery Products	$39,283,660
Animal Feed, Eggs, Honey, and Other Products of Animal Origin	$37,146,850
Miscellaneous Manufactured Products	$37,051,029
Pharmaceutical Products	$35,866,960
Precision Instruments and Apparatus	$33,616,988
Gasoline, Aviation Turbine Fuel, and Ethanol (includes Kerosene, and Fuel Alcohols)	$30,444,960
Agricultural Products (excludes Animal Feed, Cereal Grains, and Forage Products)	$26,369,720
Fuel Oils (includes Diesel, Bunker C, and Biodiesel)	$23,676,810
Electronic and Other Electrical Equipment and Components, and Office Equipment	$23,627,087
Paper or Paperboard Articles	$22,260,181
Textiles, Leather, and Articles of Textiles or Leather	$19,765,284
Waste and Scrap (excludes of agriculture or food)	$16,734,793
Articles of Base Metal	$13,427,237
Printed Products	$12,620,564
Furniture, Mattresses and Mattress Supports, Lamps, Lighting Fittings, and Illuminated Signs	$10,927,965
Fertilizers	$9,914,050
Non-Metallic Mineral Products	$3,676,958
Tobacco Products	$3,412,550
Other Coal and Petroleum Products, not elsewhere classified	$2,304,827
Alcoholic Beverages and Denatured Alcohol	$1,934,290
Gravel and Crushed Stone (excludes Dolomite and Slate)	$493,639
Other Non-Metallic Minerals not elsewhere classified	$294,305
Natural Sands	$30,954
Grand Total	**$1,875,295,409**

Source: Commodity Flow Survey, U.S. Census Bureau

This disparity points to differences in natural resource amenities, which is common in every region.

We also see the tremendous influence of mixed freight arrangements by regional carriers, as mixed freight shipments account for $385 million in value and accounts for one-fifth of all outflow volume in the region. This volume is expected to again increase as carriers continue to become more efficient in the delivery of multiple goods to multiple customers.

Agricultural and food commodities account for $263 million of total outflow. This is substantially higher than the $218 million of commodities flowing into the region. This establishes the Greater Lima Region as a net exporter of food products, further cementing the importance of this sector as a regional strength.

We also see that petroleum and related commodities account for $363 million in total outflow annually. This establishes that the chemical, petroleum, and plastics industry cluster is also a positive value-added presence in the region's manufacturing base. Again, it is important to note that the overall value of shipments in this sector is greatly depressed as shipments transported by rail and pipeline are excluded from the data set.

It is also interesting to note that the volume of machinery goods flowing out of the region is slightly more than one-third of the value of machinery flowing into the region. This suggests, while the region does have a prominent industry sector that either the value of goods produced is less than elsewhere, or that a significant volume of goods is shipped by other means.

Finally, we again see that transportation-related commodities play a significant role in the flow of commodities outside of the region. The total volume of outflow in this commodity class exceeds $165 million annually. This is again less than the value of commodity inflow in this market segment, suggesting both that some of the goods coming into the region stay in the region, and that other commodities are shipped out of the region by other means.

6.2 COMMODITY OUTFLOW BY INDUSTRY

We must conclude our preliminary analysis of commodity outflow before considering the nature of gaps that may exist within the region. This analysis concludes with a review of commodity outflow by industry sector.

It is again important to note that the volume of commodity outflow is significantly lower than the volume of commodity inflow in aggregate. As such, this results in gaps between industry patterns that may be larger in magnitude than is reflected in reality. It is finally important to remember that the information recorded in the survey data set is connected to a single point in time at the point of collection. As such, there are timing delays that may exist between commodity and industry inflow and outflow. This will become more important when we begin considering potential inflow and outflow gaps.

We see that many of the same prominent manufacturing sectors engage in significant outflow activity. The chemical, petroleum, and plastics industry segment generate $452 million in outflow volume annually. This largely comes in the form of chemical and plastics products. It is again important to note that this does not include petroleum or other products shipped by pipeline or rail.

We again see the importance of food processing in the Greater Lima Region as related industries generated $289 million in outflow activity in 2012. This represents a slight gap of $10 million of total activity, or 3 percent of total outflow. This can again be accounted for by differences in shipment modes or timing delays. Another potential explanation is differences in the value of raw and processed goods.

Finally, we see that transportation-related industries generate significant outflow volume, accounting for $152 million in total activity. This figure also represents a gap of more than $287 million, suggesting that a portion of all activity remains in the region, is shipped by other means, or is processed in a subsequent time period.

Now that we have examined the basic patterns of commodity flow activity into and out of the Greater Lima Region, we can turn our attention to an examination of some of the more significant gaps that have become evident. This will be addressed in the next section.

Figure 11: Commodity Outflow by Industry Sector

Industry Sector	Industry Activity
Warehousing and storage	$387,015,750
Chemical manufacturing	$264,575,982
Food manufacturing	$170,842,020
Plastics and rubber products manufacturing	$129,318,879
Transportation equipment manufacturing	$122,244,684
Machinery, equipment, and supplies merchant wholesalers	$120,051,790
Farm product raw material merchant wholesalers	$107,218,190
Metal and mineral (except petroleum) merchant wholesalers	$80,357,300
Paper manufacturing	$75,243,535
Wood product manufacturing	$54,479,475
Petroleum and petroleum products merchant wholesalers	$53,063,420
Grocery and related product merchant wholesalers	$52,218,370
Fabricated metal product manufacturing	$37,992,603
Miscellaneous durable goods merchant wholesalers	$27,115,050
Hardware and plumbing merchant wholesalers	$19,037,280
Corporate, subsidiary, and regional managing offices	$18,208,830
Electrical and electronic goods merchant wholesalers	$16,193,680
Machinery manufacturing	$16,168,994
Primary metal manufacturing	$14,178,784
Printing and related support activities	$13,837,507
Textile mills	$12,634,839
Lumber and other construction materials merchant wholesalers	$10,914,290
Beverage and tobacco product manufacturing	$10,791,795
Miscellaneous nondurable goods merchant wholesalers	$8,254,480
Electrical equipment, appliance, and component manufacturing	$7,736,203
Furniture and related product manufacturing	$7,059,949
Paper and paper product merchant wholesalers	$6,530,160
Furniture and home furnishing merchant wholesalers	$5,727,780
Newspaper, periodical, book, and directory publishers	$3,541,990
Motor vehicle and parts merchant wholesalers	$3,177,270
Miscellaneous manufacturing	$3,085,475
Chemical and allied products merchant wholesalers	$2,741,570
Petroleum and coal products manufacturing	$2,360,840
Beer, wine, and distilled alcoholic beverage merchant wholesalers	$1,967,960
Commercial equip. merchant wholesalers	$1,556,560
Apparel, piece goods, and notions merchant wholesalers	$1,519,080
Textile product mills	$1,472,711
Computer and electronic product manufacturing	$1,411,559
Apparel manufacturing	$972,760
Electronic shopping and mail-order houses	$779,810
Leather and allied product manufacturing	$691,130
Mining (except oil and gas)	$363,279
Drugs and druggists' sundries merchant wholesalers	$344,110
Nonmetallic mineral product manufacturing	$297,685
Grand Total	**$1,875,295,409**

Source: Commodity Flow Survey, U.S. Census Bureau

7.0 REGIONAL SUPPLY CHAIN GAP ANALYSIS

Now that we have examined both the magnitude of commodity inflows and outflows in the Greater Lima Region, it is possible for us to consider the nature and magnitude of a number of gaps by commodity and industry. There are a number of potential explanations for each of these gaps. Many of these potential causes and future solutions will be explored more fully in later sections of this analysis.

7.1 SURPLUSES AND GAPS BY COMMODITY TYPE

We can first consider the nature of potential gaps that may exist between inflow and outflow activity by commodity type. Figure 12 presents the inflow and outflow volume of commodities in comparison. Surpluses are represented by whole numbers where gaps are found in parentheses. Each of these gaps has been estimated within the context of the net gap of $177 million between inflow and outflow volume.

First, it is important to note that many gaps exist between the inflow of raw materials and the outflow of finished goods. These may be classified as process gaps. For example, the region has a slight net gap of petroleum products as recorded in the survey data, but produces a significant surplus of processed commodities. Conversely, the region produces a significant volume of basic paper products but experiences gaps in finished paper products and printed materials. Gaps of this nature are to be assumed in any advanced manufacturing region.

Conversely, there are a number of significant surplus areas where no other inputs are specifically brought into the region. We see this in many food product areas where many raw commodities are produced by farmers in the area but are processed elsewhere. This again establishes the Greater Lima Region as existing firmly within a global supply chain.

There are also a number of commodity types, such as those in the metal finishing and processing commodity classes where additional regional capacity could be beneficial. There is significant interest in building additional foundry and forming capacity, but the capital costs associated with developments of these types can be prohibitive. This case will be discussed in greater detail in the Innovation and Opportunity Analysis.

Finally, it is again important to note that the region has a significant imbalance of inflow and outflow volume in mixed freight shipments, with the region generating a $245 million surplus. This points both to the presence of a number of large regional carriers in the region, as well as changing industry preferences. It may also suggest that many of the commodities that flow out of the region leave in smaller volumes than those that come in. As such, we know that much of this volume can be attributed through other commodity classes.

Having established the presence of a number of significant commodity imbalances within manufacturing activity in the Greater Lima Region, we can now again turn our attention to estimating these same imbalances by industry sector.

Figure 12: Surpluses and Gaps by Commodity Type

Commodity Type	Inflow Volume	Outflow Volume	Surplus or Gap
Machinery	$458,991,650	$184,631,101	$(274,360,549)
Electronic and Other Electrical Equipment and Components, and Office Equipment	$80,409,360	$23,627,087	$(56,782,273)
Motorized and Other Vehicles (includes parts)	$173,374,700	$119,410,492	$(53,964,208)
Base Metal in Primary or Semi-Finished Forms and in Finished Basic Shapes	$152,312,220	$110,462,228	$(41,849,992)
Gasoline, Aviation Turbine Fuel, and Ethanol (includes Kerosene, and Fuel Alcohols)	$69,170,600	$30,444,960	$(38,725,640)
Articles of Base Metal	$45,323,950	$13,427,237	$(31,896,713)
Fuel Oils (includes Diesel, Bunker C, and Biodiesel)	$55,194,620	$23,676,810	$(31,517,810)
Non-Metallic Mineral Products	$21,440,200	$3,676,958	$(17,763,242)
Textiles, Leather, and Articles of Textiles or Leather	$35,949,140	$19,765,284	$(16,183,856)
Other Coal and Petroleum Products, not elsewhere classified	$13,988,920	$2,304,827	$(11,684,093)
Furniture, Mattresses and Mattress Supports, Lamps, Lighting Fittings, and Illuminated Signs	$20,928,560	$10,927,965	$(10,000,595)
Printed Products	$19,020,730	$12,620,564	$(6,400,166)
Alcoholic Beverages and Denatured Alcohol	$7,775,410	$1,934,290	$(5,841,120)
Paper or Paperboard Articles	$27,529,430	$22,260,181	$(5,269,249)
Tobacco Products	$5,769,590	$3,412,550	$(2,357,040)
Miscellaneous Manufactured Products	$38,233,730	$37,051,029	$(1,182,701)
Other Non-Metallic Minerals not elsewhere classified	$1,440,420	$294,305	$(1,146,115)
Gravel and Crushed Stone (excludes Dolomite and Slate)	$1,320,900	$493,639	$(827,261)
Natural Sands	$449,280	$30,954	$(418,326)
Agricultural Products (excludes Animal Feed, Cereal Grains, and Forage Products)	$26,092,910	$26,369,720	$276,810
Fertilizers	$4,733,130	$9,914,050	$5,180,920
Waste and Scrap (excludes of agriculture or food)	$3,444,530	$16,734,793	$13,290,263
Transportation Equipment, not elsewhere classified	$27,597,710	$41,239,705	$13,641,995
Wood Products	$30,013,040	$44,340,997	$14,327,957
Animal Feed, Eggs, Honey, and Other Products of Animal Origin	$22,706,720	$37,146,850	$14,440,130
Basic Chemicals	$41,503,190	$57,637,085	$16,133,895
Milled Grain Products and Preparations, and Bakery Products	$21,372,570	$39,283,660	$17,911,090
Precision Instruments and Apparatus	$13,076,340	$33,616,988	$20,540,648
Other Prepared Foodstuffs, and Fats and Oils	$108,296,860	$129,761,095	$21,464,235
Pharmaceutical Products	$11,343,220	$35,866,960	$24,523,740
Other Chemical Products and Preparations	$47,142,160	$74,131,379	$26,989,219
Cereal Grains (includes seed)	$21,846,730	$67,708,320	$45,861,590
Pulp, Newsprint, Paper, and Paperboard	$23,933,340	$76,997,721	$53,064,381
Plastics and Rubber	$96,299,520	$178,959,207	$82,659,687
Mixed Freight	$139,788,880	$385,134,418	$245,345,538
Animals and Fish (live)	$271,880		
Coal	$51,139,980		
Logs and Other Wood in the Rough	$126,520		
Meat, Poultry, Fish, Seafood, and Their Preparations	$126,540,090		
Metallic Ores and Concentrates	$1,024,290		
Monumental or Building Stone	$176,700		
Not Classified	$5,278,300		
Grand Total	**$2,052,372,020**	**$1,875,295,409**	**$(177,076,611)**

Source: Commodity Flow Survey, U.S. Census Bureau

7.2 SURPLUSES AND GAPS BY INDUSTRY SECTOR

There are a number of significant gaps that exist within the commodity flows of the Greater Lima Region. We have already discussed how these might be classified by commodity type. We will next turn to an evaluation of gaps and surpluses by industry sector. These are presented in the table in Figure 13.

When reviewing the imbalance between inflow and outflow activity by industry sector, we again must consider the role that process flows plays in the region. We see, for example that the region has a significant gap in petroleum and coal products manufacturing, but a slight surplus in petroleum and petroleum products, merchant wholesalers and more significant surpluses in all petroleum goods industries. Similarly, the region has a significant gap in primary metal manufacturing but a slight surplus among metal wholesalers. This suggests that these goods come into the region, are processed, and then sold out of the region.

The gap analysis also points to the importance of the warehousing and distribution industry sector in the region. More than $250 million more in commodities are shipped from warehouses in the region than come from outside. These commodities can again be sorted into a number of other industry sectors.

Other industry gaps that may present potential development opportunities include the development of a larger electrical component manufacturing sector, an increase in primary and fabricated metal products markets, and further diversification of the food manufacturing sector. Each of these opportunities will be further discussed in the Innovation and Opportunity Analysis and are further validated by the perspectives of industry leaders throughout the Greater Lima Region. We will next consider the importance of these perspectives.

7.3 IMPLICATIONS

The analysis of the commodity flow gaps identified in this section leads to a number of potential implications. These both present significant opportunities for development in the Greater Lima Region and risks to future economic growth. A number of these implications are already well understood by the region's business community.

- The Greater Lima Region's business patterns are dynamic and reflect the activity of a number of prominent industry sectors. The analysis presented here suggests that a number of high value-added industry sectors are active in the region, led by the Chemical Manufacturing, Food Processing and Transportation Equipment Manufacturing sectors. These sectors represent the nexus of future potential regional growth.

- The imbalance between commodity inflow and outflow is significant in numerical terms but less so in relative terms. Much of the imbalance is explained by gaps created by the flow of production processes from raw materials to processed goods. Gaps of this nature, such as in the petroleum and primary metals commodity sectors points to opportunities to secure more reliable and local sources of these materials.

- A number of notable gaps do exist, however. The gap that exists in the machinery manufacturing sector demands further investigation to understand the nature of the imbalance and support efforts to attract locally-needed producers and increase the value of outgoing shipments.

- The data presented in this analysis represents an estimate of truck freight transportation throughout the region. Many high value goods travel through the region by other means, such as rail and pipeline. This is especially true in the petroleum and chemical manufacturing, food processing, and transportation equipment manufacturing sectors. As a consequence, we know that the actual level of business activity in the region is significantly higher. This also points the particular importance for the Greater Lima Region to continue to develop a robust network of multi-modal transportation options.

Figure 13: Surpluses and Gaps by Industry

Industry Sector	Inflow Volume	Outflow Volume	Surplus or Gap
Transportation equipment manufacturing	$399,668,200	$122,244,684	$(277,423,516)
Machinery manufacturing	$169,154,800	$16,168,994	$(152,985,806)
Primary metal manufacturing	$102,637,690	$14,178,784	$(88,458,907)
Petroleum and coal products manufacturing	$83,049,580	$2,360,840	$(80,688,740)
Food manufacturing	$234,594,650	$170,842,020	$(63,752,630)
Mining (except oil and gas)	$53,968,510	$363,279	$(53,605,231)
Electrical equipment, appliance, and component manufacturing	$58,517,810	$7,736,203	$(50,781,607)
Fabricated metal product manufacturing	$65,800,840	$37,992,603	$(27,808,237)
Computer and electronic product manufacturing	$20,384,390	$1,411,559	$(18,972,831)
Miscellaneous manufacturing	$18,823,510	$3,085,475	$(15,738,035)
Nonmetallic mineral product manufacturing	$12,314,650	$297,685	$(12,016,965)
Apparel, piece goods, and notions merchant wholesalers	$11,244,210	$1,519,080	$(9,725,130)
Furniture and related product manufacturing	$15,901,990	$7,059,949	$(8,842,041)
Beverage and tobacco product manufacturing	$18,588,320	$10,791,795	$(7,796,525)
Chemical and allied products merchant wholesalers	$10,030,020	$2,741,570	$(7,288,450)
Grocery and related product merchant wholesalers	$57,734,420	$52,218,370	$(5,516,050)
Commercial equip. merchant wholesalers	$6,968,490	$1,556,560	$(5,411,930)
Motor vehicle and parts merchant wholesalers	$8,512,260	$3,177,270	$(5,334,990)
Miscellaneous nondurable goods merchant wholesalers	$13,359,110	$8,254,480	$(5,104,630)
Drugs and druggists' sundries merchant wholesalers	$4,181,700	$344,110	$(3,837,590)
Printing and related support activities	$17,074,010	$13,837,507	$(3,236,503)
Textile product mills	$3,987,640	$1,472,711	$(2,514,929)
Furniture and home furnishing merchant wholesalers	$7,729,530	$5,727,780	$(2,001,750)
Leather and allied product manufacturing	$2,593,430	$691,130	$(1,902,300)
Corporate, subsidiary, and regional managing offices	$19,454,640	$18,208,830	$(1,245,810)
Electronic shopping and mail-order houses	$1,370,320	$779,810	$(590,510)
Paper and paper product merchant wholesalers	$6,995,350	$6,530,160	$(465,190)
Apparel manufacturing	$941,620	$972,760	$31,140
Lumber and other construction materials merchant wholesalers	$10,818,300	$10,914,290	$95,990
Newspaper, periodical, book, and directory publishers	$3,266,390	$3,541,990	$275,600
Beer, wine, and distilled alcoholic beverage merchant wholesalers	$1,555,420	$1,967,960	$412,540
Petroleum and petroleum products merchant wholesalers	$51,385,920	$53,063,420	$1,677,500
Textile mills	$10,397,390	$12,634,839	$2,237,449
Electrical and electronic goods merchant wholesalers	$10,430,330	$16,193,680	$5,763,350
Hardware and plumbing merchant wholesalers	$6,774,520	$19,037,280	$12,262,760
Miscellaneous durable goods merchant wholesalers	$7,312,210	$27,115,050	$19,802,840
Paper manufacturing	$50,650,050	$75,243,535	$24,593,485
Wood product manufacturing	$18,410,310	$54,479,475	$36,069,165
Metal and mineral (except petroleum) merchant wholesalers	$30,697,320	$80,357,300	$49,659,980
Farm product raw material merchant wholesalers	$45,612,570	$107,218,190	$61,605,620
Machinery, equipment, and supplies merchant wholesalers	$58,176,900	$120,051,790	$61,874,890
Plastics and rubber products manufacturing	$65,635,660	$129,318,879	$63,683,219
Chemical manufacturing	$122,948,240	$264,575,982	$141,627,742
Warehousing and storage	$132,718,800	$387,015,750	$254,296,950
Grand Total	**$2,052,372,020**	**$1,875,295,409**	**$(177,076,611)**

Source: Commodity Flow Survey, U.S. Census Bureau

8.0 NEXT STEPS

The most direct way of assessing the needs of the region's manufacturers is to engage them in a dialogue regarding the current and future supply chain needs. There are a number of active conversations already occurring in Lima, as represented by organizations such as Mayor's Automotive Task Force, Task Force Lima, the West Central Ohio Manufacturing Consortium, and others. Much of the discussion coming out of these organizations to date has focused on improving markets for existing regional firms. This has raised the importance of supply chain availability as one of the region's most critical needs. The analysis presented in this study expands on these broader regional initiatives by engaging companies in a different manner. The intent here is not to discuss general trends, but rather to solicit and assess a deeper level of strategic and actionable information.

Future iQ Partners worked intensely with the Allen Economic Development Group and other regional economic development partners to develop and administer a targeted workforce supply chain survey. The focus of this survey is to ascertain the specific challenges faced by the region's large manufacturing firms. The relatively narrow focus of the survey analysis is intentional as far as it first reinforces the stated objective of the Defense Industry Adjustment project to support and enhance the ecosystem surrounding the Joint Systems Manufacturing Center. The focus on regional manufacturers was also selected as a means of serving as a pilot project for the deployment of a more comprehensive economic development Business Retention and Expansion outreach process.

Invited firms are being asked to identify a number of current and prospective needs. Employers are being requested to specifically identify their current and future commodity and service needs. They are also asked to identify those firms with which they have an existing relationship and assess its importance. The survey is being administered in two phases. An initial sample of thirty-five Allen County manufacturers is being invited to participate. A second cohort of firms from across the neighboring seven-county region will also be invited to participate by local economic development representatives. All firms will be personally visited over the course of the survey period, which is expected to extend throughout the next year.

These surveys will provide important data input for the supply chain visualization platform.

In addition, a number of industry leaders in the food processing, chemical and plastics, machinery manufacturing, and transportation equipment manufacturing sectors will be invited to participate in a series of focus group meetings in September 2016. Data from this and other analyses will be shared for reaction and participants will be asked to develop unique solutions. Information from these sessions will serve to validate the findings of these analyses and to inform the creation of a Regional Collaborative Growth Plan.

9.0 CONCLUSION

Future iQ Partners, in working with the Allen Economic Development Group and other stakeholders in the Allen County region over the first two phases of the Allen County Regional Collaborative Growth Plan have collected a number of observations regarding strategies to develop the regional economy. These observations have been supported by the findings of the first two analyses developed in conjunction with the formation of a Regional Collaboration Growth Plan – the Regional Workforce Needs Analysis and the Regional Supply Chain Analysis.

The findings presented in this Supply Chain Gap Analysis suggest that the Allen County Region has a vibrant and diverse business community. The commodity flows that move into and out of the region represent the importance and legacy of the region's strong manufacturing sector. There are a number of areas, such as materials and process access that may be of immediate concern to the region's manufacturers and require creative solutions.

There are also a number of long-term opportunities to develop value-added growth in a number of advanced manufacturing sectors, such as chemical manufacturing, plastics and rubber products manufacturing, and machinery manufacturing. This is especially true through the lens of the development of new additive manufacturing and materials science discussed in the Future of Manufacturing.

The future of the region's manufacturing sector depends on the further development of the region's manufacturing supply chains. It requires the engagement of a wide array of regional partners. It is a fundamental principle of a successful collaborative regional growth strategy.

10.0 ABOUT FUTURE IQ

Future iQ Partners is a market leader in the development and application of scenario planning; network analysis, industry and regional analysis, and community engagement and capacity building. We specialize in applying innovative tools and approaches to assist organizations, regions and industries shape their economic and community futures. We take a practical, hands-on approach to working with groups and communities. With over a decade of business experience, the company has grown to have a global clientele spanning three continents. To learn more about Future iQ Partners, and our recent projects visit www.future-iq.com or by email at info@future-iq.com

REPORT PREPARED BY:

Dr. Jeffrey A. Sachse

Jeffery specializes in detailed economic analysis and data interpretation. He has worked on industry clusters, regional partnerships, workforce development and economic trends and indicators. He has led research and development projects in transportation, and conducted program monitoring. He has detailed local knowledge of the USA economic landscape, having worked professionally in this area for over a decade.

David Beurle

As CEO of Future iQ Partners, David specializes in creating future planning approaches for the use in regional, community and organizational settings. David has worked in the field of organizational and regional economic and community planning for over 20 years. His work in community and economic development has earned his work international, national and state awards.

11.0 ABOUT AEDG (ALLEN ECONOMIC DEVELOPMENT GROUP)

The Allen Economic Development Group (AEDG) is a public/private partnership that was formed in 1993 as a facilitator for countywide economic development. This cooperative effort of the public and private sectors has been a significant catalyst for the economic growth in Lima/Allen County. AEDG staff have been instrumental in supporting the studies as part of the Comprehensive Growth Plan project.

For more information regarding AEDG, please contact:

Jeff Sprague, President/CEO | Allen Economic Development Group
144 S. Main Street, Suite 200, Lima, Ohio 45801
419-222-7706 (office) | 419-303-0512 (cell)
Spraguej@aedg.org | www.aedg.org

12.0 ABOUT THE ALLEN COUNTY COLLABORATIVE GROWTH PLAN

This study is one of many to be produced under an award issued by the U.S. Department of Defense Office of Economic Adjustment to assist Allen County in developing strategies to develop a regional collaborative growth plan. This includes ensuring the economic health and vitality of the Joint Systems Manufacturing Center and the broader region.

For more information regarding Allen County OEA, please contact:

Cynthia Leis
Project Manager
Allen County Office of Economic Adjustment
144 S. Main Street, Suite 204
Lima, Ohio 45801
Cell 567-204-3631

FOR MORE DETAILS, AND TO ACCESS COPIES OF ADDITIONAL REPORTS, PLEASE VISIT:

www.future-iq.com/project/task-force-lima or www.aedg.org/strategic-plan/reports/

Asset Inventory
March 2015

Scenarios of the Future
April 2015

Strategic Action Plan
May 2015

Comprehensive Gap Analysis - Part 1
August 2016

Comprehensive Gap Analysis - Part 2
August 2016

ALLEN ECONOMIC DEVELOPMENT GROUP
ALLENCOUNTY®
REAL AMERICAN STRENGTH™

future→iQ
PARTNERS