THE MANUFACTURING TASK FORCE

MANUFACTURING GROWTH STRATEGY FOR PHILADELPHIA

PRESENTED TO

MAYOR MICHAEL A. NUTTER

DECEMBER 2013

MANUFACTURING GROWTH STRATEGY STUDY

Purpose of the Study

Because of the recent emergence of more favorable conditions for growth in manufacturing, and the City of Philadelphia's historical role as a major center for manufacturing in the US, Mayor Michael A. Nutter, in coordination with Philadelphia City Councilman Bobby Henon, founded the Mayor's Manufacturing Task Force in January of 2013 to evaluate the city's competiveness and develop recommendations for growth. The Task Force itself is a diverse group of private sector business leaders working in concert with government, economic development, academia, utilities, labor, and workforce development ("Advisory Group") to identify key issues and recommend attainable solutions to make Philadelphia a better place for manufacturing. The Task Force and Advisory Group were supported by a consultant team led by IHS Global, who used independent research, private interviews, and proprietary analytics combined with the first-hand testimony of the Task Force, resulting in the *Manufacturing Growth Strategy for Philadelphia*.

The Manufacturing Growth Strategy Study consists of three tasks:

- Task One: Create a detailed definition of the City and Region's manufacturing sector.
- Task Two: Analyze five key foundational issues identified as critical to the sustained growth of the manufacturing sector: 1) Talent Pool; 2) Innovation; 3) Government; 4) Logistics, Utilities, and Transportation; and 5) Energy.
- Task Three: Develop specific, attainable strategies to encourage growth in manufacturing in the City and Region.

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A Manufacturing Growth Strategy for Philadelphia
Executive Summary

The City of Philadelphia established the Manufacturing Task Force ("Task Force") to evaluate the City's competitiveness for manufacturing and recommend specific strategies for improvement. The Task Force itself was drawn from a diverse group of private sector business leaders. The Task Force worked in concert with an Advisory Committee representing government, economic development, academia, utilities, labor, and workforce development to identify key issues and recommend attainable solutions to make Philadelphia a better place for manufacturing. The Task Force and Advisory Committee were supported by a Working Group and consultant team led by IHS Global, which used independent research, private interviews, and proprietary analytics combined with the first-hand testimony and the Task Force, resulting in a *Manufacturing Growth Strategy for Philadelphia*.

The work of the Task Force was broken into three areas:

Task 1: Create a detailed definition of the City and Region's manufacturing sector, including metrics on activity, product type, employment, output, wages, supply routes, and niche markets.

Task 2: Analyze key foundational issues identified as critical to the sustained growth of the City's manufacturing sector: 1)Talent 2)Innovation 3)Government 4)Logistics, Utilities, and Transportation 5)Energy.

Task 3: Develop specific, attainable strategies to encourage growth in manufacturing in the City and Region.

Task 1 – Define the Manufacturing Sector

Philadelphia's manufacturing sector is broad and diverse. It is no longer the traditional "smoke stacks" and vertically integrated factories abutting residential neighborhoods. Manufacturing in Philadelphia today looks much different: it's faster, more technologically driven, and largely exists within 15 industrial districts located throughout the City. Employment in Philadelphia's manufacturing sector consists of entry-level assembly workers, trained engineers, skilled craftspeople, scientists, sales, marketing, and logistics support personnel. The City's product base is also incredibly diverse, which subsequently offers the City economic stability and the ability to adapt to evolving market opportunities. While overwhelmingly a strength, this diversity provides a diffuse image of Philadelphia manufacturing that can reduce its ability to compete with other metro areas as a location for modern manufacturing.

Key Facts

Wages in Manufacturing in the City of Philadelphia

$58,977 *Average Annual*

$1.3 Billion *Total Annual Wages Paid*

Number of Workers Employed in Manufacturing

23,000 *City of Philadelphia*

163,000 *Greater Philadelphia*

750 Manufacturing Firms *in the City of Philadelphia*

575 (77%) *under 20 employees*

$105.6 Billion output in the 11 county Region (14% of Region's total)

Competitive Strengths
in the City of Philadelphia

Chemicals,
Medical Equipment,
Machinery,
Food Processing, and
Transportation Equipment and Parts

Task 2 – Analyze Key Foundational Issues

Talent: There is significant concern amongst business leaders and policy makers regarding the availability and readiness of a qualified workforce in manufacturing. This dynamic exists primarily due to a skills mismatch between job-seekers and hiring firms; however there is also a noticeable absence of academic or technical-training certificate programs that specialize in manufacturing process in the City's secondary and post-secondary institutions.

Additionally, manufacturing is not a very visible, recognized career path for students. As a result, few students take advantage of training suited for manufacturing. Adding urgency to this issue is the increasing average age of existing manufacturing workers, who predominantly are Baby Boomers and are likely to retire within the next ten years.

Innovation: The Greater Philadelphia Region is an important technology innovation center in the United States, due to its high concentration of research institutions, but still lags behind the nation as a whole in developing new technologies and patents. The majority of technology transfer in the Region is focused on licensing activity rather than start-up ventures due in part to the absence of a sizable venture capital community. However, licensing is less likely to result in new business activity, job creation, or localized product development.

For existing small to mid-sized businesses, access to working capital for new product development is limited, either because banks are unable to finance these activities due to federal lending guidelines or because the companies themselves are not able to qualify for traditional private financing. Access to flexible capital is an issue that has hindered the City's growth in innovation and product design.

Government: The City of Philadelphia was compared against nine other locations with large manufacturing clusters of similar sub-industries. Utilizing business profiles based on industry averages, this comparative model demonstrated Philadelphia as the highest in each industry for tax burden. The City's new tax-reform legislation and move to a Single Sales Apportionment, scheduled to begin implementation in 2014, will significantly address this issue. However, recent increases in Use & Occupancy Tax and the rising burden for stormwater management continue to pinch low-margin businesses financially.

Additionally, manufacturers often report encountering conflicts between regulations at the local, state, and federal levels that aren't implemented or enforced in coordination. This has led to confusion and frustration amongst manufacturers who are attempting maintain their compliance amongst several levels of government who may be enforcing regulations with different standards.

Energy: Natural gas production in parts of Western and Northeastern Pennsylvania has resulted in the Commonwealth's rapid emergence as a leading energy center in the US. However, Greater Philadelphia has not been able to take full advantage of this new activity and development. Philadelphia's large cluster of energy and chemical firms would make the City a natural fit for growth in the production of chemicals and petrochemicals; however both products use natural gas liquids as their primary feedstock and the absence of sufficient pipeline capacity hampers this industry's sizable growth potential.

Logistics, Utilities, and Transportation: Philadelphia's transportation infrastructure is largely adequate for the City's manufacturing needs and has been repeatedly cited as an asset. The City has a very strong commodity flow not only with the Northeast and Mid-Atlantic Regions, but also with cities like Houston and Chicago. In this respect, and along with other cities across America, the continued improvement and maintenance of roads, highways, and bridges is a critical factor to maintaining this competitive advantage.

Task 3 – Strategy Recommendations

Talent

Expand technical training programs offered by the community colleges that align to the needs of the manufacturing sector. Increasing opportunities for technical skills training and boosting enrollments will create a talent pipeline from which manufacturers can recruit.

Focus high school career and technical education programs on science, technology, engineering, and math (STEM) to support manufacturers. Focusing on STEM skills in high schools and vocational schools will help close the skills gap.

Innovation

Expand linkages between existing university product design programs at Philadelphia University, Drexel University and the University of Pennsylvania and regional manufacturers. Providing local firms with access to students enrolled in these programs will produce immediate benefits for both parties. Using the federal manufacturing accelerator model, explore continued development of these connections into new partnerships between industry and universities to **establish innovation centers or incubators** to assist private companies in solving technical problems and spur innovation.

Access to Capital

Create new loan and/or equity funds targeted specifically to small and mid-size manufacturers investing in product development and innovation. These targeted funds would offer an alternative to funding major investments in new products or technologies from cash flow alone.

Expand access to flexible business loans for small equipment purchases and working capital in addition to the traditional economic development loans available for building acquisition, renovations, and heavy machinery. PIDC should utilize its recent designation as a community development financial institution (CDFI) to raise new private capital for this type of small busines lending.

Advocacy, Networks, and Business Development

Conduct an image campaign to educate students, parents, teachers, and guidance counselors about employment opportunities in manufacturing. Students need to understand that careers in manufacturing can provide a challenging work environment, livable wages, and a path for professional growth.

Implement a focused business attraction campaign to publicize the City & Region's competitive advantages for manufacturing. Greater Philadelphia remains a competitive place to manufacture and that fact needs to be shared with other markets and companies who are considering relocation or strategic expansion.

Energy

Increase the supply of natural gas and natural gas liquids available to manufacturers in the City & Region by increasing pipeline capacity. Adding additional pipeline capacity will allow more natural gas and natural gas liquids to flow to Greater Philadelphia, which will provide a strong competitive advantage to the chemical and petrochemical clusters.

Promote the use of energy efficient technology, distributed energy systems, and smart grid technology to improve energy efficiency of large manufacturing operations.

Government & Regulation

Decrease the tax burden on manufacturing companies and identify targeted incentives to decrease operating costs. The Single Sales Apportionment changes that the City will begin implementing in 2014 will be an important step to reducing cost gaps with competing regions.

Continue to preserve by-right zoning in industrial corridors. Following on the recommendations of the Philadelphia Industrial Management and Land Use Strategy of 2010, preserving by-right zoning in identified industrial corridors will protect manufacturing users from being priced out of the City or from land speculators.

Enhance communications between government and manufacturers while providing services to the industry. The Department of Commerce will form and regularly convene a working group consisting of those actively engaged in the manufacturing community to coordinate the implementation of recommendations outlined by the Task Force, and further publicize the availability of the Director of Industrial Development to resolve issues related to regulation, taxes, permitting and approvals.

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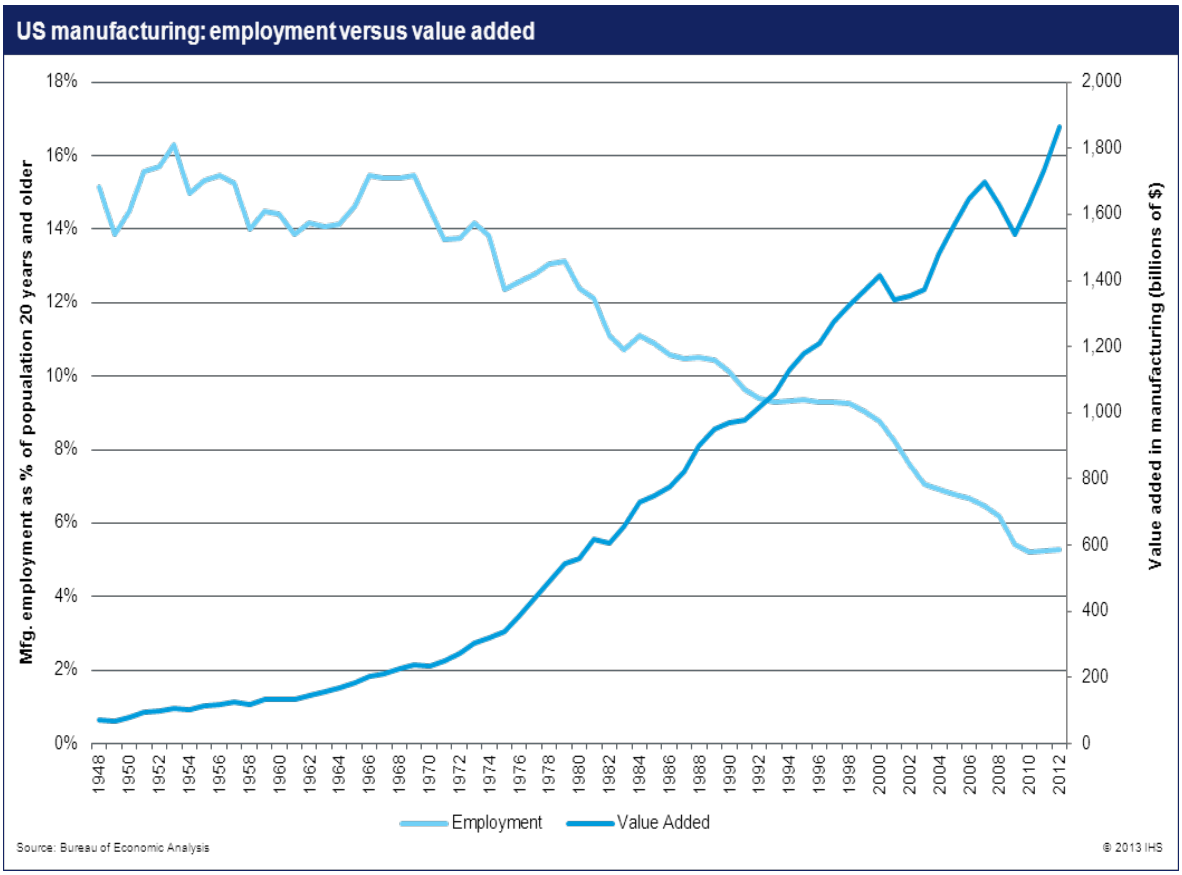
TASK ONE: DEFINE THE MANUFACTURING SECTOR

Introduction

Background on Manufacturing

The United States' (US) manufacturing sector has been steadily declining throughout the post-World War II period as a share of the US economy, both in terms of total US GDP and total employment. In 1948 just over 15.0% of the civilian, non-institutionalized population 20 years and older in the US was employed in the manufacturing sector; by 2012 the figure had fallen to only 5.3%. During the same period, the manufacturing sector's share of total US nonfarm payroll employment fell from 31.9% in 1948 to 8.9% in 2012, while gross domestic product (GDP) in manufacturing continued to rise, reaching almost $1.9 trillion in 2012. Rising productivity in the manufacturing sector explains the divergence in these two trends. While the value of manufactured goods has increased over the post-war period, their share of total US GDP has declined from 26% in 1948 to just below 12% in 2012 as the service sectors have grown faster. Even with this relative decline in share of GDP the US still has the largest manufacturing sector in the world in terms of the value of goods produced.



The decline in the economic importance of the manufacturing sector noted for the US has also occurred in many metropolitan areas throughout the country, including in the City of Philadelphia and in the larger Greater Philadelphia Region (Region). In addition to its direct contributions to US and regional economies, the manufacturing sector accounts for about two-thirds of US merchandise exports and is a major source of innovation in the US because of its high levels of research and development (R&D) spending and the generation of ideas that receive patents. According to the National Science Foundation, in 2010 the US manufacturing sector performed 60.1% of total R&D spending in the US, including 56.4% of applied R&D spending. One of the concerns with the off-shoring of production jobs in manufacturing to other countries is that other related activities, such as R&D, may follow.

The decline in manufacturing activity, especially employment, which has occurred since the 2001 recession and more recently during the Great Recession, has caused governments at all levels to begin considering policies that would strengthen the manufacturing sector. At the same time, some of the factors that led to decline in the US manufacturing sector over the past several decades have started to reverse, including: narrowing of labor costs between the US and other countries, especially those in Asia; the rise in energy prices that makes it more costly to transport manufactured goods long distances; the cost and difficulties of maintaining long and complex supply chains; a renewed appreciation for the importance of skilled workers; the need to get goods to market sooner; the rising importance of flexible production processes that can be changed quickly to produce limited runs of high-quality, high-priced goods; and more recently, the increase in energy supplies and feedstock coming from unconventional energy sources in the US, such as the Marcellus shale formation in Pennsylvania. As a result of these changes, the US and regional economies have become more competitive as locations for certain types of manufacturing activities than they have been for several decades, especially in energy-intensive industries.

Research Methodology

The manufacturing sector

This study addresses only the manufacturing sector, or industries assigned to North American Industry Classification System (NAICS) codes 31 through 33 as defined by the Bureau of the Census. As understanding the NAICS system is crucial to this study, an example is presented. A business establishment is assigned to an NAICS code based on the primary type of good it makes, or the primary type of service it provides. It is a hierarchical system in which the codes go from the two-digit to the six-digit level, so that the larger the number of digits, the narrower the sector.

Manufacturing sectors are in NAICS code 31 through 33

- NAICS code 325 is chemical manufacturing (there are 21 three-digit sectors in manufacturing)
    - NAICS code 3254 is pharmaceutical and medicine manufacturing (there are 86 four-digit NAICS sectors in manufacturing)
        - NAICS code 325411 is medicinal and botanical manufacturing
        - NAICS code 325412 is pharmaceutical preparations manufacturing

The analyses in the *Manufacturing Growth Strategy Study* have been primarily conducted at the four-digit NAICS code level as it has the appropriate amount of detail for analysis and is generally suitable for strategy development (i.e., the three-digit NAICS codes are too broad). Nevertheless, as shown by the example, there will be a need at times to provide analyses and development strategies for selected six-digit NAICS codes as even at this level of detail, there can be significant differences between adjacent sectors in terms of production functions, location requirements, workforce needs, types of raw material used, dependence on transportation, energy consumption, etc.

Some care must be taken when using and interpreting economic information based on NAICS codes. Most published economic information, such as employment, is compiled based on data obtained from or reported at the individual business establishment level, and not by company. The Bureau of the Census defines a business establishment as "a single physical location where business is conducted or where services or industrial operations are performed." The NAICS code assigned to an individual establishment, especially for a company that has many of them, is often based on the primary type of good or service produced by the company of which the establishment is a part. As a result, the NAICS code for an establishment may not accurately indicate the type of activity that occurs there. This issue is especially important for a manufacturing strategy study where analysts need to know the locations of production activities. For example, GlaxoSmithKline's US headquarters is located in its new building at the Philadelphia Navy Yard. As the company produces pharmaceutical preparations, the establishment at the Navy Yard is classified as NAICS 325412 – Pharmaceutical preparations manufacturing. Because this establishment is a headquarters, though, little or no manufacturing activity occurs there. As a result, while employment information for the City of Philadelphia at the four-digit NAICS code level 3254 – Pharmaceutical and medicine manufacturing shows a high number of jobs, the vast majority of them are not producing pharmaceuticals. This example also shows that the Greater Philadelphia Region have competitive advantages that may enable them to attract the nonproduction activities of manufacturing companies such as R&D, sales and marketing, production development, warehousing and distribution, headquarters, etc.

Durable and nondurable manufacturing subsectors

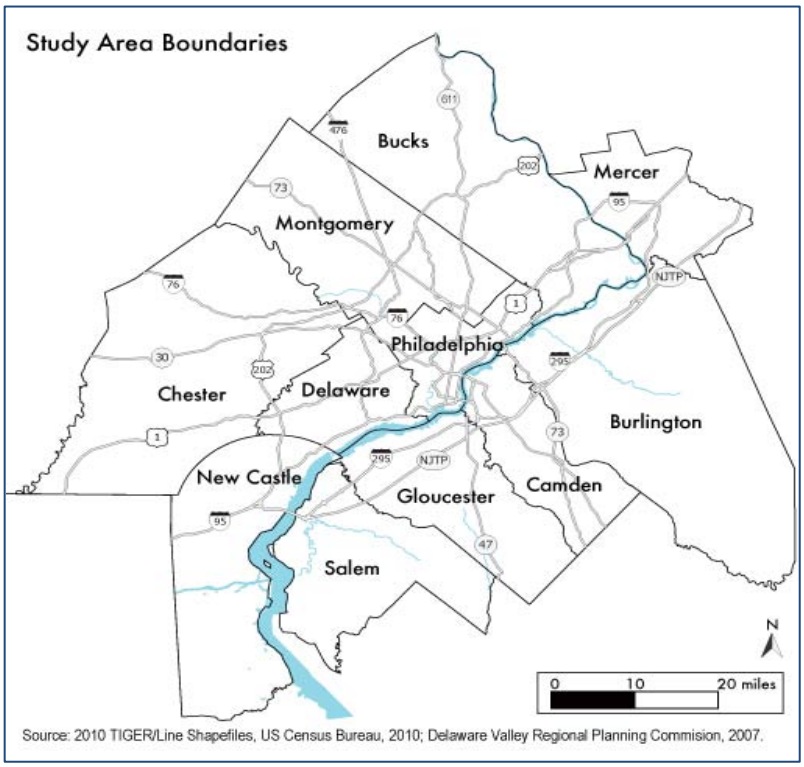
The Bureau of the Census subdivides the three-digit manufacturing sectors into two types: durables and nondurables. Durable goods are hard, do not wear out quickly, and usually have a useful life of more than three years. By contrast, nondurable goods are soft, tend to wear out quickly or can be consumed at once (e.g., food products), and have useful lives of less than three years.

Manufacturing Subsectors			
3 Digit NAICS Code Level			
Nondurables		Durables	
311	Food	321	Wood
312	Beverage & Tobacco	327	Nonmetallic Minerals
313	Textile Mills	331	Primary Metal
314	Textile Product Mills	332	Fabricated Metal
315	Apparel	333	Machinery
316	Leather & Allied Products	334	Computer & Electronics
322	Paper	335	Elect. Equip. & Appliances
323	Support - Printing	336	Trans. Equip.
324	Petroleum & Coal	337	Furniture& Related
325	Chemical	339	Misc. Mfg.
326	Plastics & Rubber		

Manufacturing activity in the City of Philadelphia is primarily concentrated in the nondurable sectors, while in the adjacent 10 counties it occurs primarily in the durable sectors.

The study area

The study area for the *Manufacturing Growth Strategy Study* consists of the 11 counties composing the Greater Philadelphia Region as follows: Bucks, Chester, Delaware, Montgomery, and Philadelphia Counties in Pennsylvania; Burlington, Camden, Gloucester, Mercer, and Salem Counties in New Jersey; and New Castle County in Delaware.



Appendix A presents maps showing some of the key systems of infrastructure and facilities that are important locational factors for manufacturing plants.

The working group convened to oversee the strategy study felt a primary objective should be to compare and contrast the characteristics of the manufacturing sector in the City of Philadelphia with that of the surrounding 10 suburban counties. This approach will benefit strategy development in both areas by identifying competitive advantages and disadvantages that are either unique to one area or the other, or that exist in both. As a result, the analyses presented will generally, where information permits, contain information for the City of Philadelphia and for the 10 suburban counties excluding the City of Philadelphia.

History of manufacturing activity

City of Philadelphia and the Greater Philadelphia Region before 1990

According to Professor Walter Licht of the University of Pennsylvania in his essay "The Workshop of the World," there were four factors that drove Philadelphia's emergence as a center of US manufacturing. First, the city has always produced a diversity of manufactured goods, ranging from textiles and specialty equipment to chemicals and locomotives. Second, the city has always produced its manufactured goods in a wide array of work settings, ranging from homes and shops to large steam-powered mills and factories.

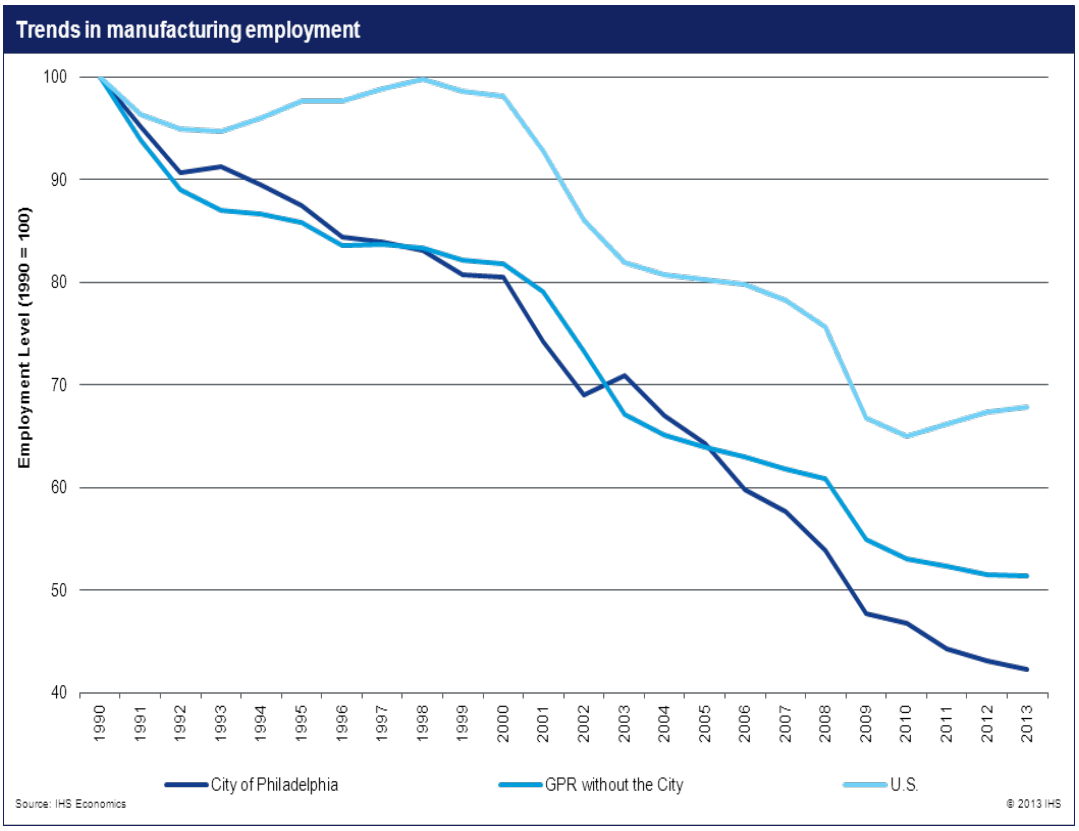
Compared with other major US cities, Philadelphia has historically had fewer large manufacturing establishments. Third, the diversity in products and settings leads to specialization as the city's firms served high valued-added, niche markets by using flexible production processes to produce custom goods. Fourth, the city's manufacturing sector consisted of a large number of small to mid-size companies and family-owned businesses that depended heavily on highly skilled workforces.

Military orders during World War II increased the level of manufacturing activity in the city so that by the post-war peak in 1953, according to Licht, approximately 365,600 Philadelphians were employed in manufacturing, amounting to just over 45% of the city's total private-sector employment. That same year, employment in the US manufacturing sector accounted for 32% of total private-sector employment.

The expansion of the US economy between 1950 and 2012 was accompanied and partially fueled by a shift from the production of goods to the provision of services. In 1950, production of goods (e.g., agriculture, natural resources and mining, construction and manufacturing) accounted for 40.8% of US GDP while the private, services-providing sectors accounted for 48.5%, and government, the remaining 10.7%. In 1950, the manufacturing sector alone accounted for 27% of US GDP. By 2012, these shares had changed dramatically, with the production of goods accounting for 18.4% of GDP, the private, services-providing sectors, for 68.7%, and government, for 12.9%. In 2012, the manufacturing sector produced 11.9% of US GDP, up from a low of 11.0% in 2009 during the depths of the Great Recession. This structural shift in the economy was even more pronounced within the Philadelphia region. Manufacturing employment in the Philadelphia area declined by 32% from 1980 to 2000, with real manufacturing earnings declining 7.3% during the same period. While the decreases in employment could be explained primarily by productivity growth within the manufacturing sector, the earnings decline was due to the outmigration of high-paying manufacturing jobs.

City of Philadelphia and the Greater Philadelphia Region since 1990

According to the IHS Business Market Insights database, which is based on the Current Employment Statistics (CES) nonfarm payroll employment series published by the Bureau of Labor Statistics (BLS), between 1990 and 2000, approximately 57,700 jobs were lost in the 10 suburban counties, followed by a larger decline of 96,700 between 2000 and 2013. The corresponding declines in the City of Philadelphia were 11,600 and 22,900 jobs, respectively. In other words, the suburban counties lost about five times as many manufacturing jobs as did the city over the last 23 years.



Since 1990, the loss of manufacturing jobs in both the City and the Region without the city has been greater than in the US, with the city experiencing a larger decline. The trends lines show the difference in the level of manufacturing employment widened dramatically during the 1990s—as US manufacturing employment grew it fell in both the City and the adjacent 10 counties. Between 2000 and 2009, the level of manufacturing employment in the City and adjacent 10 counties declined at about the same rate. Nevertheless, starting in 2009, the gap again started to widen as the level of US manufacturing employment rose, while it was generally stable in the city and the Region excluding the City.

According to monthly estimates published by the Federal Reserve Bank of Philadelphia, since January 1990 nonfarm manufacturing employment in the City of Philadelphia has declined 68.0% compared with 48.9% in the Philadelphia-Camden-Wilmington metropolitan statistical area (MSA) and 32.9% in the US. More recently, since December 2007, the city's manufacturing employment has fallen 18.4%, again above the declines of 17.7% in the Philadelphia MSA and 13.2% for the US. In June 2013 manufacturing employment in the City of Philadelphia was 23,000 jobs, or just over 4% of total private-sector employment. The corresponding shares for the Philadelphia MSA and US were 7.5% and 10.5%, respectively. One recent trend of concern is that, according the Federal Reserve Bank of Philadelphia, manufacturing employment in the City of Philadelphia and in the Philadelphia MSA between June 2012 and June 2013 fell by 0.9% and 0.7%, respectively, while in the US it declined by only 0.2%.

Current characteristics of the manufacturing sector

Employment and output by sector

To formulate a manufacturing growth strategy, it is essential to describe the composition of the City's and region's manufacturing base at a detailed level. IHS has used its proprietary Business Market Insights database which contains employment, output, and establishment data by employment-size category down to the six-digit NAICS level from 1990 onward. The manufacturing sector in all 11 counties of the Region currently accounts for 6.3% of total nonfarm payroll employment with 188,200 jobs; has just under 5,300 establishments with payroll; and produces $105.6 billion in output, or 14.05% of the Region's total.

Analyzing shares of employment by three-digit NAICS sector shows that the structures of the manufacturing sectors in the city and the 10 suburban counties are different. Currently, 56.3% of manufacturing employment in the city is in the nondurable sectors compared with 43.7% of the 10 suburban counties, and vice versa. The durable and nondurable employment shares in the 10 suburban counties are more similar to the US shares than are those in the city.

Employment in 2013						
Sector	City of Philadelpha		GPR excluding Philadelphia		US	
	Number of Jobs	% of Total Manufacturing	Number of Jobs	% of Total Manufacturing	Number of Jobs	% of Total Manufacturing
311 Food	5,272	20.8%	15,445	9.5%	1,472,295	12.2%
312 Beverage & Tobacco	694	2.7%	2,393	1.5%	195,605	1.6%
313 Textile Mills	300	1.2%	752	0.5%	113,300	0.9%
314 Textile Product Mills	284	1.1%	1,005	0.6%	116,036	1.0%
315 Apparel	802	3.2%	1,091	0.7%	147,712	1.2%
316 Leather & Allied Products	11	0.0%	175	0.1%	27,571	0.2%
322 Paper	1,178	4.7%	6,245	3.8%	373,038	3.1%
323 Support - Printing	1,234	4.9%	10,345	6.4%	455,890	3.8%
324 Petroleum & Coal	995	3.9%	2,610	1.6%	114,117	0.9%
325 Chemical	3,020	11.9%	23,594	14.5%	794,190	6.6%
326 Plastics & Rubber	452	1.8%	7,604	4.7%	648,759	5.4%
Total Non-durable	**14,242**	**56.3%**	**71,259**	**43.7%**	**4,458,513**	**37.1%**
321 Wood	118	0.5%	2,096	1.3%	364,191	3.0%
327 Nonmetallic Minerals	170	0.7%	5,264	3.2%	368,863	3.1%
331 Primary Metal	200	0.8%	3,863	2.4%	398,509	3.3%
332 Fabricated Metal	2,606	10.3%	18,555	11.4%	1,442,363	12.0%
333 Machinery	991	3.9%	12,882	7.9%	1,102,973	9.2%
334 Computer & Electronics	285	1.1%	16,464	10.1%	1,086,788	9.0%
335 Elect. Equip. & Appliances	1,058	4.2%	3,981	2.4%	366,982	3.1%
336 Trans. Equip.	3,355	13.3%	15,384	9.4%	1,493,883	12.4%
337 Furniture & Related	796	3.1%	4,031	2.5%	349,828	2.9%
339 Misc. Mfg.	1,472	5.8%	9,104	5.6%	586,851	4.9%
Total Durable	**11,051**	**43.7%**	**91,624**	**56.3%**	**7,561,231**	**62.9%**
Total Manfuacturing	**25,293**	**100.0%**	**162,883**	**100.0%**	**12,019,744**	**100.0%**

Source: IHS and Business Markets Insights database

Unlike the makeup of manufacturing sectors, real output by durable and nondurable sectors in Philadelphia and the Region more closely mirror each other. Approximately 79% of the city's real output is in the nondurable sectors and is concentrated in three sectors—petroleum and coal, chemicals, and food. About 63% of real output in the 10 suburban counties is in the nondurable sectors, well above the 43% share of employment. We believe this is because of the number of high-capacity refining and chemical facilities located in the suburban counties that have very high ratios of output per employee. The other sectors that account for large shares of real output are food and beverages, especially in the 10 suburban counties; transportation equipment (which includes Cardone Industries in the city, Boeing in Delaware County, and the various Lockheed Martin facilities in the region), and durable sectors 331 through 335 in the suburban counties. By way of comparison, US-level real output is almost evenly distributed between the durable and nondurable sectors.

Real Output in 2013

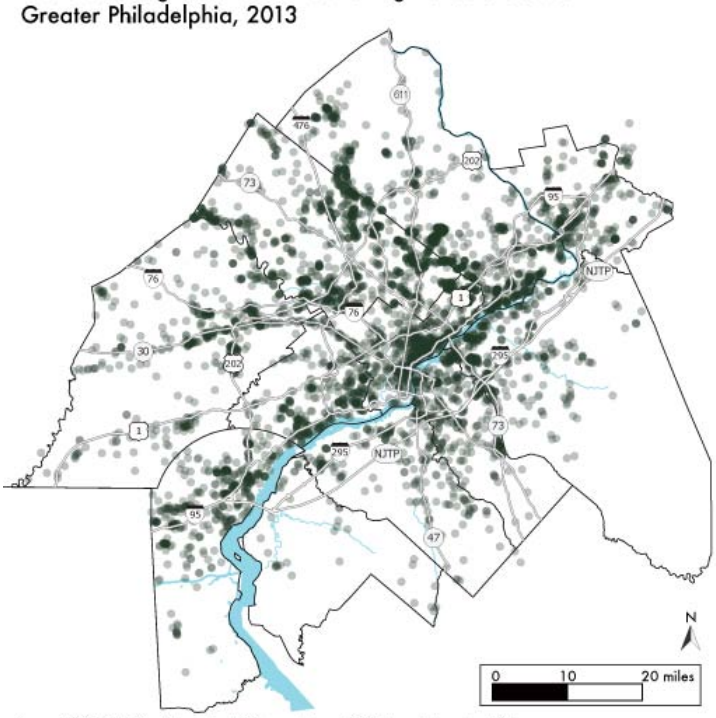
	City of Philadelpha		GPR excluding Philadelphia		US	
Sector	Output (millions of 2010 $)	% of Total Manufacturing	Output (millions of 2010 $)	% of Total Manufacturing	Output (millions of 2010 $)	% of Total Manufacturing
311 Food	2,016	12.8%	6,873	8.7%	661,378	12.5%
312 Beverage & Tobacco	372	2.4%	3,460	4.4%	151,486	2.9%
313 Textile Mills	73	0.5%	186	0.2%	28,544	0.5%
314 Textile Product Mills	47	0.3%	187	0.2%	19,953	0.4%
315 Apparel	54	0.3%	81	0.1%	11,876	0.2%
316 Leather & Allied Products	2	0.0%	31	0.0%	5,370	0.1%
322 Paper	469	3.0%	2,325	2.9%	159,133	3.0%
323 Support - Printing	195	1.2%	1,867	2.4%	78,148	1.5%
324 Petroleum & Coal	6,943	44.1%	15,318	19.4%	648,211	12.2%
325 Chemical	2,177	13.8%	17,152	21.7%	715,668	13.5%
326 Plastics & Rubber	137	0.9%	2,592	3.3%	210,535	4.0%
Total Non-durable	**12,485**	**79.2%**	**50,073**	**63.3%**	**2,690,300**	**50.7%**
321 Wood	25	0.2%	504	0.6%	79,134	1.5%
327 Nonmetallic Minerals	41	0.3%	1,437	1.8%	95,224	1.8%
331 Primary Metal	115	0.7%	2,669	3.4%	243,152	4.6%
332 Fabricated Metal	581	3.7%	4,393	5.6%	350,056	6.6%
333 Machinery	309	2.0%	4,204	5.3%	362,850	6.8%
334 Computer & Electronics	60	0.4%	5,684	7.2%	331,339	6.2%
335 Elect. Equip. & Appliances	278	1.8%	1,240	1.6%	115,413	2.2%
336 Trans. Equip.	1,362	8.6%	5,680	7.2%	818,099	15.4%
337 Furniture& Related	130	0.8%	695	0.9%	60,338	1.1%
339 Misc. Mfg.	374	2.4%	2,565	3.2%	165,424	3.1%
Total Durable	**3,275**	**20.8%**	**29,071**	**36.7%**	**2,621,028**	**49.3%**
Total Manfuacturing	**15,760**	**100.0%**	**79,144**	**100.0%**	**5,311,328**	**100.0%**

Source: IHS and Business Markets Insights database

Presented on the next four pages is a set of maps showing the spatial distribution of establishments in the durable and nondurable manufacturing subsectors in the City of Philadelphia and the Region. The concentration of the durable and nondurable establishments along the Delaware River and along the major highways is clearly evident. The concentration of pharmaceutical establishments along highway corridors in Chester, Montgomery, and Mercer Counties is shown in the nondurable map.

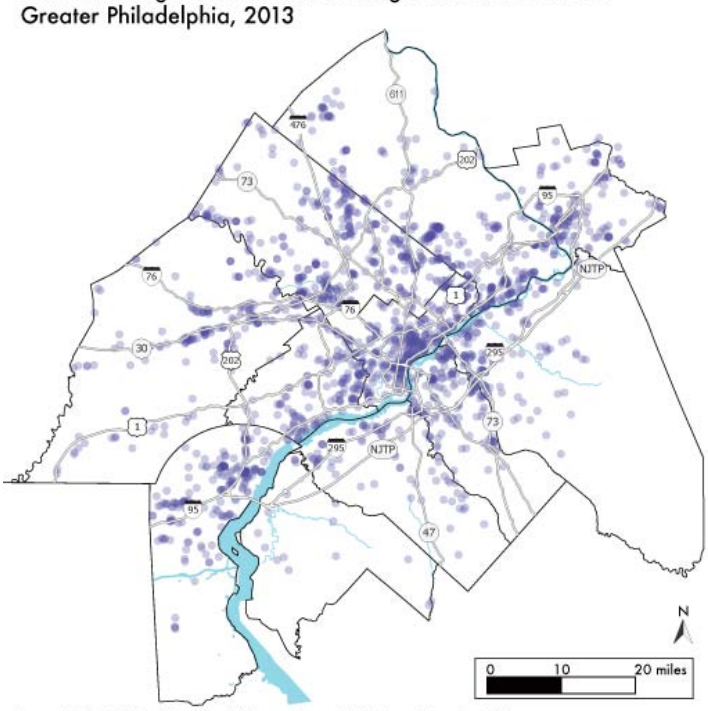
We provided the Manufacturing Task Force with a set of maps showing the distribution of manufacturing establishments by three-digit NAICS code in the city and in the 10 suburban counties.

Manufacturing Establishments Making Durable Goods
Greater Philadelphia, 2013



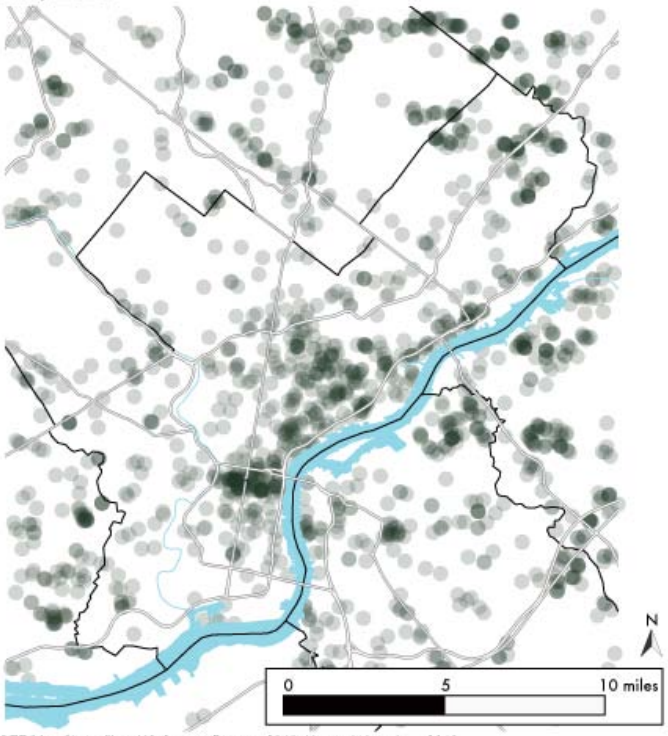
Source: 2010 TIGER/Line Shapefiles, US Census Bureau, 2010; Hoover's Inc. June 2013.

Manufacturing Establishments Making Non-Durable Goods
Greater Philadelphia, 2013



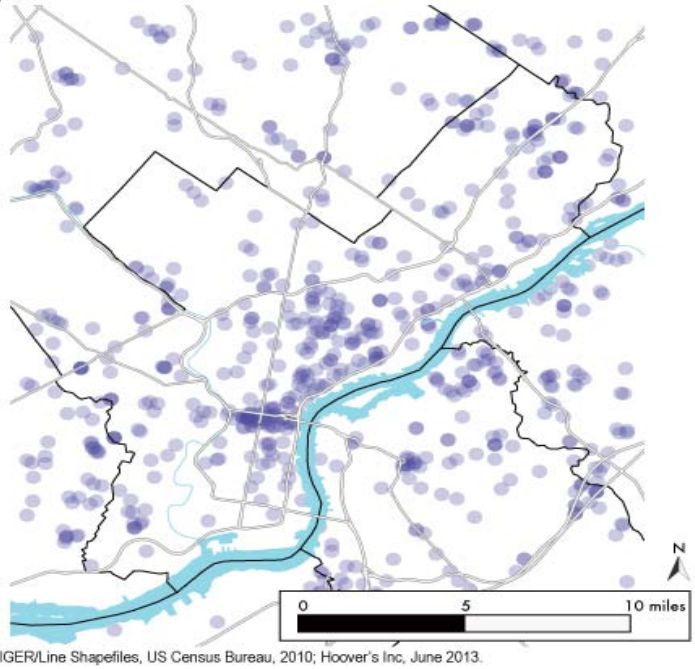
Source: 2010 TIGER/Line Shapefiles, US Census Bureau, 2010; Hoover's Inc. June 2013.

Manufacturing Establishments Making Durable Goods
Philadelphia, 2013



Source: 2010 TIGER/Line Shapefiles, US Census Bureau, 2010; Hoover's Inc, June 2013.

Manufacturing Establishments Making Non-Durable Goods
Philadelphia, 2013



Source: 2010 TIGER/Line Shapefiles, US Census Bureau, 2010; Hoover's Inc, June 2013.

Size distribution of manufacturing establishments by sector

The current distribution of manufacturing establishments by three-digit NAICS sector in the city and in the 10 suburban counties shows that in both areas approximately 88% of the establishments have fewer than 50 payroll jobs. The durable sector has a slightly higher share of establishments with fewer than 50 employees because of the concentration of small manufacturing enterprises in the fabricated metal, machinery, and miscellaneous manufacturing sectors.

Size Distribution of Manufacturing Establishments with Payroll in the City of Philadelphia - 2013

Number of Establishments by Employment Size Category

Sector	1-4 employees	5-9 employees	10 -19 employees	20-49 employees	50-99 employees	100-249 employees	250-499 employees	500-999 employees	1,000 or more employees	Total by Sector
311 Food	39	35	17	11	6	7	5	1	-	121
312 Beverage & Tobacco	6	1	2	2	-	2	-	-	-	13
313 Textile Mills	10	1	1	2	2	-	-	-	-	16
314 Textile Product Mills	13	3	2	3	-	-	-	-	-	21
315 Apparel	20	8	8	2	3	1	-	-	-	42
316 Leather & Allied Products	2	1	-	-	-	-	-	-	-	3
322 Paper	6	4	1	4	2	2	1	-	-	20
323 Support - Printing	35	13	9	6	4	3	-	-	-	70
324 Petroleum & Coal	3	-	2	1	-	-	-	1	-	7
325 Chemical	11	7	9	3	3	5	1	-	-	39
326 Plastics & Rubber	7	5	5	5	-	1	-	-	-	23
Total Non-durable	**152**	**78**	**56**	**39**	**20**	**21**	**7**	**2**	**-**	**375**
321 Wood	11	3	2	1	-	-	-	-	-	17
327 Nonmetallic Minerals	12	3	-	2	-	-	-	-	-	17
331 Primary Metal	3	-	-	1	1	1	-	-	-	6
332 Fabricated Metal	52	31	17	14	1	5	-	1	-	121
333 Machinery	18	5	5	5	3	2	-	-	-	38
334 Computer & Electronics	5	-	3	2	1	1	-	-	-	12
335 Elect. Equip. & Appliances	4	1	-	2	1	3	1	-	-	12
336 Trans. Equip.	8	-	1	2	3	2	-	3	-	19
337 Furniture& Related	20	5	5	4	5	1	-	-	-	40
339 Misc. Mfg.	52	16	11	10	2	2	-	-	-	93
Total Durable	**185**	**64**	**44**	**43**	**17**	**17**	**1**	**4**	**-**	**375**
Total by Size	**337**	**142**	**100**	**82**	**37**	**38**	**8**	**6**	**-**	**750**

Source: IHS and Business Markets Insights database

Size Distribution of Manufacturing Establishments with Payroll in the Greater Philadelphia Region excluding the City of Philadelphia - 2013

Number of Establishments by Employment Size Category

Sector	1-4 employees	5-9 employees	10 -19 employees	20-49 employees	50-99 employees	100-249 employees	250-499 employees	500-999 employees	1,000 or more employees	Total by Sector
311 Food	160	56	66	44	21	24	4	2	1	378
312 Beverage & Tobacco	18	6	6	5	2	3	1	1	-	42
313 Textile Mills	13	3	4	6	4	-	-	-	-	30
314 Textile Product Mills	50	12	8	6	3	-	-	-	-	79
315 Apparel	47	6	6	3	3	1	1	-	-	67
316 Leather & Allied Products	17	1	-	-	2	-	-	-	-	20
322 Paper	22	6	10	12	11	9	4	2	-	76
323 Support - Printing	233	100	73	59	23	12	7	1	-	508
324 Petroleum & Coal	22	2	3	5	4	1	2	-	1	40
325 Chemical	96	37	32	53	28	19	8	5	1	279
326 Plastics & Rubber	72	28	36	33	20	18	2	-	-	209
Total Non-durable	**750**	**257**	**244**	**226**	**121**	**87**	**29**	**11**	**3**	**1,728**
321 Wood	60	22	10	14	7	3	-	-	-	116
327 Nonmetallic Minerals	83	36	37	27	10	12	1	-	-	206
331 Primary Metal	27	5	6	5	7	8	3	-	-	61
332 Fabricated Metal	307	152	157	132	48	17	3	1	-	817
333 Machinery	161	63	68	53	22	18	1	1	1	388
334 Computer & Electronics	117	44	56	49	27	15	7	1	1	317
335 Elect. Equip. & Appliances	42	19	22	14	12	5	3	-	-	117
336 Trans. Equip.	51	9	13	21	8	10	6	-	2	120
337 Furniture& Related	107	49	25	22	6	1	1	-	1	212
339 Misc. Mfg.	249	63	58	45	19	11	3	-	-	448
Total Durable	**1,204**	**462**	**452**	**382**	**166**	**100**	**28**	**3**	**5**	**2,802**
Total by Size	**1,954**	**719**	**696**	**608**	**287**	**187**	**57**	**14**	**8**	**4,530**

Source: IHS and Business Markets Insights database

Location Quotients by Durable and Non-Durable Sectors				
Sector	Employment		Real Output	
	City of Philadelphia	GPR Excluding Philadelphia	City of Philadelphia	GPR Excluding Philadelphia
311 Food	1.70	0.77	1.03	0.70
312 Beverage & Tobacco	1.69	0.90	0.83	1.53
313 Textile Mills	1.26	0.49	0.86	0.44
314 Textile Product Mills	1.16	0.64	0.79	0.63
315 Apparel	2.58	0.55	1.54	0.46
316 Leather & Allied Products	0.19	0.47	0.12	0.39
322 Paper	1.50	1.24	0.99	0.98
323 Support - Printing	1.29	1.67	0.84	1.60
324 Petroleum & Coal	4.14	1.69	3.61	1.59
325 Chemical	1.81	2.19	1.03	1.61
326 Plastics & Rubber	0.33	0.86	0.22	0.83
Total Non-durable	**1.52**	**1.18**	**1.56**	**1.25**
321 Wood	0.15	0.42	0.11	0.43
327 Nonmetallic Minerals	0.22	1.05	0.14	1.01
331 Primary Metal	0.24	0.72	0.16	0.74
332 Fabricated Metal	0.86	0.95	0.56	0.84
333 Machinery	0.43	0.86	0.29	0.78
334 Computer & Electronics	0.12	1.12	0.06	1.15
335 Elect. Equip. & Appliances	1.37	0.80	0.81	0.72
336 Trans. Equip.	1.07	0.76	0.56	0.47
337 Furniture& Related	1.08	0.85	0.73	0.77
339 Misc. Mfg.	1.19	1.14	0.76	1.04
Total Durable	**0.69**	**0.89**	**0.42**	**0.74**

NOTE: Location quotients were calculated based on percent shares of the manufacturing sector.

Source: IHS Economics and Business Market Insights database

Employment location quotients show the manufacturing activity in the city and in the 10 suburban counties are more heavily concentrated in the nondurable sectors than is the US manufacturing sector. A location quotient (LQ) above 1.0 for a subsector shows it has an above-average concentration of economic activity (e.g., employment or output) compared to that subsector's share of the US economy. Nine of the 11 nondurable sectors in the city have employment LQs greater than 1.0 compared with only four in the 10 suburban counties. On an overall basis, the employment LQ for the entire durable sector in both the city and the 10 suburban counties is above 1.0, while it is below 1.0 for the total durable sector.

The output LQs tell a similar story, as again they are greater than 1.0 for the entire nondurable sector in the city and the 10 suburban counties, and less than 1.0 for the entire durable sector in both areas. There are some nondurable sectors in the city (e.g., food, beverage and tobacco, apparel, paper, petroleum and chemicals) and the suburbs (e.g., chemicals) where the employment LQs are much higher than the output.

These differences likely indicate that in these sectors a high share of employment is engaged in nonproduction activities such as headquarters activities, R&D, sales and marketing, etc. The same effect occurs in the durable sector in the city where all the employment LQs are greater than the output LQs, again suggesting relatively low levels of production activity there. In the 10 suburban counties, the employment and output LQs are generally the same across the durable sectors, indicating that manufacturing establishments there are more likely to be engaged in production than those in the city.

Gap analysis

IHS performed a "gap" analysis to identify manufacturing subsectors where it may be possible to increase local production that could then be sold to local customers. A supplier gap exists when a company needing a specific type of manufacturing input buys only a small share of it from local companies in that subsector (i.e., a supply shortfall or gap exists).

Just because customers can buy only small shares of the manufacturing inputs they require from local suppliers does not necessarily mean that a gap exists that could be filled by increasing local production for several reasons. The presence of a gap also begs the question of why it has not been filled earlier by local suppliers. One reason for a gap may be that the Greater Philadelphia Region do not have competitive advantages for making the required input so that local customers must import it. Some manufacturing inputs have never been made in the region, or once were but are unlikely to ever be made here again at competitive costs and at an industrial scale, such as textiles. Finally, customers may have established relationships with suppliers located outside the Region who can meet their needs better than local vendors, so that there would be costs incurred in changing to local suppliers.

As the first step in identifying potential gap sectors, IHS used data from the Minnesota IMPLAN Group's IMPLAN input/output (I/O) economic model for the Region in 2011 to identify the manufacturing subsectors that had:

- Below average supply/demand ratios. An industry sector's supply/demand ratio is total supply available in the region in the sector divided by the total demand in the region for that sector's output from all suppliers, local and nonlocal. The demand includes both other sectors that use the product to make another good or service (i.e., it is an intermediate input), and sales to final demand. A low supply/demand ratio indicates the local demand is greater than local supply, so an opportunity may exist for local suppliers to meet the excess demand.
- Below-average regional purchase coefficients (RPCs). An RPC is the share of demand for an input by all users in a region that is purchased from producers in the region. If the RPC for an input such as glass containers is 10%, it means companies in the region requiring it as an input purchase only 10% of their demand from glass container producers in the region; the remaining 90% would have to be imported.

Greater Philadelphia Region

Manufacturing Growth Strategy Study: Industry GAP analysis

Manufacturing sub-Sectors with Supply/Demand Ratios and RPCs in the Lowest Quartile

NAICS-07	Commodity Description	Commodity Output (Millions of $ in 2011)	Gross Commodity Demand (Millions of $ in 2011)	Supply Demand Ratio	Regional Purchase Coefficient (RPC)	Net Commodity Supply (Millions of $ in 2011)
311230	Breakfast cereal	$ -	$ 233.98	8.23%	3.30%	$ 19.26
311311-2	Sugar cane mills and refining	$ -	$ 91.26	0.00%	0.00%	$ -
31183	Tortilla	$ -	$ 66.72	0.00%	0.00%	$ -
31324	Knit fabric mills	$ 0.81	$ 21.98	3.04%	2.99%	$ 0.67
31411	Carpet and rug mills	$ 7.73	$ 215.55	5.23%	2.67%	$ 11.28
31412	Curtain and linen mills	$ 45.05	$ 352.00	16.03%	2.64%	$ 56.41
31522	Men's and boys' cut and sew apparel	$ 81.50	$ 731.19	11.06%	2.17%	$ 80.90
3159	Apparel accessories and other apparel	$ 23.59	$ 146.47	9.69%	1.73%	$ 14.20
3161	Leather and hide tanning and finishing	$ 4.34	$ 15.49	10.18%	0.39%	$ 1.58
3162	Footwear	$ 5.21	$ 501.12	0.82%	0.16%	$ 4.09
3169	Other leather and allied product	$ 7.36	$ 224.38	1.97%	0.25%	$ 4.41
32211	Pulp mills	$ -	$ 205.08	8.17%	2.07%	$ 16.75
325182	Carbon black	$ -	$ 17.89	0.00%	0.00%	$ -
325411	Medicinal and botanical	$ 292.78	$ 2,376.65	8.40%	2.08%	$ 199.70
327121-3	Brick, tile, and other structural clay product	$ 4.01	$ 70.97	7.06%	3.50%	$ 5.01
331411	Primary smelting and refining of copper	$ -	$ 87.10	9.95%	2.99%	$ 8.66
33151	Ferrous metal foundries	$ 24.13	$ 201.90	11.98%	3.52%	$ 24.19
332994-5	Arms, ordnance, and accessories	$ 5.96	$ 94.56	15.25%	1.40%	$ 14.42
33312	Construction machinery	$ 114.70	$ 280.67	28.55%	3.24%	$ 80.12
333314	Optical instrument and lens	$ 111.62	$ 107.90	22.81%	1.62%	$ 24.61
333315	Photographic and photocopying equipment	$ 0.86	$ 38.98	22.39%	0.39%	$ 8.73
333992, 333997, 333999	Other general purpose machinery	$ 244.38	$ 231.27	2.02%	0.16%	$ 4.68
334112	Computer storage device	$ 29.65	$ 341.65	12.69%	0.57%	$ 43.35
3343	Audio and video equipment	$ 163.13	$ 896.75	10.72%	0.47%	$ 96.15
334417	Electronic connector	$ 36.24	$ 96.50	14.04%	1.57%	$ 13.55
334613	Magnetic and optical recording media	$ -	$ 51.45	0.00%	0.00%	$ -
33511	Electric lamp bulb and part	$ 2.31	$ 83.67	2.25%	2.22%	$ 1.88
335221	Household cooking appliance	$ -	$ 121.91	0.53%	0.18%	$ 0.65
335222	Household refrigerator and home freezer	$ -	$ 140.29	2.04%	0.28%	$ 2.86
335224	Household laundry equipment	$ -	$ 160.45	0.75%	0.36%	$ 1.20
335228	Other major household appliance	$ -	$ 120.10	0.00%	0.00%	$ -
335912	Primary battery	$ 33.43	$ 128.28	22.58%	1.94%	$ 28.97
335991	Carbon and graphite product	$ 4.65	$ 38.07	7.34%	1.54%	$ 2.79
336111	Automobile	$ 58.70	$ 2,537.63	1.37%	0.24%	$ 34.89
336112	Light truck and utility vehicle	$ -	$ 1,852.14	1.89%	0.21%	$ 34.96
336120	Heavy duty truck	$ -	$ 541.29	1.51%	0.25%	$ 8.16
336213	Motor home	$ -	$ 84.38	0.42%	0.19%	$ 0.36
336214	Travel trailer and camper	$ 9.94	$ 86.50	7.81%	1.21%	$ 6.76
336612	Boat building	$ 34.56	$ 95.90	26.38%	4.02%	$ 25.30
336991	Motorcycle, bicycle, and parts	$ 49.99	$ 223.10	16.63%	1.87%	$ 37.11
337124-5	Metal and other household furniture (except woo	$ 27.91	$ 145.26	12.02%	3.05%	$ 17.45
337127	Institutional furniture	$ 21.24	$ 216.64	8.02%	0.86%	$ 17.37
33991	Jewelry and silverware	$ 124.03	$ 543.31	7.51%	1.18%	$ 40.79
33992	Sporting and athletic goods	$ 80.62	$ 409.02	19.39%	2.78%	$ 79.29

1. The row figures in column three are the values of the row commodities made by all industries as multiple industries often make the same commodity. For example, in row 17 total output for commodity 325411 is $292.78 million, of which $284.44 million is made by industry 325411. These figures provide the fullest measure of total commodity supply made within a region.

2. RPC = % of gross demand for a commodity, across all sectors, that is obtained from local suppliers. It indicates the local use of the locally available supply.

3. Supply/demand ratio = net commodity supply divided by gross commodity demand

4. Net commodity supply can exceed commodity output because of either imports from outside the region, or because other industries make the row commodity. By contrast, commodity output can exceed net commodity supply because of exports out of the region.

Source: Minnesota Implan Group. 2013. Input/output model for the Greater Philadelphia Region.

IHS identified potential gap subsectors as those that both currently supply only low shares of regional demand, and where there is evidence of excess demand for their outputs. Because there is substantial variation in the types of goods made within a single four-digit NAICS manufacturing sector, they used the 277 manufacturing subsectors in the IMPLAN model, which are generally at the five-digit NAICS level. A major determinant of whether a gap can be narrowed by increasing local production will be the ability of local companies to make exactly the type of input required (e.g., design specifications, chemical composition, performance characteristics, volume, etc.) at a competitive price, so using the more detailed IMPLAN sectors improved the accuracy of the analysis. They identified subsectors where both their supply/demand ratios and RPCs were in the lowest quartiles, which yielded a total of 44 "potential" gap sectors.

It will not be feasible to increase location production in all of the potential gap sectors for several reasons. First, some commodities have never been made in the Region (e.g., sugar cane, copper smelting); and for others the region has few, if any, remaining competitive advantages (e.g., fabric mills, apparel, pulp paper) such that it is highly unlikely that facilities to make them cost effectively at an industrial scale could ever be established here again. The closure of the Chrysler and General Motors automotive assembly plants in Newark, Delaware, in 2008 and 2009 suggests that the Region would have difficulty again attracting a large-scale automotive assembly plant. Second, there are some commodities where economies of scale need to be attained and high entry costs would be incurred, such as primary metals and ferrous metal foundries, which would make it difficult to economically justify building a plant here even when regional demand greatly exceeds supply. It is possible that the availability of competitively priced industrial electricity, and natural gas from the Marcellus shale, could make it economically feasible to establish smaller production facilities for energy-intensive products serving high-valued, niche, or specialty markets. Third, there are commodities produced in other regions with cost advantages and established production complexes for which it will always be cheaper to ship them here than make them here.

We conclude that a market analysis would have to be performed for each of the potential gap sectors by an industry expert to determine if it is feasible to expand output to close the gap. The primary focus of each analysis must be the ability of new or expanded firms to precisely meet the requirements of customers in the Region, and those in the larger 600-mile radius market around the city where a significant share of the manufacturing goods produced here are sold.

Wage levels

An advantage of the manufacturing sector is that its jobs have above-average wage levels. According the Bureau of Labor Statistics' Quarterly Census of Employment and Wages (QCEW) database, in 2012 the average annual wage in the City of Philadelphia's manufacturing sector was $58,977 compared with $57,616 across all private sectors; the comparable US figures were $60,496 and $49,200. The average wage level for a manufacturing company in a local economy depends on the types of activities it performs, which in turn determines the occupations of the workers it needs. A manufacturing firm that performs R&D or has a headquarters operation, and thus requires highly educated and well-paid managerial or STEM workers, will have a higher average annual wage than a firm in the same sector that conducts mostly

production activities. This is because production occupations, which accounted for 51% of total US manufacturing employment in 2012, pay below-average wages. According to the BLS, in the 2012 the average annual wage for production workers in the five counties of southeastern Pennsylvania was $38,700 compared with $50,710 across all sectors. The corresponding US figures were $34,500 and $45,790. However, the levels of education and experience required to get an entry-level job in the production occupations are lower than in some other major occupational groups so they are more accessible to younger residents with less education and little or no work history. In this sense, the manufacturing sector provides opportunity for economically disadvantaged residents. The likelihood that a manufacturing company pays average annual wages in a local economy depends much more on the types of nonproduction workers it needs than on its use of production workers.

Economic impacts of manufacturing subsectors

The economic impacts of the manufacturing subsectors were derived from the IMPLAN model for the Region for 2011. The multipliers presented are the backward linkages and measure the purchase relationships for each subsector within the local economy. They represent the total increases in economic activity that occurs in the Region when there is a direct increase in final demand in a manufacturing subsector in either employment or sales. The multipliers include both the indirect effect (i.e., an additional increase in economic activity generated by purchases of inputs within the regional economy) and the induced effect (i.e., spending of wages and salaries by the additional direct employees). The multipliers for each three-digit NAICS manufacturing subsector are presented in unit terms: 1) total employment increase per 100 new direct employees and 2) total increase in output per $1,000,000 of new output or sales. The multipliers are for the Region because an increase in final demand in a single county will generate increases in economic activity across the region.

The economic multiplier effects, especially for employment, vary widely by subsector depending on: 1) the amounts, types, and shares of required inputs (e.g., raw materials, goods, and services) that can be purchased from within the region; 2) on the level of wages paid to workers; and 3) the production function, especially productivity (i.e., output per worker) and labor intensity (i.e., number of jobs per unit value of plant and equipment). A subsector present in the region for a long time, such as chemicals, usually has a well-developed backward supply chain as firms have been established in the region to sell to them; as a result, the subsectors will have higher indirect multiplier effects.

Employment multipliers range from a low of 173 total new jobs per 100 direct jobs in wood products to a high of 987 jobs per 100 new jobs in petroleum and coal. The petroleum and coal employment multiplier is high because refineries are automated, so they do not require a large number of employees to operate, and because they have high ratios of annual output per worker. In addition, refinery jobs pay high wages, which boosts the induced effects as the workers purchase large amounts of goods and services from the local economy, excluding the crude oil inputs, which generates a high indirect effect.

The output multipliers are more closely bunched than the employment multipliers, ranging between 1.34 in petroleum and coal (i.e., virtually all of the sector's primary input—crude oil—is purchased from outside

the Region to 1.89 in support – printing. The multipliers for the City of Philadelphia are slightly lower than those for the Region as a higher portion of the direct spending leaks out of the city into the adjacent 10 suburban counties.

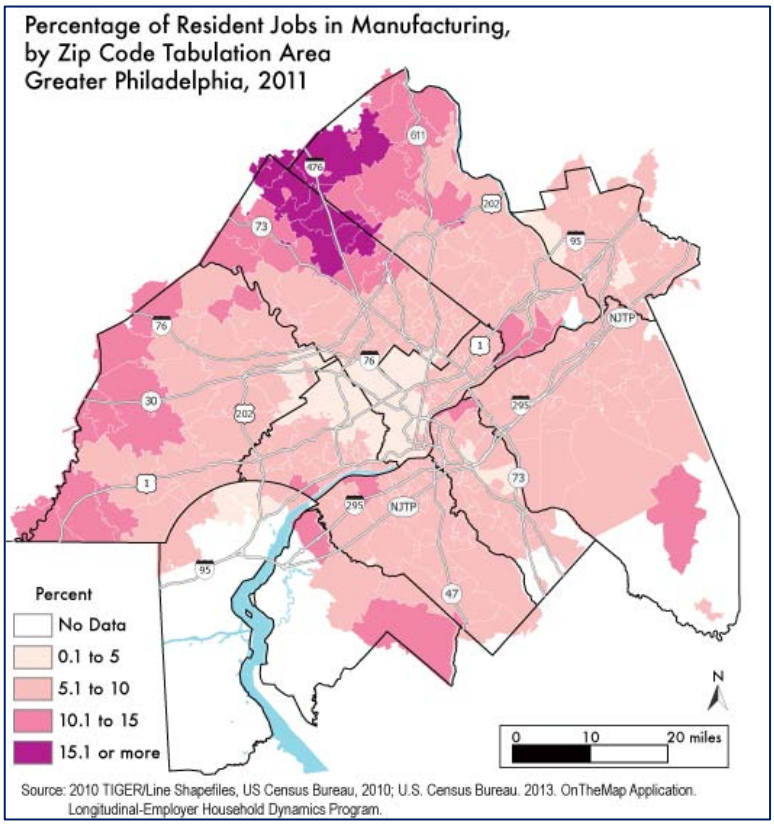
Economic Multipliers for 3-digit Manufacturing Subsectors

NAICs Code	Employ. increase per 100 new jobs	Output increase per $1 million new sales (Millions of $)
311 Food	277	1.66
312 Beverage & Tobacco	391	1.49
313 Textile Mills	179	1.63
314 Textile Product Mills	195	1.88
316 Leather & Allied	178	1.78
321 Wood Products	173	1.70
322 Paper	321	1.78
323 Support - Printing	193	1.89
324 Petroleum & Coal	987	1.34
325 Chemical	584	1.76
326 Plastics & Rubber	208	1.64
327 Nonmetallic Minerals	241	1.87
331 Primary Metal	463	1.79
332 Fabricated Metal	223	1.77
333 Machinery	256	1.69
334 Computer & Electronics	307	1.71
335 Electrical Equipment & Appliances	263	1.67
336 Transportation Equipment	275	1.54
337 Furniture & Related	206	1.75
339 Miscellaneous mfg	233	1.73
Total Manufacturing	322	1.64

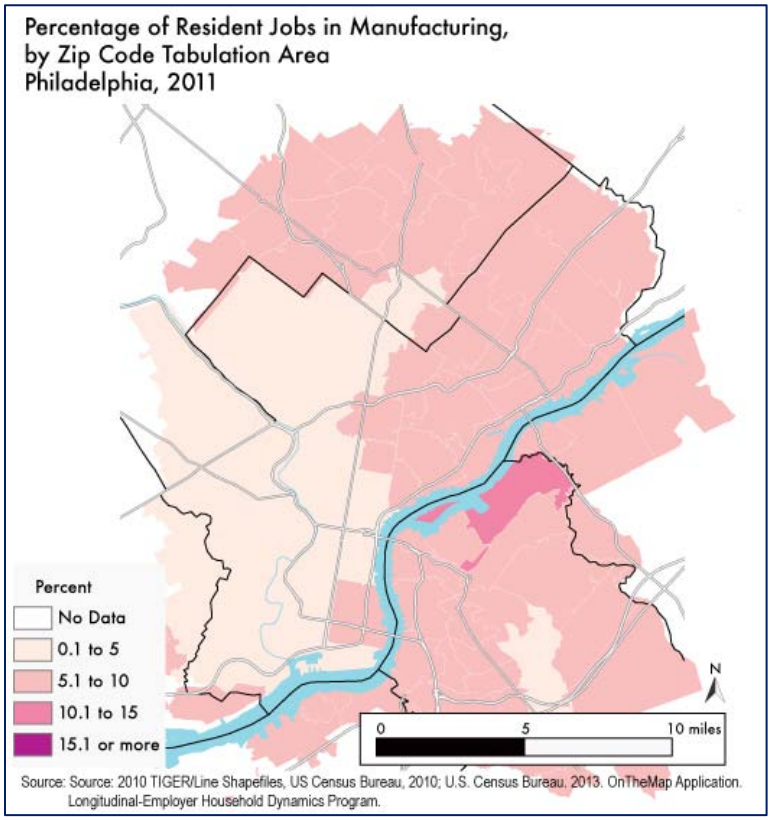
Note: the figures above the are Social Accounting Matrix (SAM) multipliers from the IMPLAN model for the GPR in 2011 base year. A SAM mulitplier accounts for the direct and indirect effects, and it also includes the household sector in the model to more accurately capture the induced effects.

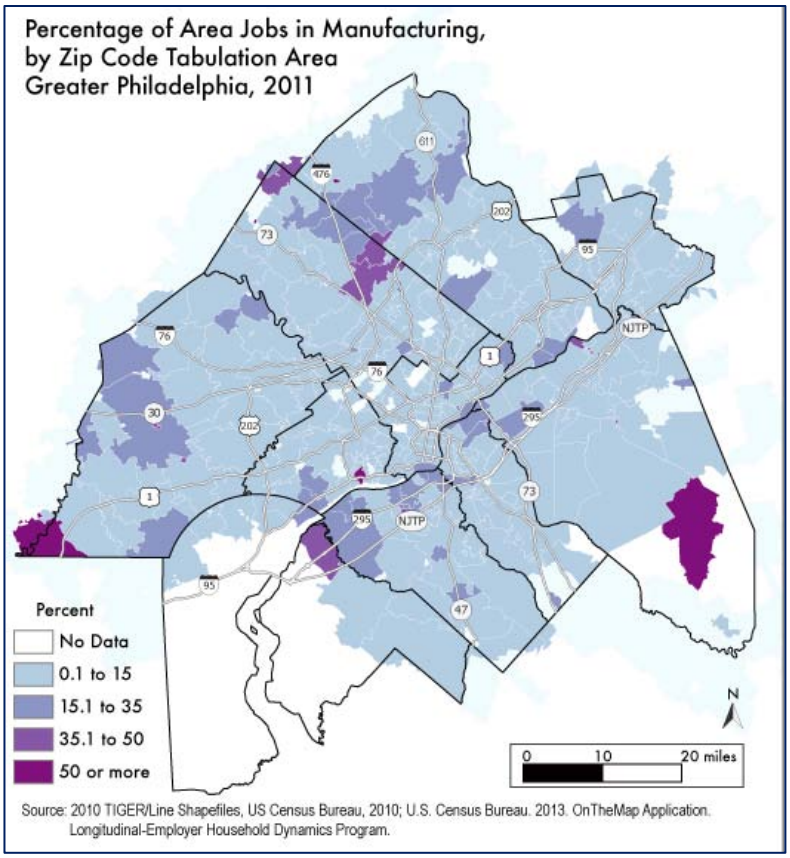
Source: Minnesota IMPLAN Group. August 2013.

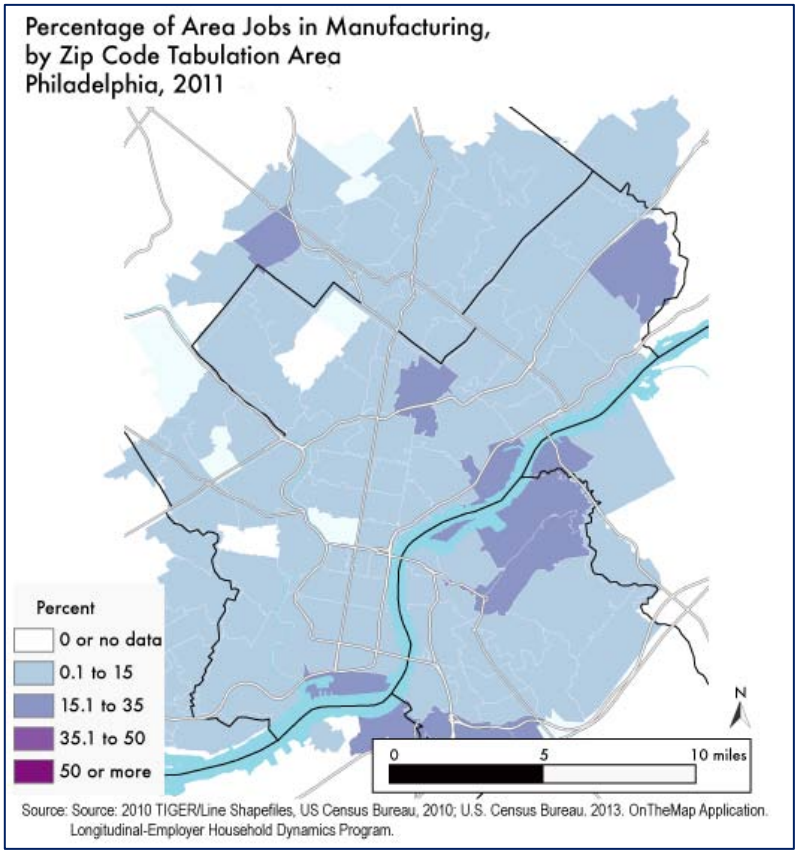
Spatial distribution of manufacturing workers and jobs



This section presents a spatial analysis of the distribution of manufacturing jobs by showing: 1) the current place of residence of persons who are employed in manufacturing (i.e., place-of-residence employment in manufacturing), regardless of where they work; and 2) the location of manufacturing jobs (i.e., place-of-work employment in manufacturing) regardless of where the workers reside. A set of four heat maps showing the distribution of manufacturing workers and jobs is presented here. Each map is based on Zip Code Tabulation Areas (ZCTAs). The first two maps show the distribution of place-of-residence employment based on the percentage of residents living in each ZCTA who work in manufacturing. The dark areas in upper Montgomery County and in western Chester County likely reflect the high share of residents there who work in nearby pharmaceutical establishments. The third and fourth maps present place-of-work employment data showing manufacturing jobs as a percentage of total jobs located in each ZCTA. The darker-shaded ZCTAs indicate concentrations of manufacturing jobs.




Percentage of Area Jobs in Manufacturing,
by Zip Code Tabulation Area
Greater Philadelphia, 2011
Percent
No Data
0.1 to 15
15.1 to 35
35.1 to 50
50 or more
0
10
20 miles
N
Source: 2010 TIGER/Line Shapefiles, US Census Bureau, 2010; U.S. Census Bureau. 2013. OnTheMap Application.
Longitudinal-Employer Household Dynamics Program.


Percentage of Area Jobs in Manufacturing,
by Zip Code Tabulation Area
Philadelphia, 2011
Percent
0 or no data
0.1 to 15
15.1 to 35
35.1 to 50
50 or more
0
5
10 miles
N
Source: Source: 2010 TIGER/Line Shapefiles, US Census Bureau, 2010; U.S. Census Bureau. 2013. OnTheMap Application.
Longitudinal-Employer Household Dynamics Program.

Shift-share analysis

Methodology

IHS conducted a shift-share analysis of the manufacturing subsectors in the city, and in the Greater Philadelphia Region excluding the city, using employment data at the four-digit NAICS code level from our BMI database. The purpose of the shift-share analysis was to examine the performance of the four-digit manufacturing subsectors based on changes in employment between 1990 and 2013, and then to classify each sector into one of four types based on its performance. The classification of the subsectors is considered in developing the growth strategies presented in Task Three of this study

Shift-share analysis is an analytical technique used to decompose changes in a variable, such as employment or income, which occurred in a regional economy over a historical period. It compares the performance of an individual economic sector over time within the regional economy of interest to that same sector's performance in a larger reference economy, usually the US, over the same time period. Shift-share analysis is based on the theory that an individual sector's performance in a regional economy over time is due to three effects: 1) national—the share of growth in the larger reference economy that was captured by the region; 2) industry mix—the shares of high-growth and low-growth sectors in the region and how they changed over time; and 3) competitive—the extent to which an individual economic sector in the region outperformed or underperformed the same sector at the level of the reference economy over the analysis period.

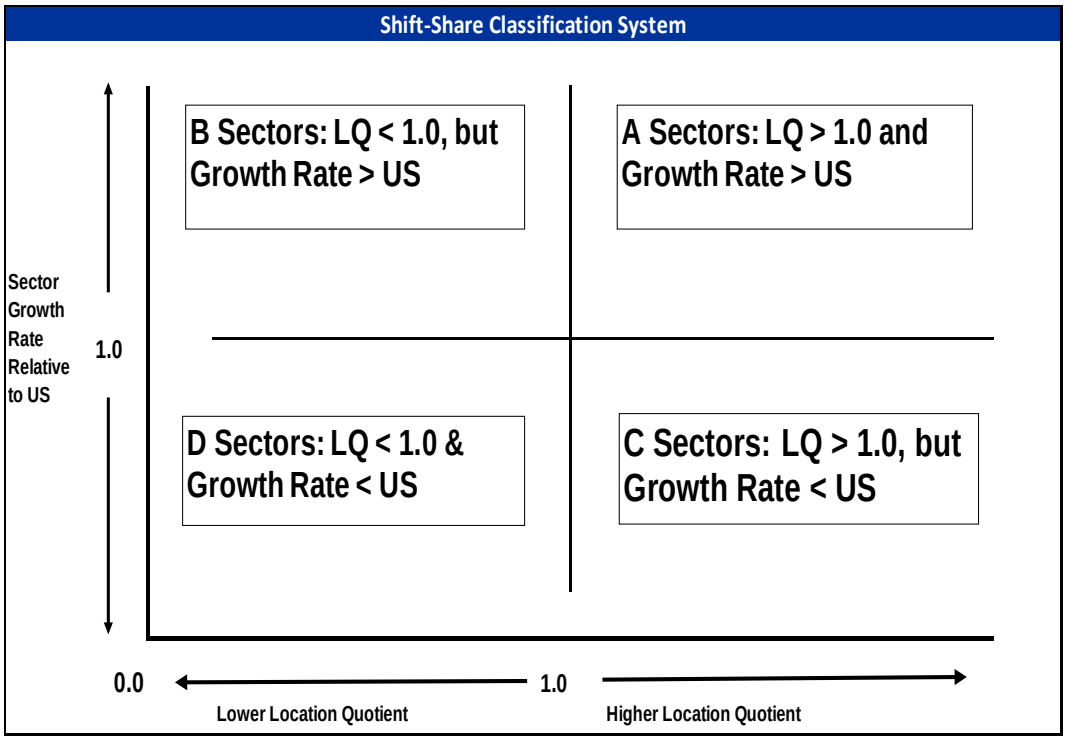
Shift-share analysis can be used to analyze a regional economy, such as the City of Philadelphia or the Region, to reveal its most competitive industries. Stated another way, shift-share analysis enables an analyst to determine how much of the change in a variable, such as employment, in an individual economic sector over time was due to growth in the US economy, and how much was attributable to characteristics of the regional economy such as competitive advantages or disadvantages.

The shift-share analyses performed for the *Manufacturing Growth Strategy Study* were conducted over two time periods: 1990 through 2013, and 2000 through 2013. IHS concluded that the shift-share analysis for the 2000–13 time period was the most applicable for this study as it was based on economic conditions and trends that are more likely to continue into the future. Finally, we used location quotients (LQs) for 2013, or the terminal year of the analysis, in our shift-share calculations to capture the current economic structure.

The shift-share analysis classified each four-digit manufacturing sector into one of the following four classes based on its employment performance.

- Type A: A sector's 2013 employment LQ is greater than 1.0, and its annual growth rate (AGR) in employment during the analysis period was greater than the sector's employment AGR for the US over the same period;
- Type B: A sector's 2013 LQ is less than 1.0, but its employment AGR was greater than the sector's employment AGR for the US over the same period;

- Type C: A sector's 2013 LQ is greater than 1.0, but its employment AGR was less than the sector's employment AGR for the US over the same period; and
- Type D: A sector's 2013 LQ is less than 1.0 and its employment AGR during the analysis period was less than the sector's employment AGR for the US over the same period.



The highest-performing sectors are those classified as A as they both outperformed the US, and because the region currently has an above-average share of economic activity in them (i.e., their employment LQs are above 1.0). The analytical issue is then to examine the A sector more closely to identify the competitive advantages that the city or the region provides them, and even to identify the individual companies representing the A sector. B sectors are high performers, but for some reason the regional economy currently has a below-average concentration of economic activity in them. Emerging sectors are often classified as B sectors—they are doing well, but do not yet account for large shares of regional economic activity. C sectors tend to consist of the traditionally important legacy industries as the region still has above-average shares of economic activity in them, but for a variety of reasons these sectors are underperforming the same sectors at the US level. Finally, the D sectors are the lowest performing as they have LQs less than 1.0 and grew more slowly than at the US level over the analysis period.

As in any purely numerical analysis, it is important not to take the results at face value, but to analyze the results to identify factors that led to one industry sector being classified as an A while another was classified as B. For example, can we identify and explain the city's or the region's competitive advantages that resulted in the A sectors, or the competitive disadvantages for the C sectors? In performing shift-share analyses, IHS also identifies the individual companies constituting each of the four sectors. For example,

the region may contain an especially innovative or well-managed company that explains why a particular economic sector was classified as A or B.

The shift-share analyses performed for the *Manufacturing Growth Strategy Study* considered only historical employment growth. IHS extended the shift-share by adding two forward-looking criteria: 1) a sector's forecast output AGR over the next 10 years at the US level; and 2) IHS's current industry risk rating for each sector. For example, while it is useful to know that a particular four-digit NAICS manufacturing sector deserves to be classified as an A sector based on its historical performance, it is also helpful to know going forward whether that sector is also forecast to have an above-average or below-average output AGR and its industry risk rating. IHS's industry risk rating is a proprietary modeling and ranking system that assigns a risk score to economic sectors at the US level based on the following 16 factors. Risk scores between 1 (lowest risk) and 10 (highest risk) are assigned.

- Growth in real revenue
- Growth in sales
- Sales growth: Forecast vs. history
- Pricing strength
- Growth in operating margins
- Business failure rate
- Cash flow variability
- Inventory overhang
- Capacity overhang
- Supplier base dependence
- Customer base dependence
- Energy inputs dependence
- Labor dependence
- Export dependence
- Import penetration
- Interest rates

While the industry risk scores are not included in shift-share results presented, they were used in the cluster analysis described in the next section. The industry risk scores were also considered in identifying the proposed target manufacturing sectors.

Results

This section presents the results of the shift-share analysis starting with top-10 A sectors in the City and the 10 suburban counties, and so forth. Shaded sectors are defined as energy intensive where energy consumed as a fuel, excluding that used as a feedstock, comprise above-average shares of total production costs than the share for the entire manufacturing sector.

The Appendix B of this study contains a table comparing the results of the shift-share analysis in the two areas. The comparison table presented in the appendix shows that a total of 18 four-digit NAICS sectors were classified the same in the city and in the 10 adjacent counties, while 23 were ranked higher in the city, and 18 were ranked higher in the region excluding the city.

Shift Share Results: A Sectors			
Top 10 based on 2013 Employment			
City of Philadelphia		Greater Philadelphia Region excluding City	
3363	Motor Vehicle Parts	3399	Other Miscellaneous
3254	Pharmaceutical & Medicine	3256	Soap, Cleaning Compound, & Toilet Preparation
3391	Medical Equipment & Supplies	3333	Commercial & Service Industry Machinery
3329	Other Fabricated Metal Product	3372	Office Furniture (including Fixtures)
3372	Office Furniture (including Fixtures)	3119	Other Food
3366	Ship & Boat Building	3273	Cement & Concrete Product
3359	Other Electrical Equipment & Component	3334	Ventilation, Heating, Air-Conditioning, & Commercial
3221	Pulp, Paper, & Paperboard Mills	3324	Boiler, Tank, & Shipping Container
3113	Sugar & Confectionery Product	3279	Other Nonmetallic Mineral Product
3379	Other Furniture Related Product	3346	Manufacturing & Reproducing Magnetic & Optical Media

NOTE: Energy intensive sectors (where energy costs, excluding energy used as a feedstock, are above the average percent share of total production costs) are highlighted.

Source: IHS Economics

Shift Share Results: B Sectors			
Top 10 based on 2013 Employment			
City of Philadelphia		Greater Philadelphia Region excluding City	
3327	Machine Shops; Turned Product; & Screw, Nut, & Bolt	3363	Motor Vehicle Parts
3339	Other General Purpose Machinery	3219	Other Wood Product
3115	Dairy Product	3272	Glass & Glass Product
3114	Fruit & Vegetable Preserving & Specialty Food	3336	Engine, Turbine, & Power Transmission Equipment
3219	Other Wood Product	3262	Rubber Product
3279	Other Nonmetallic Mineral Product	3353	Electrical Equipment
3333	Commercial & Service Industry Machinery	3221	Pulp, Paper, & Paperboard Mills
3341	Computer & Peripheral Equipment	3149	Other Textile Product Mills
3364	Aerospace Product & Parts	3212	Veneer, Plywood, & Engineered Wood Product
3272	Glass & Glass Product	3322	Cutlery & Handtool

NOTE: Energy intensive sectors (where energy costs, excluding energy used as a feedstock, are above the average percent share of total production costs) are highlighted.

Source: IHS Economics

Shift Share Results: C Sectors			
Top 10 based on 2013 Employment			
City of Philadelphia		Greater Philadelphia Region excluding City	
3118	Bakeries & Tortilla	3254	Pharmaceutical & Medicine
3231	Printing & Related Support Activities	3231	Printing & Related Support Activities
3116	Animal Slaughtering & Processing	3364	Aerospace Product & Parts
3323	Architectural & Structural Metals	3345	Navigational, Measuring, Electromedical, & Control
3241	Petroleum & Coal Products	3327	Machine Shops; Turned Product; & Screw, Nut, & Bolt
3222	Converted Paper Product	3222	Converted Paper Product
3399	Other Miscellaneous	3118	Bakeries & Tortilla
3121	Beverage	3391	Medical Equipment & Supplies
3152	Cut & Sew Apparel	3339	Other General Purpose Machinery
3252	Resin, Synthetic Rubber, & Artificial Synthetic Fibers	3241	Petroleum & Coal Products

NOTE: Energy intensive sectors (where energy costs, excluding energy used as a feedstock, are above the average percent share of total production costs) are highlighted.

Source: IHS Economics

Shift Share Results: D Sectors			
Top 10 based on 2013 Employment			
City of Philadelphia		Greater Philadelphia Region excluding City	
3261	Plastics Product	3261	Plastics Product
3251	Basic Chemical	3116	Animal Slaughtering and Processing
3334	Ventilation, Heating, Air-Conditioning, and Commercial	3323	Architectural and Structural Metals
3328	Coating, Engraving, Heat Treating, and Allied Activities	3344	Semiconductor and Other Electronic Component
3371	Household and Institutional Furniture and Kitchen	3329	Other Fabricated Metal Product
3332	Industrial Machinery	3359	Other Electrical Equipment and Component
3344	Semiconductor and Other Electronic Component	3121	Beverage
3259	Other Chemical Product and Preparation	3332	Industrial Machinery
3321	Forging and Stamping	3335	Metalworking Machinery
3335	Metalworking Machinery	3342	Communications Equipment

NOTE: Energy intensive sectors (where energy costs, excluding energy used as a feedstock, are above the average percent share of total production costs) are highlighted.

Source: IHS Economics

Cluster analysis

Introduction

IHS identified clusters of related manufacturing subsectors, and the drivers of those clusters, in both the city and in the adjacent 10 counties using two related, sophisticated mathematical and statistical techniques—cluster analysis and discriminant analysis. The primary purpose of performing the two analyses was to identify groups of manufacturing subsectors at the four-digit NAICS code level that shared similar attributes (e.g., productivity, capital intensity, wage levels, reliance on supplies coming from outside the region, share of output sold within the region, historical performance, degree of innovation, labor requirements, etc.). If such relatively homogeneous groups or clusters existed, they would enable the Task Force to develop growth strategies designed specifically for them.

A primary reference for performing the cluster analysis was the paper "A Methodology for Identifying Drivers of Industrial Clusters: The Foundation of Regional Competitiveness Advantage" prepared by Edward W. Hill and John F. Brennan of Cleveland State University and published in the *Economic Development Quarterly* in February 2000. The main difference between the two analyses is that theirs considered the entire private sector, while this one covers only the manufacturing sector. Because the manufacturing sector is more homogenous across its various subsectors (i.e., they all produce goods) than is the entire private-sector economy, some attributes were adapted. Additional attributes were identified based on information obtained from the IHS industry group—notably output-per-worker data from the BMI database, the industry risk analysis, and investment in computer hardware and software. One benefit of compiling the data for the attributes is that it provided additional detail on the similarities and differences in the characteristics of the manufacturing subsectors in the City of Philadelphia and in the 10 suburban counties. This information is used in Task Three—Strategy Development.

Methodology

IHS identified the competitive industrial bases of Philadelphia's and the Greater Philadelphia Region's manufacturing sectors by conducting a cluster analysis. A disjoint clustering of the sectors based on the linkages among a series of attributes describing the manufacturing subsectors at the four-digit NAICS level was performed. The disjoint nature of the groups implies that each sector is placed in a single cluster. The goal of this first step is to identify the groups of industries that have common needs as indicated by attributes; once clusters are identified the attributes can be analyzed further using discriminant analysis to identify the factors that provide the greatest sources of competitive advantage for manufacturing subsectors located in the City of Philadelphia and the 10 suburban counties. The discriminant analysis identifies which attributes are driving the cluster formations. In other words, it tells us which attributes are responsible for a group of sectors clustering together.

The process of identifying the groups of clusters is based on detailed sector data, including labor productivity, average wages, employment, sales, risk, and energy intensity indicators. In cases where the data series have different units of measurement (as in our case), it is necessary to rescale the data by standardizing them with mean zero and standard deviation 1. This rescaling of the data is necessary for two main reasons. First, rescaling is done to remove the (sometimes large) effects the variances of some attributes used can have on the clustering procedure. Second, standardized data generate results that are comparable and that are easier to interpret.

Attributes
Output/ Worker 2013 (Thou.)
Average Annual Wage per worker
IHS Industry Risk Rating 2013q1 - National Variable
Share of Sector's Total Output exported out of City - 2010 - IMPLAN
Backward Linkages in 2010 - Direct + Indirect Multiplier - IMPLAN
Forward Linkage in 2010 - Direct + Indirect Multiplier - IMPLAN
Non-Farm Employees per Establishment - 2013
% of Occupations Requiring some Post-Seconday Education for an Entry-Level Position - 2011 - National Variable
Production Occupations as Percent of Total Employment - 2011 - National Variable
Whole Patents per Output (average from 1999 - 2008) - National Variable
% Share of Total Investment in Computers and Software - 2013 - National Variable
Total Depreciable Assets (Net of Depreciation) as % Sales - 2010 - National Variable
Energy Intensity- % of Production costs used for energy (average from 1999 - 2011) - National Variable
Transportation Inputs as Percentage of Output - 2002 - National Variable
Shift Share Ranking: A =4. B = 3, C =2, and D = 1

Several iterations were performed using combinations of the 26 attributes compiled for the cluster analysis; the set presented here yielded the best overall results in the City and in the adjacent 10 suburban counties.

The choice of the number of industry groups to be identified using the statistical clustering approach is determined mainly on a qualitative basis. Based on the literature, and on the full set of 86 four-digit NAICS manufacturing subsectors being analyzed, a range of between five and ten clusters was initially determined to be appropriate. There are no formal statistical tests that could be used to determine the optimal number of clusters. A multi-step cluster analysis was performed on the standardized data attributes. First, analysis was run with a maximum number of 15 clusters, which generated many clusters containing only one industry. While the petroleum industry makes sense to be classified as a separate group, we found it difficult to give an intuitive economic interpretation for the other groupings (for instance, beverage or tobacco manufacturing). Therefore, the analysis was re-run using a progressively smaller number of maximum clusters.

The iterative process led to an initial selection a maximum number of eight clusters. Furthermore, the largest groupings, in one case containing as many as 37 industries, were further broken down by re-assigning some of the sectors to the nearest clusters in terms of distance between cluster centroids.

Results

Using the methodology described, the analysis ultimately revealed there are 11 groups or clusters of manufacturing subsectors in the 10 suburban counties and 9 in the City of Philadelphia. The resulting industry groupings provide an economic map of the structure of the manufacturing sectors in both the City and the Region. The subsectors composing each cluster help interpret the economic performance in the two areas analyzed based on the attributes selected. This analysis can determine how much the City of

Philadelphia and the 10 suburban counties vary in employment growth, wages, energy intensity, or risk factors.

Some similar clusters were defined in both places including: pharmaceuticals and chemicals, petroleum, electronics, food and beverage, metal products, nonmetallic minerals, and textiles and clothing. Interestingly, the transportation equipment subsector, which was part of the broad machinery and transportation equipment cluster in the 10 suburban counties, emerged as its own cluster in Philadelphia. By contrast, the machinery and metal products cluster in the City became a separate metal products cluster in the suburbs, with the equipment subsectors assigned to the large machinery and transportation equipment cluster. There were two clusters in the suburbs—information technology and iron and steel—that did not emerge as clusters in the city.

The larger size of the manufacturing sector in the suburbs than in the city (i.e., 162,883 jobs versus 25,293 jobs), and because 13 of the four-digit subsectors are not present in the City, produced more differentiation among subsectors and resulted in the identification of two more clusters in the suburbs. The larger size also meant that the clusters in the suburbs tended to be more homogenous in terms of goods made and production processes used.

On an overall basis, the number and composition of the clusters identified in the City and the 10 suburban counties are relatively similar, which suggests that most types of manufacturing growth strategies should be applicable to both areas. However, it is also important to note that there are some factors that may constrain manufacturing development more in the city than in the suburbs, such as the quality of the labor force for production activities; higher density of development; shortage of large, developable sites; highway accessibility; and taxes. City-specific growth strategies will have to take these constraints into account.

Manufacturing clusters and their composition in the city of Philadelphia	
Pharmaceuticals and Chemicals	**Petroleum**
Pharmaceutical and Medicine	Petroleum and Coal Products
Other Chemical Product and Preparation	**Textiles, Clothing, and Paper**
Rubber Product	Apparel Knitting Mills
Resin, Synthetic Rubber, and Artificial Synthetic Fibers and Filaments	Other Wood Product
Basic Chemical	Textile and Fabric Finishing and Fabric Coating Mills
Printing and Related Support Activities	Other Textile Product Mills
Plastics Product	Office Furniture (including Fixtures)
Paint, Coating, and Adhesive	Textile Furnishings Mills
Soap, Cleaning Compound, and Toilet Preparation	Other Furniture Related Product
Primary Metals	Fiber, Yarn, and Thread Mills
Foundries	Fabric Mills
Forging and Stamping	Cut and Sew Apparel
Nonferrous Metal (except Aluminum) Production and Processing	Apparel Accessories and Other Apparel
Steel Product from Purchased Steel	Pulp, Paper, and Paperboard Mills
Coating, Engraving, Heat Treating, and Allied Activities	Leather and Hide Tanning and Finishing
Electronics	Other Leather and Allied Product
Computer and Peripheral Equipment	**Non-Metallic Minerals**
Semiconductor and Other Electronic Component	Converted Paper Product
Navigational, Measuring, Electromedical, and Control Instruments	Glass and Glass Product
Manufacturing and Reproducing Magnetic and Optical Media	Cement and Concrete Product
Electric Lighting Equipment	Lime and Gypsum Product
Electrical Equipment	Other Nonmetallic Mineral Product
Aerospace Product and Parts	**Food and Beverage**
Other Electrical Equipment and Component	Fruit and Vegetable Preserving and Specialty Food
Machinery and Metal Products	Dairy Product
Architectural and Structural Metals	Animal Slaughtering and Processing
Boiler, Tank, and Shipping Container	Bakeries and Tortilla
Spring and Wire Product	Beverage
Cutlery and Handtool	Other Food
Hardware	Sugar and Confectionery Product
Other Fabricated Metal Product	Tobacco
Machine Shops; Turned Product; and Screw, Nut, and Bolt	**Transportation Equipment**
Other General Purpose Machinery	Railroad Rolling Stock
Metalworking Machinery	Ship and Boat Building
Other Miscellaneous	Other Transportation Equipment
Ventilation, Heating, A-C, & Commercial Refrigeration Equipment	Motor Vehicle Parts
Engine, Turbine, and Power Transmission Equipment	
Household and Institutional Furniture and Kitchen Cabinet	
Medical Equipment and Supplies	
Industrial Machinery	
Commercial and Service Industry Machinery	

Manufacturing clusters and their composition in the 10 suburban counties	
Information Technology	**Food and Beverage**
Computer and Peripheral Equipment Manufacturing	Animal Food Manufacturing
Communications Equipment Manufacturing	Grain and Oilseed Milling
Semiconductor and Other Electronic Component Manufacturing	Sugar and Confectionery Product Manufacturing
Pharmaceuticals and Chemicals	Fruit and Vegetable Preserving and Specialty Food Manufacturing
Pulp, Paper, and Paperboard Mills	Dairy Product Manufacturing
Converted Paper Product Manufacturing	Animal Slaughtering and Processing
Resin, Synthetic Rubber, and Artificial Synthetic Fibers and Filaments Manufacturing	Seafood Product Preparation and Packaging
Pharmaceutical and Medicine Manufacturing	Bakeries and Tortilla Manufacturing
Paint, Coating, and Adhesive Manufacturing	Other Food Manufacturing
Soap, Cleaning Compound, and Toilet Preparation Manufacturing	Beverage Manufacturing
Other Chemical Product and Preparation Manufacturing	Tobacco Manufacturing
Plastics Product Manufacturing	**Textiles and Clothing**
Rubber Product Manufacturing	Fiber, Yarn, and Thread Mills
Basic Chemical Manufacturing	Textile Furnishings Mills
Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing	Fabric Mills
Machinery and Transportation Equipment	Textile and Fabric Finishing and Fabric Coating Mills
Agriculture, Construction, and Mining Machinery Manufacturing	Other Textile Product Mills
Industrial Machinery Manufacturing	Apparel Knitting Mills
Ventilation, Heating, Air-Conditioning, and Commercial Refrigeration Equipment	Cut and Sew Apparel Manufacturing
Metalworking Machinery Manufacturing	Apparel Accessories and Other Apparel Manufacturing
Engine, Turbine, and Power Transmission Equipment Manufacturing	Leather and Hide Tanning and Finishing
Other General Purpose Machinery Manufacturing	Footwear Manufacturing
Electric Lighting Equipment Manufacturing	Other Leather and Allied Product Manufacturing
Household Appliance Manufacturing	**Metal Products**
Electrical Equipment Manufacturing	Forging and Stamping
Other Electrical Equipment and Component Manufacturing	Cutlery and Handtool Manufacturing
Motor Vehicle Manufacturing	Architectural and Structural Metals Manufacturing
Motor Vehicle Body and Trailer Manufacturing	Boiler, Tank, and Shipping Container Manufacturing
Railroad Rolling Stock Manufacturing	Hardware Manufacturing
Other Transportation Equipment Manufacturing	Spring and Wire Product Manufacturing
Medical Equipment and Supplies Manufacturing	Machine Shops; Turned Product; and Screw, Nut, and Bolt Manufacturing
Other Miscellaneous Manufacturing	Coating, Engraving, Heat Treating, and Allied Activities
Commercial and Service Industry Machinery Manufacturing	Other Fabricated Metal Product Manufacturing
Motor Vehicle Parts Manufacturing	**Printing and Furniture**
Ship and Boat Building	Printing and Related Support Activities
Electronic Equipment	Household and Institutional Furniture and Kitchen Cabinet Manufacturing
Audio and Video Equipment Manufacturing	Office Furniture (including Fixtures) Manufacturing
Navigational, Measuring, Electromedical, and Control Instruments Manufacturing	Other Furniture Related Product Manufacturing
Manufacturing and Reproducing Magnetic and Optical Media	**Natural Resources and Minerals**
Aerospace Product and Parts Manufacturing	Sawmills and Wood Preservation
Petroleum	Veneer, Plywood, and Engineered Wood Product Manufacturing
Petroleum and Coal Products Manufacturing	Other Wood Product Manufacturing
Iron and Steel	Clay Product and Refractory Manufacturing
Iron and Steel Mills and Ferroalloy Manufacturing	Glass and Glass Product Manufacturing
Steel Product Manufacturing from Purchased Steel	Lime and Gypsum Product Manufacturing
Foundries	Other Nonmetallic Mineral Product Manufacturing
	Alumina and Aluminum Production and Processing
	Nonferrous Metal (except Aluminum) Production and Processing
	Cement and Concrete Product Manufacturing

Target manufacturing clusters

This section presents the relative ranking of the clusters identified in the previous section. The primary reason for ranking the clusters is that, by definition, they are homogenous in that the subsectors that comprise each one share a common set of attributes that determine their economic competitiveness. Ranking the clusters makes sense from a policy perspective as their dependence on the same set of attributes suggests that all the subsectors within a single cluster will be similarly affected by the same growth strategy policy.

Discriminant analysis determines the relative importance of each individual attribute in a cluster, and also indicates how the importance of a single attribute varies between two clusters. For example, the attribute percent of entry-level jobs requiring workers with at least some post-secondary education may be more important for a cluster consisting of pharmaceutical and aerospace manufacturing subsectors that require highly skilled workers than for a cluster comprising food and garment manufacturers.

The following factors were considered in determining the relative rankings of the clusters in each of the two areas.

- The shift-share analysis classification of subsectors into A, B, C, and D classes.
- IHS industry risk scores; sectors with lower risk were preferred to those with a higher risk.
- IHS US output forecasts by industry sector.
- A cluster's current size and share of total activity in the manufacturing sector.

The relative cluster rankings were based primarily on past economic performance (the shift-share analysis) and on two forward-looking economic measures (output growth rates and the industry risk rankings). Also considered were recent changes in the global manufacturing sector that are making the US a more competitive location for some types of production activities as evidenced by the re-shoring of production jobs to the US. The current size of sector in terms of employment and output was also a consideration since larger clusters are also more likely to have the critical mass and generate the positive agglomeration effects that make them the natural focal points of economic development planning. Finally, we relied on our understanding of both the current competitive advantages and disadvantages in the city and in the 10 suburban counties, and on future changes that are likely to affect the competitiveness of the two areas such as the availability of large supplies of natural gas and accompanying natural gas liquids from the Marcellus shale formation and the dredging of the main channel of the Delaware River to 45 feet. To the extent possible at the US level, the industry risk rankings take into account the potential effect of new production processes in manufacturing subsectors.

We emphasize the use of the term relative in the ranking of the clusters, and we do not view them as inflexible or deterministic. We acknowledge that there is risk in ranking clusters, and indirectly the subsectors within them, as we may undervalue an emerging subsector where a new technology, a rising regional competitive advantage, or its achieving critical mass, could significantly increase the subsector's potential growth rate. The relative ranking of the 9 clusters identified for the City of Philadelphia is presented here; the two figures following each cluster's name are its current shares of employment and real output, respectively, in the manufacturing sector.

- Pharmaceuticals and Chemicals: 18.6% and 15.9%
- Food and Beverage: 23.6% and 15.2%
- Transportation Equipment: 13.1% and 8.6%
- Machinery and Metal Products: 19.5% and 7.7%
- Nonmetallic Minerals: 4.1% and 1.9%
- Natural Resources Products: 9.7% and 3.3%
- Petroleum: 3.9% and 44.1%
- Electronics: 5.5% and 2.2%
- Metalworks: 2.1% and 1.2%

The relative ranking of the 11 clusters identified above for the 10 suburban counties is presented here; the two figures following each cluster's name are its current shares of employment and real output, respectively, in the manufacturing sector.

- Chemicals: 23.0% and 27.9%
- Machinery and Transportation Equipment: 19.5% and 13.4%
- Food and Beverage: 11.0% and 13.1%
- Electronic Equipment: 12.3% and 9.0%
- Printing and Furniture: 8.8% and 3.2%
- Petroleum: 1.6% and 19.4%
- Minerals and Wood: 5.2% and 3.3%
- Metals Products: 11.4% and 5.6%
- Information Technology: 3.8% and 2.1%
- Textiles and Clothing: 1.9% and 0.6%
- Iron and Steel: 1.7% and 2.5%

TASK TWO: ANALYZE THE FOUNDATIONAL ISSUES

Foundational Issues

Significant research has shown that there are a set of broad foundational issues that affect the competitiveness of the manufacturing sector at the US, regional and local levels. Through the course of its work, the Task Force identified and studied the following five foundational issues:

- Talent
- Innovation
- Policy and Regulatory Environment
- Energy
- Logistics, Utilities and Transportation

This section presents the Task Force's analysis of the five foundational issues. Each foundational assessment analyzes the current characteristics of the manufacturing subsectors in the City of Philadelphia and the 10 surrounding suburban counties; identifies competitive advantages and disadvantages; and compares conditions in the city and the suburban counties. Comparisons to US characteristics and benchmarks are provided as appropriate. This analysis of the five foundational assessments provides the basis for the manufacturing growth strategies presented in the final section of this report.

Talent

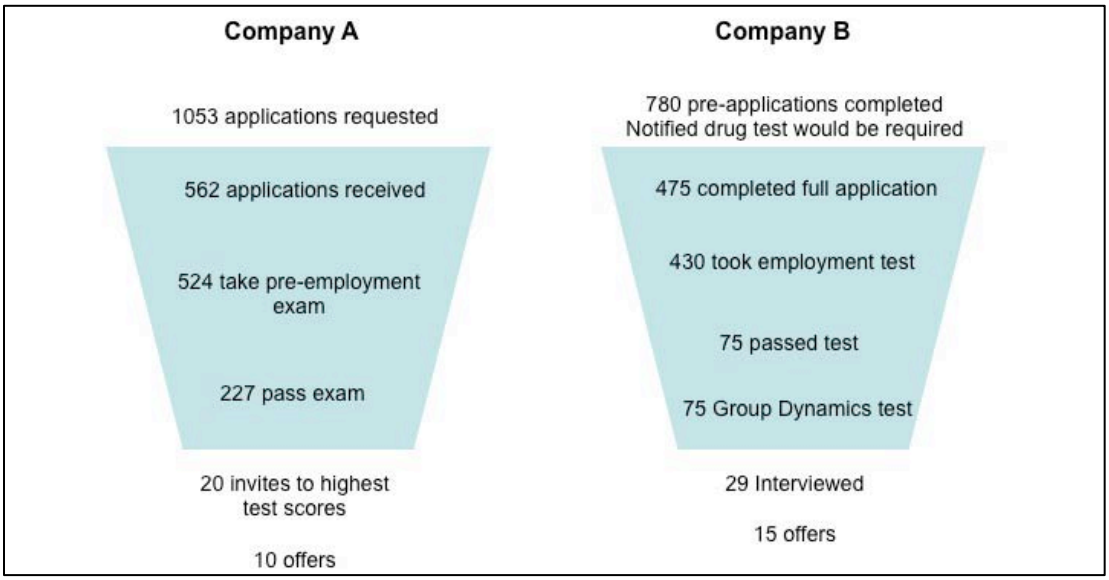
This section describes the characteristics of the labor pool available to the manufacturing sectors of the city and the Greater Philadelphia Region, and organizations in the two areas that provide job training services. The consultants to the Task Force analyzed demographic and occupational data from Philadelphia Works, plus actual hiring data obtained from several manufacturers, to develop a profile of the manufacturing workforce dynamics. Additional insights were gained from extensive interviews with over 30 representatives of the manufacturing sector to create a more complete picture of Philadelphia's and the Greater Philadelphia Region's manufacturing workforce challenges and opportunities.

Availability of skilled talent

Consistently, manufacturers said the Greater Philadelphia Region have a "workforce problem." Companies indicated they are willing to train workers, but cite as a hurdle their inability to find enough trainable candidates. Historically, lower-skilled production jobs had less stringent hiring guidelines, but high turnover rates reduced productivity because of the constant need to retrain workers. As a result, basic hiring requirements have been instituted which has made it harder to find qualified individuals to fill the lower-skilled positions.

Two of the companies interviewed provided hard data on recent hiring experiences, and told similar stories on the difficulty of finding qualified production workers.

The Hiring Funnel



From the initial applicant pool recruited by the two companies in this example, only 50-60% completed the application process. Of these, less than 50% passed the employment test measuring eighth-grade literacy and math skills. Of the remaining applicants who passed the test, only 15-35% met the necessary employment criteria. The average candidate yield rate was 3-6% in these two cases. Based on interviews with other manufacturing employers, the highest yield percentage was approximately 10%.

While the business community may frame the problem as a "workforce" issue, much of the challenge they describe is a basic literacy issue, which is both an economic and a broader social concern. The need for workforce development programs is most applicable to workers at the bottom of the hiring funnel, defined as persons that possess basic literacy skills and have passed pre-employment exams. A workforce challenge arises here as the workers at the bottom of the hiring funnel may still not have the workforce readiness and applied skills to meet the specific requirements unique to every employer; while the purpose of workforce development and training programs is to provide these workers with the necessary skills.

Why the hiring funnel matters for manufacturing and Greater Philadelphia

An analysis of a sample of occupational categories of production workers in the city found that approximately 1,824 production workers in these occupations are over the age of 55. Depending on the specific category, anywhere from 10% to 25% of the workforce is nearing retirement age, indicating a shortage of skilled production workers is coming if the next generation does not have basic skills and does not receive the training necessary to eventually fill these positions.

Unlike manufacturing of 30 years ago, few manufacturing companies today maintain the headcount levels to sustain an in-house "apprentice" pool which can develop into skilled production workers. Therefore, the public workforce development system and recruitment process will increasingly play critical roles in replacing these workers. Unfortunately, based on present hiring yield rates derived from our analysis, it would take 30,000 to 60,000 candidates from within the city over 10 years to fill those jobs. Difficulty in

replacing skilled and experienced workers may force companies to respond with dramatic gains in productivity, including increased automation, which would have the effect of displacing those jobs.

Older workers share of employment in selected occupations in the City of Philadelphia

Occupation	Age 55 to 64	% of Total occupation
Electromechanical Equipment Assemblers	33	23%
Team Assemblers	318	17%
Computer-Controlled Machine Tool Operators, Metal and Plastic	36	21%
Extruding and Drawing Machine Setters, Operators, and Tenders, Metal and Plastic	29	21%
Cutting, Punching, and Press Machine Setters, Operators, and Tenders, Metal and Plastic	54	20%
Machinists	149	25%
Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic	32	22%
Chemical Equipment Operators and Tenders	53	23%
Production Workers, All Other	24	16%
Laborers and Freight, Stock, and Material Movers, Hand	1096	13%
Total:	**1,824**	

Source: Ninigret Partners

Technical skills development

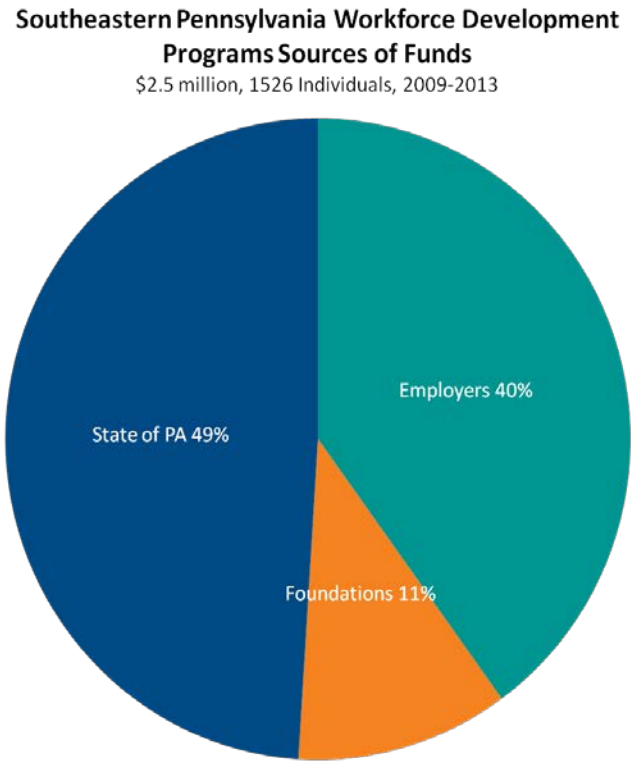
Philadelphia, like many cities, has an extensive array of job training programs. During the interviews, business response was mixed on the effectiveness of career and technical education programs in developing the technical skills needed by manufacturing workers. Career and technical education programs are viewed as valuable because they are selected by students interested in manufacturing who are more likely to have some mechanical aptitude, which accelerates their rate of learning. Programs, such as those sponsored by Philadelphia Works, are viewed as valuable by manufacturing companies because the training is designed to meet existing needs as defined by the business community.

The drawbacks cited about these programs include: training equipment that may not reflect what is currently used on the manufacturing floor; an over-emphasis on hard skills when soft skills and analytical skills are also important; and that the training often occurs in a classroom versus in a simulated "environment."

One significant hurdle facing Philadelphia is getting these programs to a scale capable of having a real impact across the entire industry. The Center for Workforce Solutions estimates that the current penetration rate or the percent of companies participating in Southeastern Workforce Development

Programs (SEWDP) is 5% for companies in all industry sectors, while the penetration rate for existing manufacturing companies is just 1.1%.

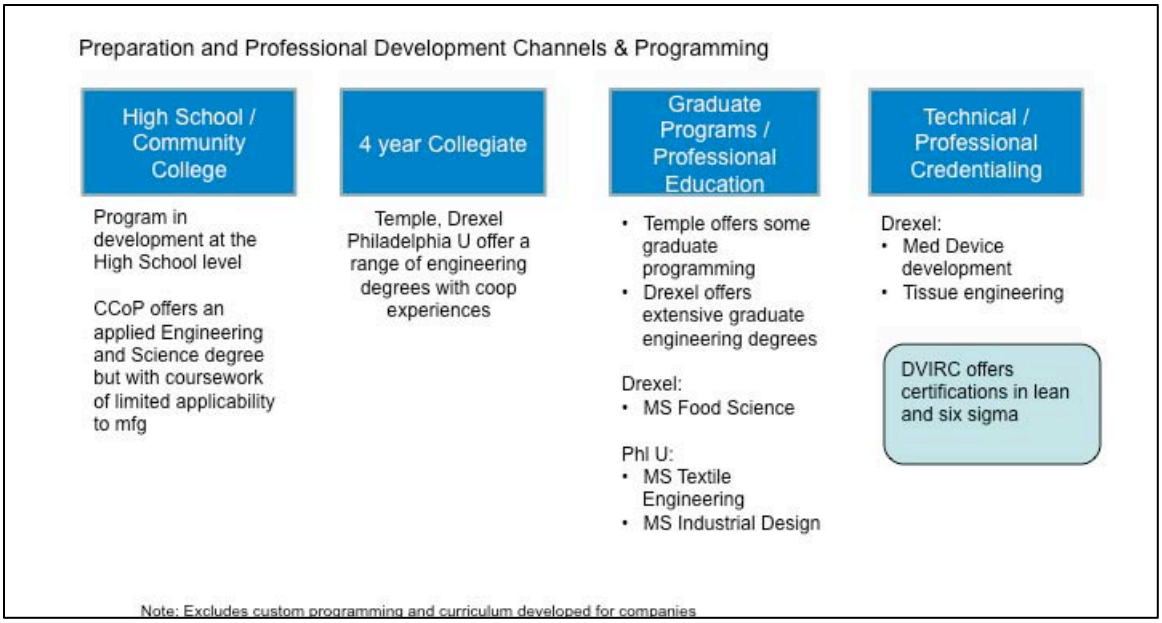
It is not only the relatively small penetration rate that is a concern, but also the actual number of people receiving training. For example, in Philadelphia, $3.4 million of Workforce Investment Act funds were spent on contracts for manufacturing workforce training between July 2005 and August 2013. During this period, 602 individuals participated in these programs. As a point of reference, according the Federal Reserve Bank of Philadelphia, there were about 23,000 manufacturing sector jobs (seasonally adjusted) in the city in August 2013.



Manufacturing-oriented education

In addition to scalability, accessibility to manufacturing-related, non-sponsored educational programming for residents within Philadelphia is an issue. A look at preparation and professional development channels and programming in Philadelphia shows a limited number of programs at all levels of training and education. In addition, the region, and especially the city, has a shortage of local programs that specifically train industrial or manufacturing engineers and technicians.

Within the city, only Philadelphia University awarded certificates and degrees industrial engineering during 2011/12 academic year; and only Philadelphia University, the University of the Arts, and the Art Institute of Philadelphia awarded degrees and certificates that year in industrial product design.



At the community college level there is evidence of relatively low enrollment rates for engineering programming. Four of the 10 community colleges in the Greater Philadelphia Region offer an engineering technologies degree and during the 2010/11 academic year they awarded a total of 101 certificates and degrees in this major. The largest program, at the Delaware County Community College awarded 43 degrees during the year, while the smallest at Montgomery County Community College awarded only eight. By comparison, the Community College of Philadelphia awarded 12 certificates and degrees that academic year.

Engineering certificates and degrees awarded by community colleges

Institutions	Engineering associate's degrees	Engineering technologies & engineering-related fields asssociate's degree	Engineering technologies & engineering-related fields certificates below the bachelor's level	Precision production associate's degrees	Precision Production Certificates below the bachelor's level
Community College of Philadelphia	19	12	1		
Camden County College	15	38	31	1	1
Delaware County Community College	17	43	3		
Montgomery County Community College	17	8			
Community College of Allegheny County		46	17	13	133

NOTES: Community College of Philadelphia engineering technologies did not issue any degrees or certificates in manufacturing related fields
Camden County and Delaware County offer programming
For Allegheny County as an illustration rates are still low in manufacturing oriented fields
-4 industrial production technologies
-2 mechanical technologies
-6 electrical engineering
Source: National Center for Education Statisics. 2013. Integrated Postsecondary Education Data Set (IPEDS)

Camden Community College offers precision production degrees and certificate programs. According to the Integrated Postsecondary Education Data Set two students received either a degree or a certificate during the 2010/11 academic year.

Findings

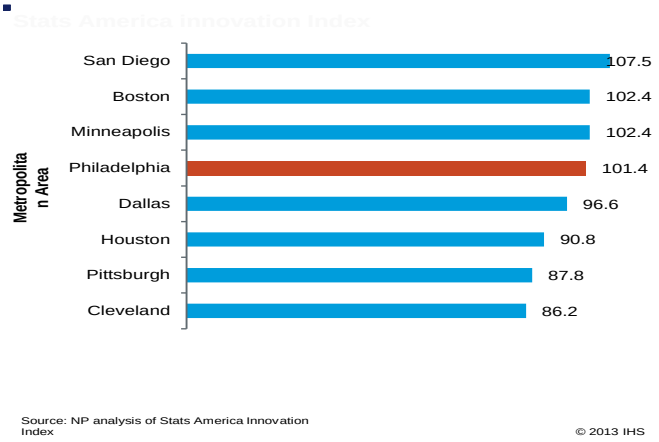
The Greater Philadelphia Region needs to take additional actions to ensure the workforce can get access to, and be properly trained for, the manufacturing jobs being created, as well as be qualified to meet the replacement needs. Four areas of critical concern include:

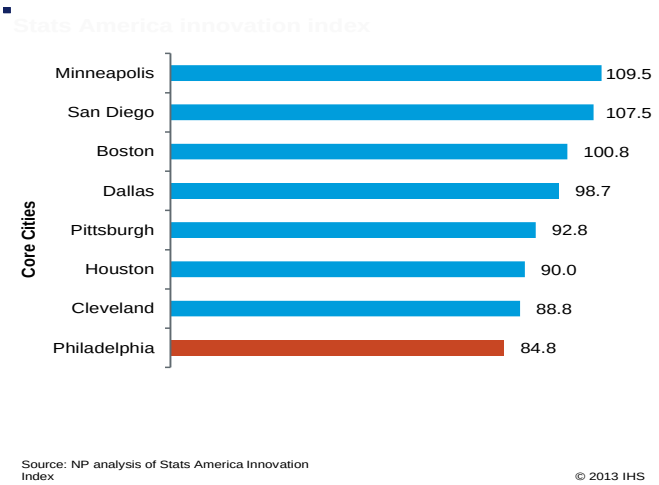
- The aging of the production workforce in the region
- The low level of basic skills possessed by a large number of applicants for entry-level production manufacturing jobs
- The low level of penetration of existing workforce programs into the region's manufacturing establishments
- The low take-up rates of students receiving manufacturing-oriented education and training

Innovation

The term "innovation" refers to ways in which a community or region and its related assets support the creation of new ideas and capture the economic value of those ideas. Understanding how Philadelphia and the Greater Philadelphia Region perform in these areas, both overall and in comparison to other communities, can provide a framework for analyzing the city's competitiveness in the manufacturing sector.

While it is important to consider overall innovation measures and rankings, it is also important to note that these measures are imperfect. Most measures look at data strictly at the state level, not the metropolitan level, with one notable exception. The Stats America Innovation Index compares regional performance within the United States. Four weighted component indexes—Human Capital, Economic Dynamics, Productivity and Employment, and Economic Well-Being—are used to calculate the overall score. Using this measure, the Philadelphia region has a relatively high innovation index of 101.4 and ranks in the middle of other large MSAs, but Philadelphia lags the region and the competitive communities with a value of 84.8.





The Stats America project will release an updated report reflecting 2013 data. Given Philadelphia's positive advances in the study's innovation metrics since 2009, such as population growth, educational attainment, venture capital investment levels, and high-tech employment, the City may rank higher in the future.

To create a more complete picture of Philadelphia and the Greater Philadelphia Region's innovation capacity, Ninigret Partners performed a deeper analysis of several key indicators, including: the supply of engineers and scientists in the workforce, patent activity in the region, the ability to attract venture funding, the availability of research funding, the current state of the region's tech transfer framework and the existence of an entrepreneurial culture.

Capacity for innovation

The Philadelphia region has been an important source of discovery and innovation in the United States since colonial times. Important discoveries and inventions such as ENIAC (one of the first practical computers) advanced materials like Kevlar, and basic elements of daily life such as the revolving door and the pencil with eraser were invented in the Greater Philadelphia Region.

The Greater Philadelphia Region remains an important source of innovation for the US economy and it consistently ranks in the top 10 of the nation's leading metropolitan areas in total generated patents, small business innovation research awards, and research and development spending.

Capacity to innovate relies heavily on three factors: the availability of research funding, the presence of engineers and scientists in the workforce, and patent generation. The right mix of these factors in a local or regional economy fosters competitiveness in the "knowledge economy" and increases the likelihood that the region can become an important center for innovation.

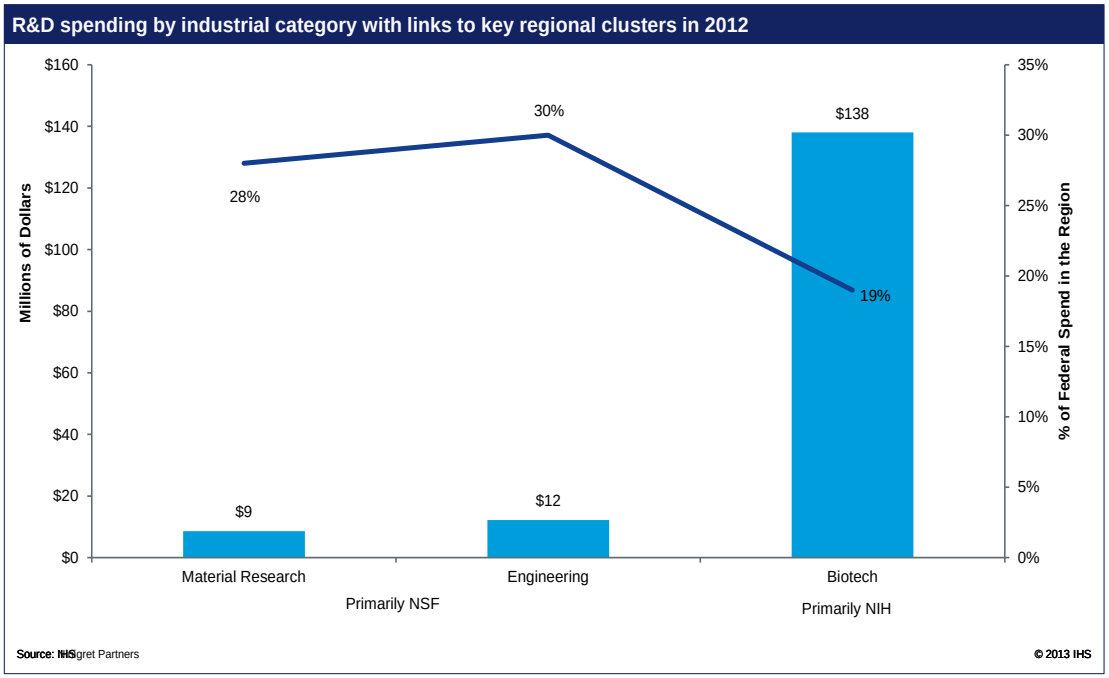
The availability of research funding

Innovation is fueled largely by research dollars. Federal research dollars are a major source of funding and allow for comparisons across geographies. Moreover, federal research dollars play a critical role in the innovation economy. The findings of "Sparking Economic Growth 2.0," a report published by the Science Coalition on October 29, 2013, demonstrate the essential nature of those dollars. Key findings include:

- Basic research is the first step in the innovation process.

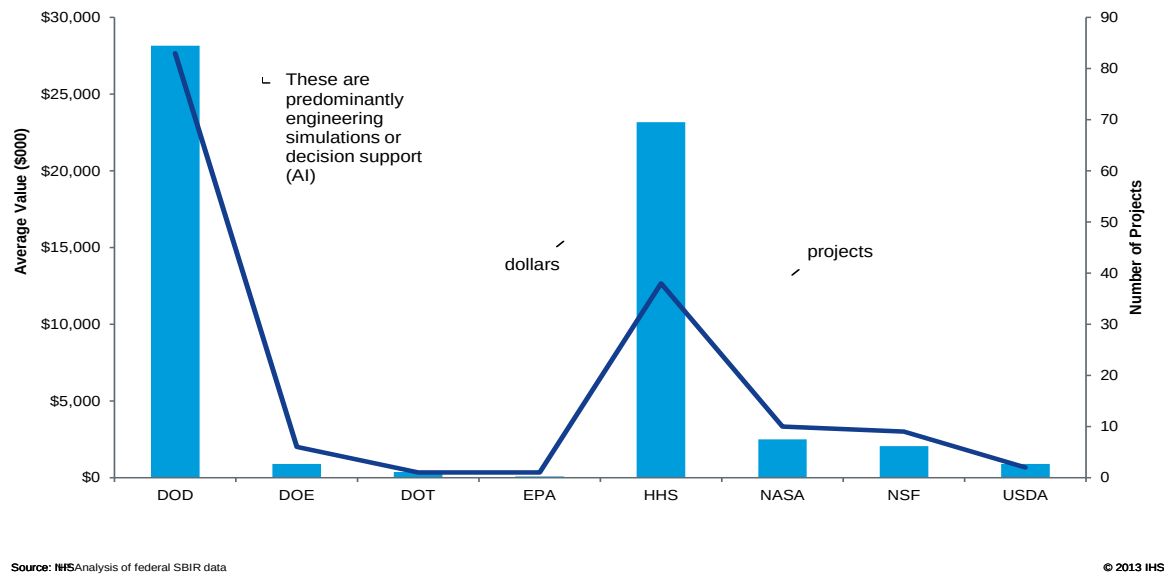
- The federal government is the primary source of funding for basic research conducted in the United States, providing 53.3% of the funding in 2009. The second-largest source of basic research funding is business which provided 21.7%, followed by colleges and universities with a 14.2% share.
- Universities conduct the majority of basic research in the United States — 53.4% in 2009. Business and industry were next performing 19.5% of basic research, followed by the federal government at 15%.
- Applied research is performed primarily by business at 57.7%, followed by the federal government, and colleges & universities, with 17.8% and 16.7% shares respectively. Investment in applied R&D is almost evenly split between business at 48.2% and the federal government providing 42.2% of the funds.
- Experimental development is overwhelmingly performed and paid for by the business sector. According to the National Science Foundation, in 2009, businesses performed 89.5% of experimental development, while paying for 77.6% of it.

According to the National Science Foundation (NSF), colleges and universities located in the Greater Philadelphia Region spent $1.73 billion on R&D in fiscal year 2011, of which $1.24 billion, or 71.8%, was spent by institutions located in the City of Philadelphia. IHS estimates that businesses in the Greater Philadelphia Region spent approximately $11 billion in R&D in 2011 based on their total output and NSF estimates of R&D spending as percentages of sales by industry sector. When spending by government agencies is added in, primarily by the federal government, total R&D spending in the Greater Philadelphia Region in 2011 was approximately $12.9 billion, amounting to about 3.4% of the Greater Philadelphia Region's gross regional product. By comparison, total US R&D spending in 2009 (the latest year for which this figure is available) was 2.9% of GDP.



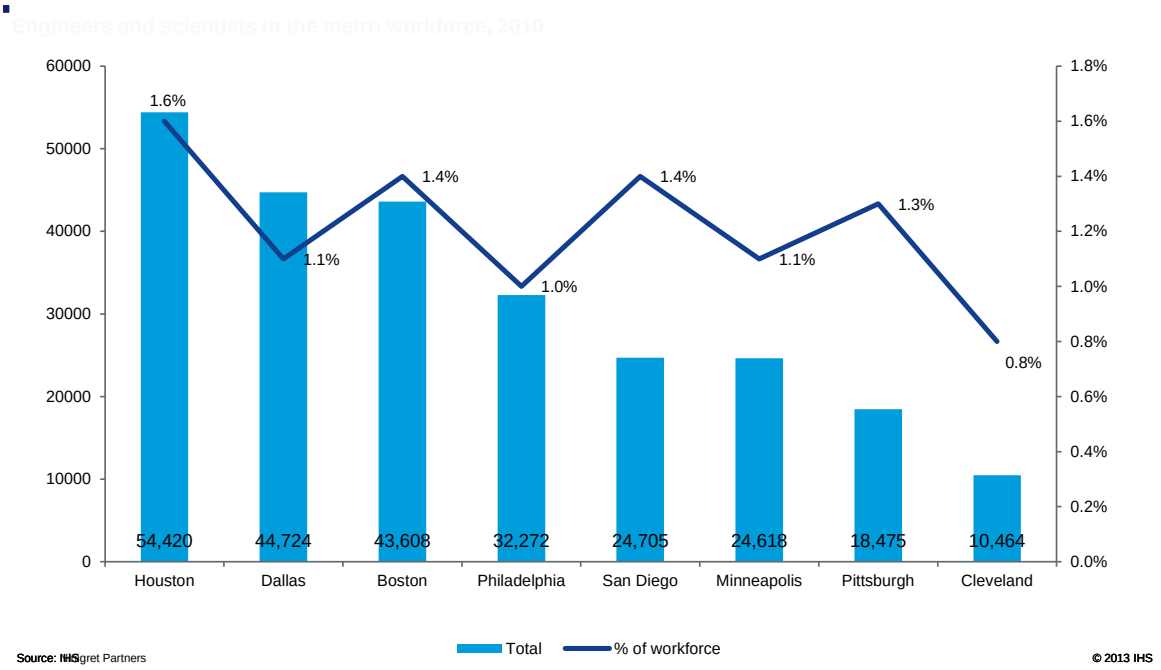
Using NSF data, Ninigret Partners estimates that R&D spending for biotech (one of the core clusters identified during Task 1 of this document) in the Greater Philadelphia Region in 2012 was $136 million.

Another perspective is to consider research and development activities conducted by small business. Federal support in this area comes through the Small Business Innovation Research (SBIR) program. US Department of Defense dollars represent the largest source of SBIR grants for the Philadelphia metro area. Philadelphia represents 9% of the total projects and 11% of the funding from 2010 to 2012. Total SBIR investment in Philadelphia from 2010 through 2012 was approximately $6.2 million.



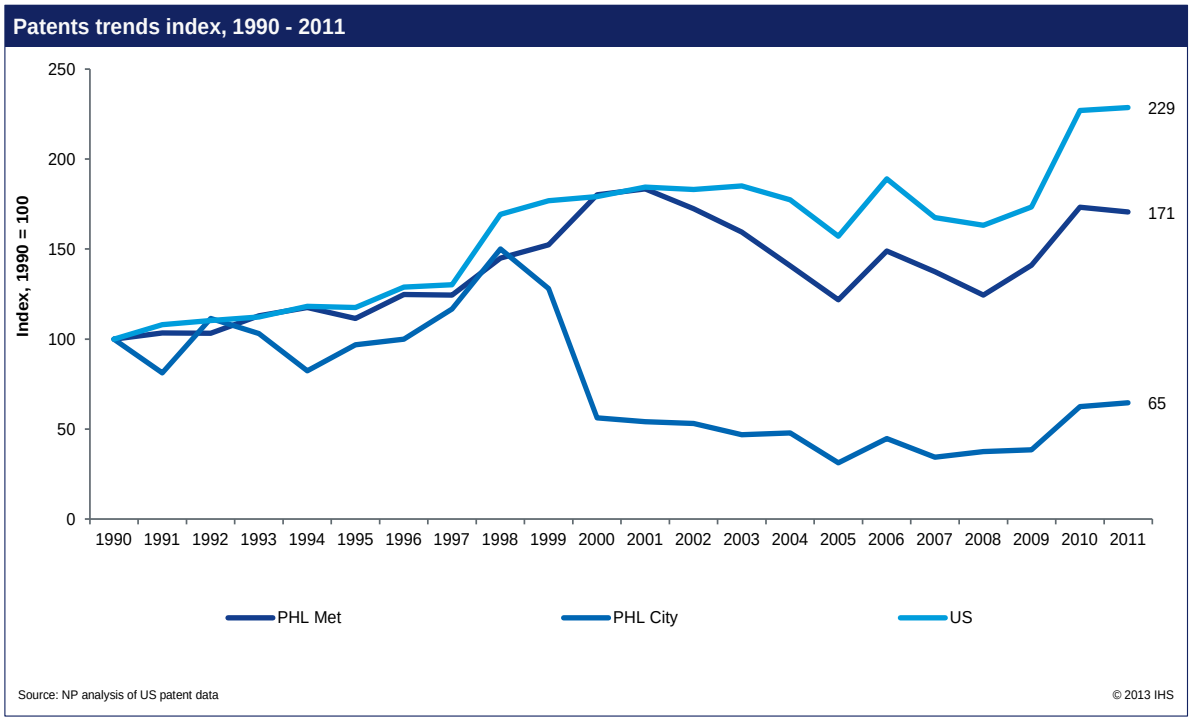
Engineers and scientists in the workforce

The presence of key technical skills in the workforce, namely technicians, scientists and engineers, is a critical indicator of an area's potential for innovation. Of the competitive communities, the Greater Philadelphia Region has one of the largest supplies of engineers and scientists, but they represent a smaller percentage of the workforce. The smaller percentage of the workforce is reflective of the mix of industrial and research activity taking place in the region. Although the City of Philadelphia had 5,581 engineers and scientists in 2010, they represented just 0.7% of the workforce, a substantially smaller percentage than the Greater Philadelphia Region overall.



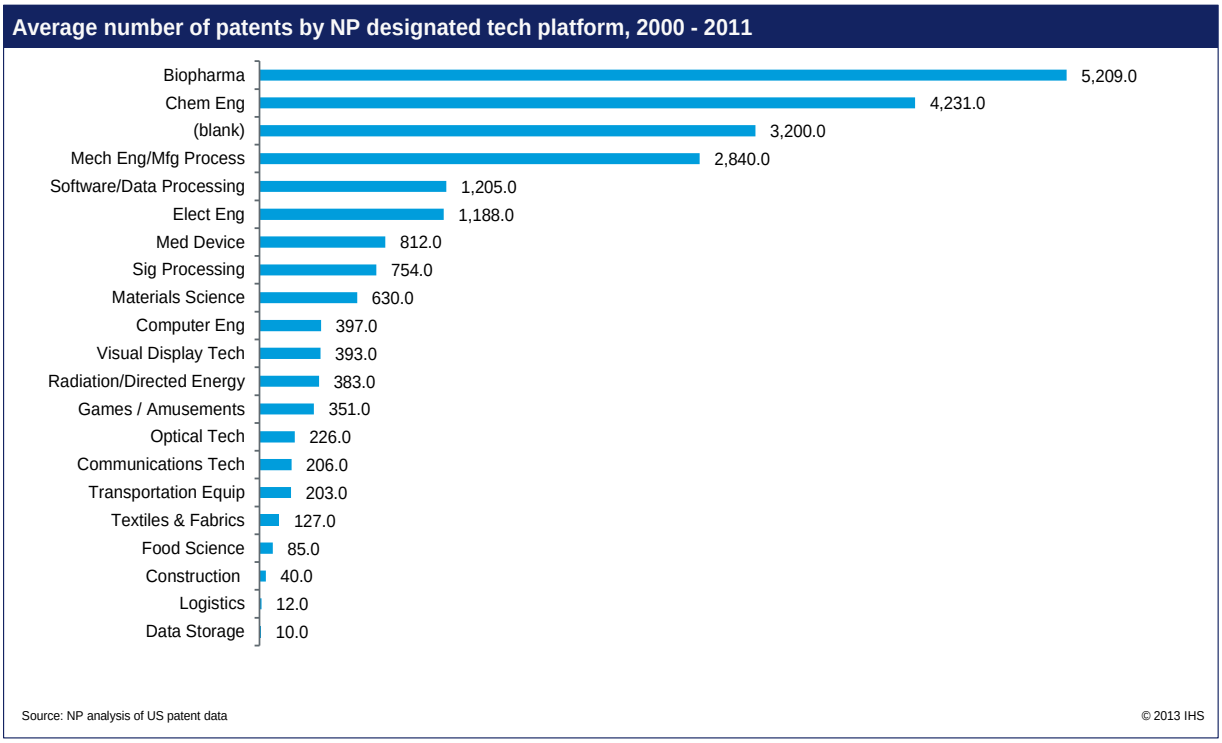
Patent generation

Generation of patents is a commonly used measure of innovative activities and can provide insight into an area's ability to create new technologies and to remain competitive. Patents, however, are not necessarily indicative of the adoption of new technologies into business or industrial processes, which is the true measure of innovation.



Patent generation in the United States has more than doubled in the past 20 years. While patent generation in the Philadelphia Metro Region has also grown, it has not kept pace with the rest of the nation, and patent generation in the City of Philadelphia has fallen off dramatically.

Most of the patent generation in the city reflects the large corporate R&D presence, especially in the life sciences, and the growth of life science research activity within the universities. According to the National Science Foundation, in fiscal year 2010, 62.6% of the R&D expenditures by colleges and universities in the Greater Philadelphia Region were in the life sciences. In the city, the life sciences spending share was 78%. Had it not been for university investment, the city would have seen an even steeper decline in patent generation.



Philadelphia and the Greater Philadelphia Region, with their substantial R&D and innovation resources, remain important sources of innovation for the US economy. However, the region lags the nation as a whole, and substantially lags other metro areas such as Boston and San Francisco in developing new technologies and ideas. The city has fallen off substantially over the last 20 years. Philadelphia's ability to remain competitive in the "knowledge economy" requires increased focus and attention on expanding both the potential for innovation and entrepreneurs' ability to turn new products or processes into new ways to bring additional revenue to the region.

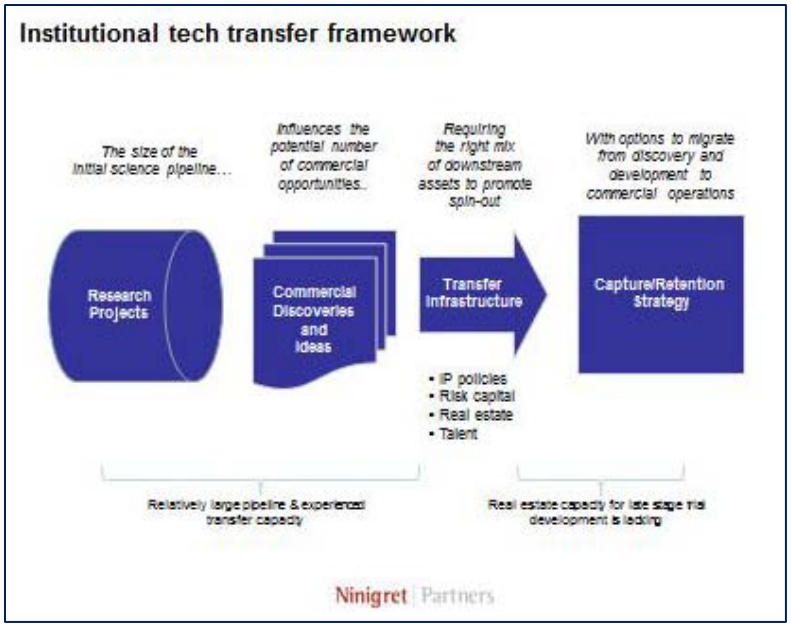
Capturing innovation

Creating technology or leading innovation is not the same as capturing economic value. How and where innovation disseminates through the local and regional economy are great challenges of innovation-based strategies. An area's capacity to capture the commercial value of innovation depends largely on the

presence of an institutional technology transfer framework, the ability to attract venture funding for new business start-ups, and a supportive environment for entrepreneurs.

Presence of an institutional technology transfer framework

The transfer of new technologies or ideas from the discovery and development phase to the product design phase and, ultimately, to the marketplace depends greatly on the transfer infrastructure within the region. The right mix of assets—intellectual property (IP) policies, risk capital, real estate, talent—must be present to promote spin-out. The Greater Philadelphia Region has a relatively large pipeline of research projects and experienced transfer capacity of this research into commercial discoveries and ideas.



The vast majority of technology transfer in the Philadelphia region is focused on licensing activity rather than start-ups, which is in line with other regions in the technology transfer space. Institutional technology transfer activity for 2011 in Philadelphia and the Greater Philadelphia Region shows that 872 available technologies yielded 168 licenses/options and 11 start-ups. It is important to note the transfer of licenses/options does not necessarily occur with local companies. Licenses transferred to companies outside of the region are examples of lost opportunity for capturing economic value. A number of Philadelphia's institutional anchors, such as University of Pennsylvania and Drexel University, are in the process of transforming their technology transfer models in order to stress business incubation and commercialization.

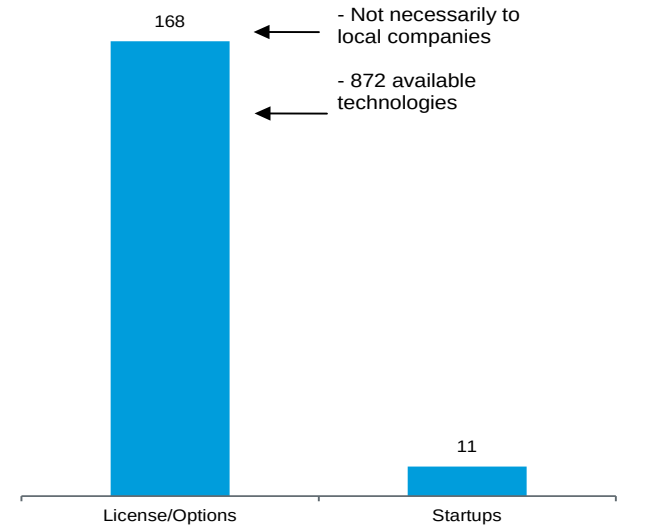
Access to venture capital

Capital is the lifeblood of any business. Companies interested in diversification, product development, or geographic expansion requires financial capital to make initial investments or support the "carrying costs" of new initiatives. Most of the companies interviewed for this study shared that their ability to pursue growth opportunities is constrained by providing their own working capital to meet their regular cash flow needs, as well as when making investments in new products, markets, or facilities.

The Philadelphia region significantly lags behind the leading centers and regional competitors in attracting venture funding for its ideas. While geographically the two regions are roughly the same size, venture capital investment in the New England region exceeds that of the Philadelphia region by a ratio of about 8:1.

During the second quarter of 2013, 29 companies secured venture capital funding, 86% of which was biomed related. Five of those companies were located in Philadelphia and of those five, one was in the field of biotechnology.

Philadelphia institutional tech transfer activity, 2011



Source: NP analysis of AUTM licensing survey data; college

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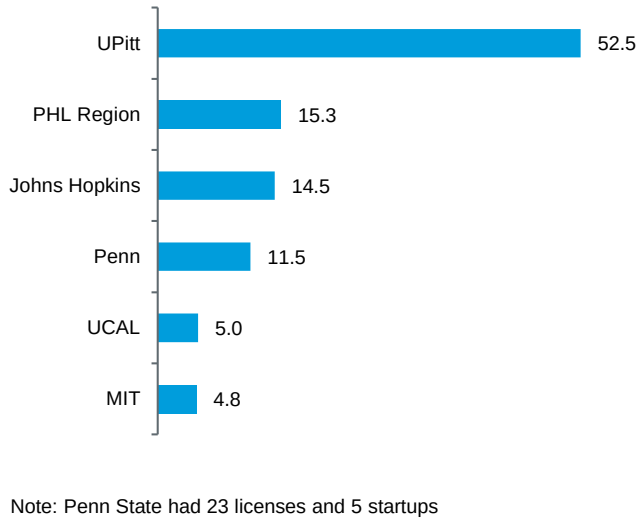
Licenses per startup: minimum 100 licenses



Source: NP analysis of AUTM licensing survey data; college tech transfer offices

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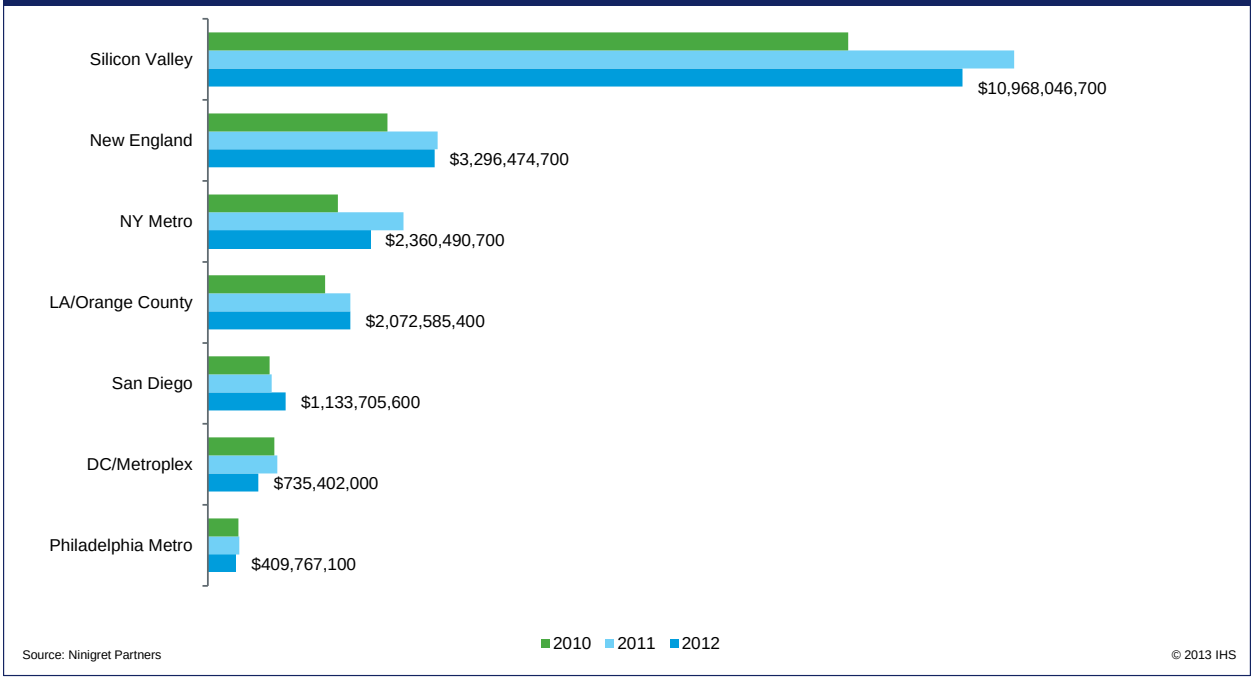
Venture capital funding by area, 2010 - 2012



Source: Ninigret Partners

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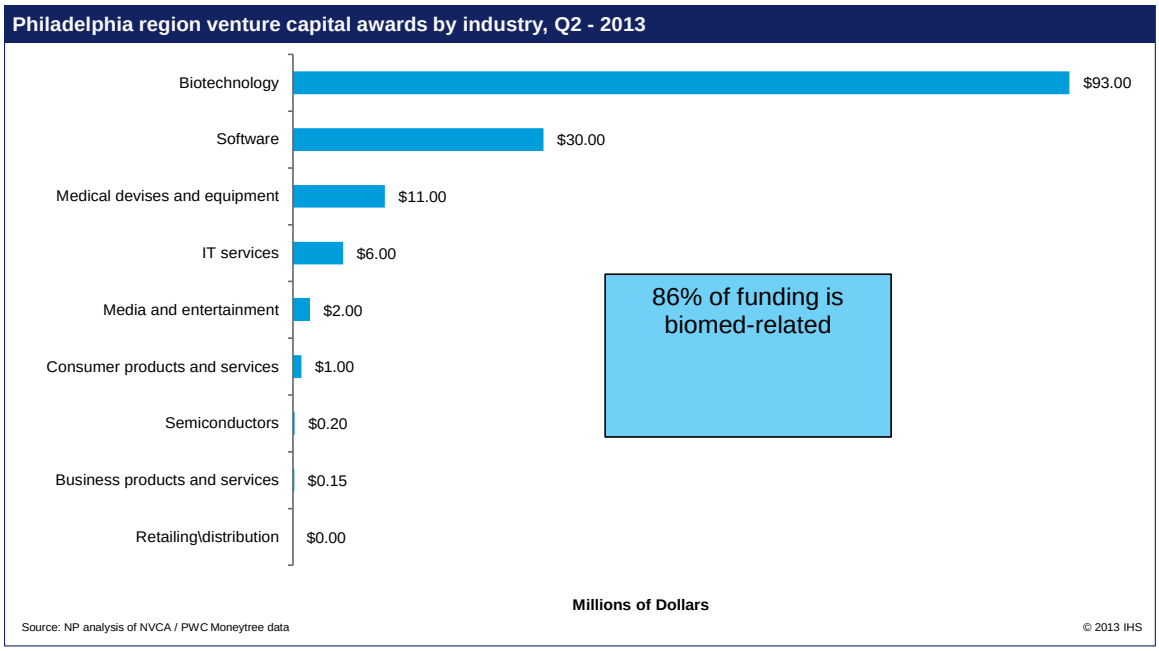
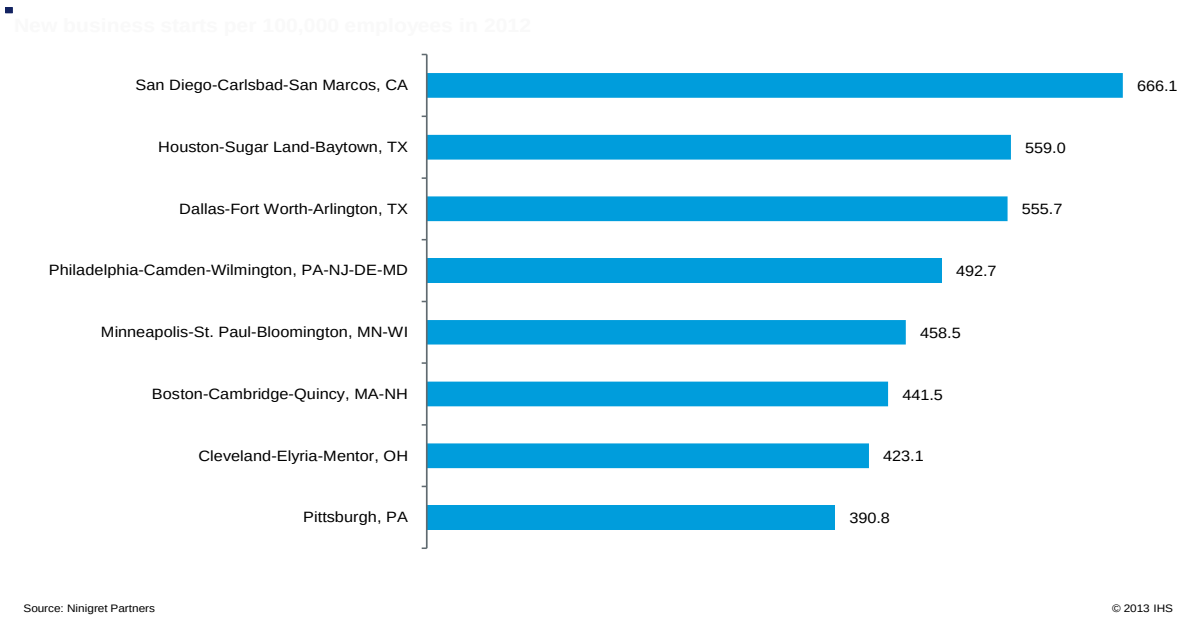


Entrepreneurial culture

Entrepreneurial culture is difficult to measure. One of the dilemmas of using measures such as business starts per population metrics is they miss two important considerations: business starts tend to be more prominent in areas with faster-growing populations. The second is that employees, not the general population, tend to start businesses.

Ninigret Partners performed a comparative analysis of business starts using some of the metro areas considered in the Taxation foundational assessment presented in the next section of this report, and adjusting for the number of the workers rather than for total population. The Greater Philadelphia Region has a fairly high level of new business activity; among the competitive communities located in the Northeast and Midwest, it had the highest level of business starts.



In addition, a product-driven entrepreneurial culture is emerging in Philadelphia where small design companies are driving the product development and manufacturing growth. Kickstarter, a web-based crowd source funding mechanism, is an indicator of such activity. A snapshot was taken of products seeking funding on Kickstarter. Products included a bacon jam, clothing, decanters, clips for the wiring of electronic devices, bike equipment, and a loose leaf tea steeping device. However, more important than the products, are the business models and supply chain structure. Most of the products were from small design firms in the area, not manufacturing companies. Yet, most of the supply chain/value chain, including production, was locally sourced. This local sourcing shortens the time-to-delivery and also reduces the need for working capital usually required for inventory carry, an important part of the success story of the small manufacturers we interviewed. Moreover, this emerging product development ecosystem reinforces the need to consider manufacturing as a supply chain/value chain system that creates demand for goods and services from other non-manufacturing sectors such as product and engineering design services, and logistics. This growing culture could be a potential focal point for a "source local" effort where global supply chain economics and value added capacity are less critical.

Conclusion

Philadelphia remains an important source of innovation for the U.S. economy. However, increased focus and attention must be paid to expanding the potential for innovation and to improving the ability of individual entrepreneurs to generate revenue through new products and processes. More must be done not only to launch new businesses, but also to help existing firms come up with efficient, creative and cost-effective ways to design, produce and sell products and services. Philadelphia has an opportunity both to develop manufacturing talent and to provide low-cost, novel ideas to the existing manufacturing sector. One strategy to consider is investing resources in product design so as to increase the number of companies developing or launching new products and increase company revenues from the sales of these products.

Public Policy and Regulatory Environment

Historical context

The purpose of this section is to explore the role of local government, and the local tax structure, on the competitiveness of the manufacturing sector in Philadelphia. Manufacturing has a rich legacy in Philadelphia. In the first half of the 20th century, factories employed legions of Philadelphia residents, making such nationally recognized products as Stetson hats and Baldwin locomotives and rendering the name "Philadelphia" synonymous with quality production. The second half of the 20th century brought the decentralization, automation, and globalization of manufacturing processes, resulting in a precipitous decline in national manufacturing employment, particularly in older urban centers like Philadelphia. Philadelphia's economy is now dominated by "eds and meds," with universities, hospitals, and research facilities now securing the largest proportion of the workforce and of the national spotlight.

Current trends

Manufacturing is by no means a bygone industry in the US or in Philadelphia. According to the Federal Reserve Bank of Philadelphia and the US Bureau of Labor Statistics (BLS), in August 2013 there were a total of 11.9 million jobs (seasonally adjusted) in the US manufacturing sector and 23,000 in the City of Philadelphia. And, presently, manufacturing is enjoying a renaissance of sorts in the US, due to a confluence of factors:

- The labor cost differential between US and non-US locations is shrinking rapidly due to rising wages in developing countries and stagnant wages in the US;
- Technology and high-skilled labor are now larger components of the production cost equation, advantaging the US over other locations whose edge is in the availability of a low-cost, low-skilled workforce;
- Higher energy costs and increased energy uncertainty worldwide has resulted in more production of items closer to the markets in which they are being sold; and
- Access to cheap shale gas makes the US an attractive location for energy-intensive manufacturing processes.

Manufacturing and local government

Philadelphia-based manufacturing firms are aware of these global trends, and seek to position themselves to be competitive in such a landscape. Their interest in the role of local government stems from the fact that local government can, through a variety of levers, positively or negatively influence their ability to compete at a regional, national, and global level.

Government, in turn, has at least two reasons to prioritize its intersection with the manufacturing sector. First, manufacturing can potentially generate a large number of high quality jobs for residents. Second, manufacturing can potentially be a large export engine for the City, making products for sale across the country and around the world, and thus creating local economic opportunities and generating local tax revenues.

This foundational assessment looks primarily at tax policy and regulatory policy, two levers local governments can use to positively or negatively influence the landscape within which manufacturing firms operate. It also touches on the role of programs and incentives, infrastructure investment, and workforce development, as well as on the convening and liaising function that local governments can and do play in their intersection with industry.

Tax burden

If a particular federal tax or regulation is seen as burdensome, the only way to avoid it is to leave the country. Similarly, unless one is located near a state border, avoiding a particular state tax or regulation requires a significant relocation. Conversely, a local tax or regulation can be avoided much more easily, by relocating just outside that locality's borders, without losing access to the same base of employees, suppliers, customers, or partners.

Therefore, tax policy and regulatory policy are two important levers that local governments must take care to wield, for they can have a significant influence on the landscape in which firms compete. It is for this reason that the majority of analytical attention for this report was given to taxes and regulations.

Comparative Framework

Specifically, Philadelphia was compared against nine other locations with large manufacturing clusters in sub-industries in which Philadelphia has large clusters. These sub-industries and locations were chosen to reflect a diversity of products and geographies.

Manufacturing sub-sectors and comparison locations used in this study

Manufacturing sub-sector	NAICS Code	Philadelphia example	Comparison localities
Food	311	Kraft Foods Global, Inc	Nottingham, PA
Beverage and Tobacco Products	3121	The Philadelphia Coca-Cola Bottling Company	Downingtown, PA
Chemicals	325	Arkema Delaware, Inc.	Houston, TX; Cleveland, OH
Transportation Equip.	336	Lockheed Martin Corporation	San Diego, CA; Dallas, TX; Fort Worth, TX
Miscellaneous	339	Perfecseal, Inc.	Minneapolis, MN; Boston, MA

Source: Econsult Solutions, Inc. (2013)

There are two ways of thinking about this kind of locality-to-locality comparison. One is to imagine a Philadelphia establishment contemplating a move to another locality, or vice versa, and weighing the tax and regulatory climate of the two jurisdictions. The other is to imagine a Philadelphia establishment competing with an establishment from another locality in the same national consumer marketplace, and being relatively advantaged or disadvantaged against that competitor as a result of some local tax or regulation. In both cases, taxes and regulations are very important determinants of competitive success,

and as a result firms of all kinds scrutinize local taxes and regulations very carefully when making location decisions.

Tax types in Philadelphia and the comparison cities

Philadelphia is located within the Commonwealth of Pennsylvania, and therefore Philadelphia-based establishments are subject not only to Philadelphia taxes but also to Pennsylvania taxes, just as Cleveland-based establishments are subject to both Cleveland and Ohio taxes and Dallas-based establishments are subject to both Dallas and Texas taxes. Therefore, Philadelphia's tax differences with other locations may stem from differences in local taxes and/or in state taxes.

Pennsylvania is not much different from the states within which the comparison locations in this report are located: it levies a personal income tax, a sales tax, and a business tax, just like the other states (with the exception of Texas, which does not levy a personal income tax). However, Philadelphia is unique among the comparison locations in levying a personal income, sales, and business tax at the local level, over and above the personal income, sales, and business taxes levied at the state level.[1] It should be noted that while firms may remit local income or sales tax, businesses themselves do not actually pay those taxes. In fact many manufacturing firms do not remit sales taxes, as they often sell products at a wholesale level.

Types of taxes imposed by state and local governments

	Local taxes			State taxes		
Locality	Personal income	Sales	Business	Personal income	Sales	Business
Philadelphia, PA	x	x	NI & GR	x	x	NI
Boston, MA				x	x	NI
Cleveland, OH	x	x	NI	x	x	GR
Dallas, TX		x			x	NI
Downingtown, PA	x			x	x	NI
Fort Worth, TX		x			x	NI
Houston, TX		x			x	NI
Minneapolis, MN		x		x	x	NI
Nottingham, PA	x			x	x	NI
San Diego, CA		x	GR	x	x	NI & GR

NI: Net Income Business Tax; GR: Gross Receipts Business Tax
Source: Econsult Solutions, Inc. (2013)

Tax burden methodology

When comparing tax burden across localities, there are manifold nuances that determine just how much a particular company will pay in taxes. In other words, broad comparisons may mask meaningful variations

[1] See Appendix D for additional detail on tax types in Philadelphia and comparison cities.

at a single-establishment level. Nevertheless, it is still useful to make such broad comparisons as they are usually consistent with the overall perception of a locality's relative tax burden.

In each of the manufacturing sub-industries analyzed in this report, illustrative business profiles were created and populated with financial data based on industry averages as provided by the Internal Revenue Service. To further explore relative tax burden, within each illustrative business profile, eight total profiles were prepared:

1. Industry average
2. Industry median
3. Larger firm
4. Smaller firm
5. More capital intensive firm
6. More labor intensive firm
7. Higher profit margin
8. Lower profit margin

For each of these 40 scenarios (five sub-industries x eight profiles each), the total local and state tax burden was calculated for Philadelphia and for each comparison location. The resulting tax amounts were then ranked (1 = lowest, 10 = highest) and indexed (Philadelphia = 100).[2]

Tax Burden in the City of Philadelphia and the comparison cities

For each scenario, Philadelphia's tax burden was calculated as the highest among comparison locations by a substantial margin.[3] This analysis includes local and state taxes that manufacturing businesses do not pay, such as personal income and sales taxes.

Comparison of combined state and local tax burden for selected cities

Locality	Rank	Index (Philadelphia = 100)
Philadelphia	10	100
San Diego, CA	9	67
Minneapolis, MN	8	55
Downingtown, PA	7	46
Nottingham, PA	6	46
Boston, MA	5	43
Cleveland, OH	4	36
Dallas, TX	2	30
Fort Worth, TX	3	30
Houston, TX	1	30

Source: Internal Revenue Service (2011), Econsult Solutions, Inc. (2013)

[2] See Appendix E for additional detail on tax burden methodology.

[3] See Appendix D for additional detail on tax burden in Philadelphia and comparison cities.

The analysis is consistent with the perception expressed by Philadelphia manufacturing establishments of the heavy burden associated with Philadelphia taxes.

Importantly, it is largely the city and not commonwealth taxes that create an uncompetitive situation for Philadelphia manufacturing establishments. The commonwealth rates fairly well against other states, and it is the very wide gap between Philadelphia's tax burden and other municipal tax burdens that impedes Philadelphia-based manufacturing firms. Prior to this study's commissioning, the City of Philadelphia approved new tax reform legislation, known as the single sales factor apportionment, which would lower the tax burden for businesses whose customers are predominately outside of the City itself. Those changes take effect January 1, 2014.

Regulatory burden

Overview

Government regulations span an array of categories that affect business operations: labor and employment, workforce safety, economic, environment, energy efficiency, zoning and land use, licensing and permitting, legal, and homeland security. Whether at the federal, state, or local level, these regulations are intended to promote important public policy objectives, such as safety and equity.

However, regulations can also impose compliance costs upon businesses, and negatively influence the operational decisions they would otherwise make absent the regulations.

When states and localities impose regulations on top of the existing federal ones, they may create a business climate that disadvantages firms within their borders as they compete with firms in other states and localities. While differences in tax burdens often receive more attention, differences in regulatory burdens can be just as, if not more, of a deterrent to attracting new companies or to encouraging existing companies to expand. A recent report by the Mercatus Center of George Mason University called regulatory policy "the most important policy variable in terms of explaining economic growth in the states."[4]

A fundamental contrast between Philadelphia and the comparison cities

Companies can relatively easily avoid a locality that imposes a particularly burdensome regulation without much disruption in business operations, whereas avoiding a federal regulation would create significant dislocation. This is true for a firm's core operations as well as for satellite locations and functions.

High-regulation localities impose more stringent regulations above and beyond state and federal guidelines. In contrast, low-regulation localities seek to impose no local regulation that is any more burdensome than that of the state or federal government. As noted above, regulatory policy should be evaluated not just on the costs and restrictions it imposes on firms but also on the various public objectives it is intended to achieve. Nevertheless, low-regulation locations tend to be more successful than high-regulation locations at attracting businesses and business activity.

[4] "Freedom in the 50 States," George Mason University (2013).

Regulatory burden comparison

A number of third-party rankings exist to illustrate the perception of relative regulatory burden in Philadelphia and Pennsylvania versus other locations. Four were examined for the purpose of this report: two from *Forbes Magazine*, one from the US Chamber of Commerce, and one from the Mercatus Center of George Mason University.

These rankings also indicate that Pennsylvania is considered a relatively average state compared with the states in which other comparison cities are located. A deeper look at the state rankings shows that Pennsylvania's regulations tend to track (in type but not in magnitude) those of the more regulatory burdensome states, particularly in terms of wage and labor laws. Pennsylvania compared very poorly against Texas, which was seen as being much less costly and a much more streamlined place to do business.

Selected third party rankings of state and local governments regulatory burdens for selected states and cities

Locality	Forbes – The Best Places for Business and Careers [1]	Forbes – Regulatory Burden - States [2]	US Chamber of Commerce – Employment Regulatory Burden - States [3]	Freedom in the 50 States – Regulatory Burden - States [4]
Philadelphia, PA	83rd / 200 Cities	20th / 50 States	Poor	31st / 50 States
Boston, MA	38th	42nd	Poor	36th
Cleveland, OH	113th	16th	Fair	21st
Dallas, TX	13th	15th	Good	24th
Fort Worth, TX	15th	15th	Good	24th
Houston, TX	25th	15th	Good	24th
Minneapolis, MN	23rd	32nd	Fair	18th
San Diego, CA	78th	40th	Poor	50th

Source: Econsult Solutions, Inc. (2013)

[1] "The Best Places for Business and Careers," Forbes Magazine (August 2013).

[2} "The Best States for Business and Careers", Forbes Magazine (December 2012).

[3] "The Impact of State Employment Policies on Job Growth, A 50-State Review," US Chamber of Commerce (2011).

[4] "Freedom in the 50 States, An Index of Personal and Economic Freedom", George Mason University (2013).

Programs and incentives

Overview

Programs and incentives often attract significant attention in economic development circles, as they are typically associated with high-profile business attraction initiatives. They come in many forms, and usually involve a form of financial incentive (grants, loans, tax credits and abatements) and/or some other useful resource that improves the competitive position of the recipient (land/infrastructure, workforce development, regulatory relief). Nevertheless, the existence of many programs and incentives is not necessarily the sign of a robust economic climate and, in fact, can indicate the opposite: struggling locations with high tax and regulatory burdens often require aggressive programs and incentives to compensate for their inherent disadvantages. Therefore, while cities and states should consider how to deploy programs and incentives, such efforts should not be at the expense of broader measures to foster a competitive climate for manufacturing firms.

Program and incentive comparison

In reviewing the economic development agencies of Philadelphia, comparison cities, and their host states, it was determined that all locations offer a wide range of program and incentive types. Cities and states tend to distribute incentives through formal programs as well as through customized responses.

Selected Programs And Incentives Offered By Philadelphia, Comparison Cities, And Their Respective States

Locality	Grants	Loans	Tax breaks	Land	Infra-structure	Regulatory relief	Workforce development
Philadelphia, PA	C	X	X			X	X
Boston, MA		X	S	C		S	X
Cleveland, OH	X	X	S	X			X
Dallas, TX	X	X	S	C	C		X
Fort Worth, TX	X	X	X	C			S
Houston, TX	S	X	X	C			S
Minneapolis, MN	S	X	S	X		C	X
San Diego, CA		C	X	S	C	C	X

C = city, S = state, X = both
Source: Econsult Solutions, Inc. (2013)

The research in this report indicates that all localities use a number of programs and incentives to attract and retain manufacturing firms. Notably, it also indicates that even those locations that have relatively low tax and regulatory burdens still aggressively deploy programs and incentives to woo establishments (see Table 4.2). As it was recently described in *Governing Magazine*:

> "Leaders have figured out how to combine the low-tax/low-regulation environment with financial incentives, the power of research institutions and the construction of critical infrastructure."

Selected programs and incentives offered by comparison cities and their respective states		
City of state	Incentive type	Description
Minnesota	Grant	Since its inception in 2008, the Growth Acceleration Program has funded 250 Minnesota manufacturing companies, which have created and retained 1,700 jobs in Minnesota, boosted company sales by $106 million, and saved these companies $16 million in business cost.
Dallas, TX	Loan	Southern Dallas Development Fund provides loans up to $250,000 for City of Dallas or Southern Dallas County businesses. Funds can be used for working capital, machinery, equipment or real estate.
Texas	Tax Break	State sales and use tax exemptions are available to taxpayers who manufacture, fabricate or process tangible property for sale. Companies that also use at least 50 percent of their electricity or natural gas for manufacturing may gain an exemption on natural gas and electricity.
Houston, TX	Land	The City of Houston Brownfield Redevelopment Program functions to facilitate the identification, assessment, cleanup and re-use of environmentally contaminated properties within the City of Houston.
San Diego, CA	Infrastructure	The Guaranteed Water for Industry Program provides an uninterruptible supply of water for manufacturing and R&D firms, many of whom are highly dependent on water for industrial processing and cooling needs. "Certified" water customers are "exempt" from mandatory water conservation measures in the event of a drought ("water warning") situation.

Source: Econsult Solutions, Inc. (2013)

Conclusion

As the US aggressively pursues pro-manufacturing strategies at the national level, Philadelphia must act decisively and significantly to create a business climate conducive to success for local manufacturing firms. To do so will help the local manufacturing sector usher in a new era of manufacturing success in a city rich in manufacturing history. To not do so will render local manufacturing firms disadvantaged against their non-Philadelphia competitors and less able to grow in size and in headcount, resulting in deterioration in the base of firms, jobs, and economic activity within the City.

Energy

Trends in the regional energy market

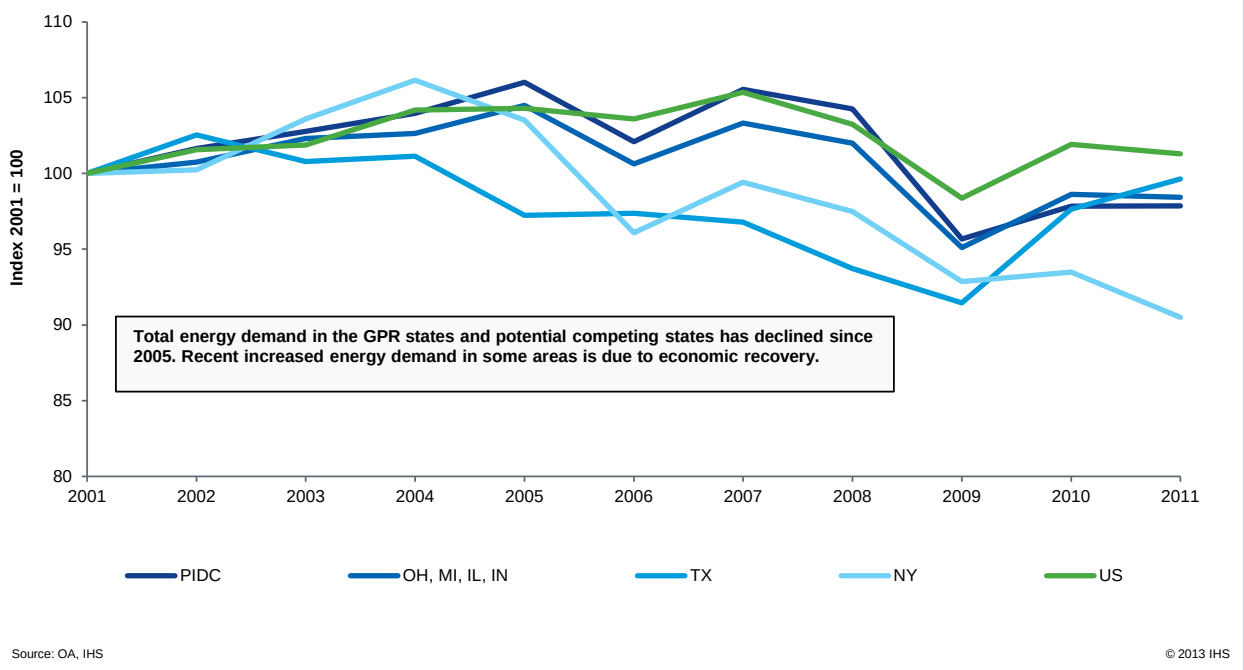
Both total energy demand and energy intensity, defined as the amount of energy consumed per unit of gross domestic product (GDP) made, in the Greater Philadelphia Region have fallen over the last several years. While energy intensity has fallen consistently for decades, the decline in the amount of energy used is a recent development. Going forward, significant growth in energy demand is not expected in the region or nationwide. Falling demand for energy is the result of three factors:

- The demand response to high oil and gas prices through 2008 and the on-going high oil prices since then;
- Higher energy efficiency standards resulting from government policies; and
- Maturing demographics and changes in attitudes regarding the need to own a car which are resulting in less driving and a drop in the demand for fuel.

While declining energy demand results in lower levels of energy expenditures, it can also result in increased unit energy costs to some consumers of natural gas and electric power. Because a significant

portion of a utility's 'costs are largely fixed regardless of the amount of energy delivered, the fixed costs are distributed across fewer units of energy consumption when demand declines, so that unit costs increase for customers even when amount of energy consumed falls. This shift has been seen since the middle of the last decade in several areas of the US, including the states in the Greater Philadelphia Region.

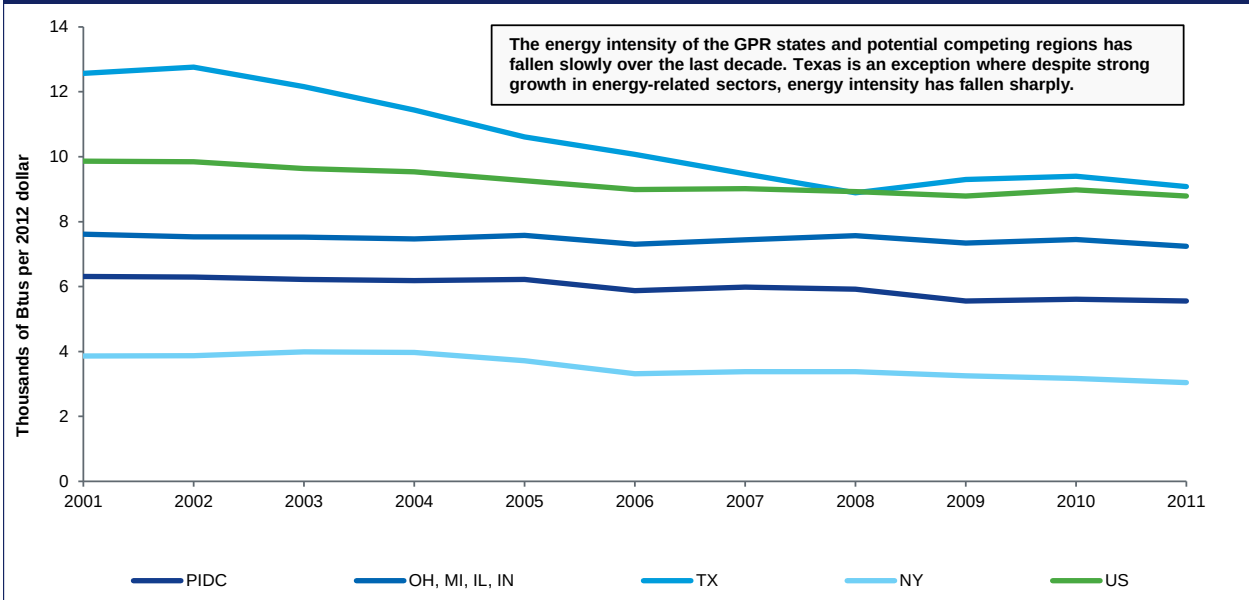
Total energy demand



Natural gas demand with the exception of coal displacement in electric power generation has been slightly lower to unchanged for the better part of the past decade. One implication for the region is that the cost of delivering natural gas and electric power may continue to increase to all but the largest of consumers without an increase in demand unless per-unit distribution costs can be reduced. Increased throughput in both the natural gas and power distribution systems is needed to keep unit energy costs from increasing. If demand for energy continues to decline, there will be fewer units of energy sold to cover fixed costs.

The energy intensity of the U.S. economy has been falling at a relatively steady pace for the last 25 plus years. The three states in the Greater Philadelphia Region have followed a similar path as the US average in terms of gradually declining energy intensity. Since the mid-1980s when oil was displaced in power generation by coal, nuclear and natural gas, the decline in energy intensity across the region and the US has been gradual and reflective of improvements in energy efficiency and capital stock turnover. Energy intensity could fall at a faster rate in the future due to the on-going effects of high energy prices and policy-driven measures that require even higher levels of efficiency.

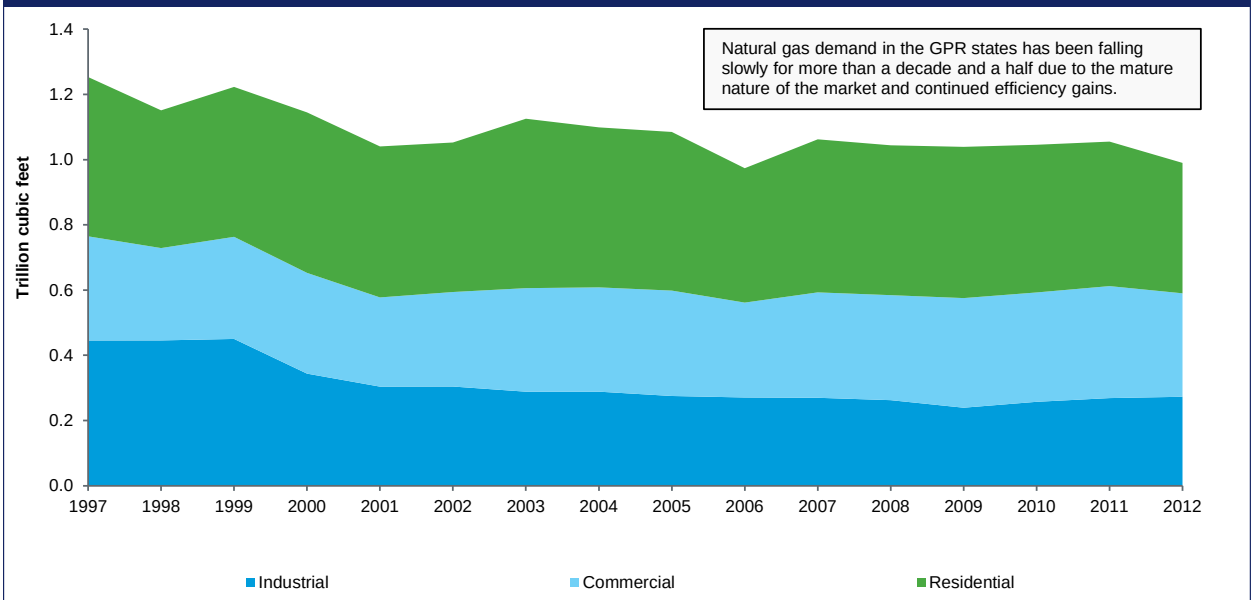
Energy intensity of the economy



Source: IHS © 2013 IHS

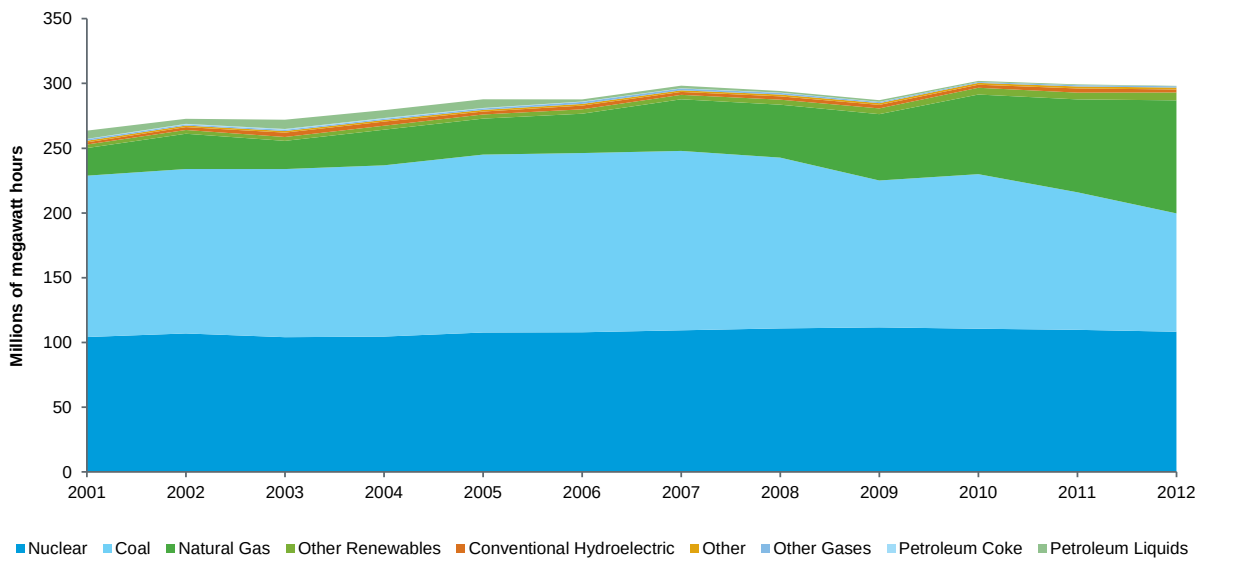
Natural gas demand in the industrial, commercial and residential sectors in the Greater Philadelphia Region peaked in 1999 and fell through 2006; since then demand has been relatively stable. Nevertheless, demand has grown substantially in the electric power sector due principally to the substitution of natural gas for coal. Total power demand in the Greater Philadelphia Region has been relatively unchanged for much of the past decade, which represents an inflection point in power demand; prior to 2004 electricity demand in the region had increased nearly every year since statistics have been kept.

Natural gas demand is mature in the GPR's states



Source: EIA © 2013 IHS

Trends in fuel used to produce electricity in DE, NJ, and PA



Source: EIA

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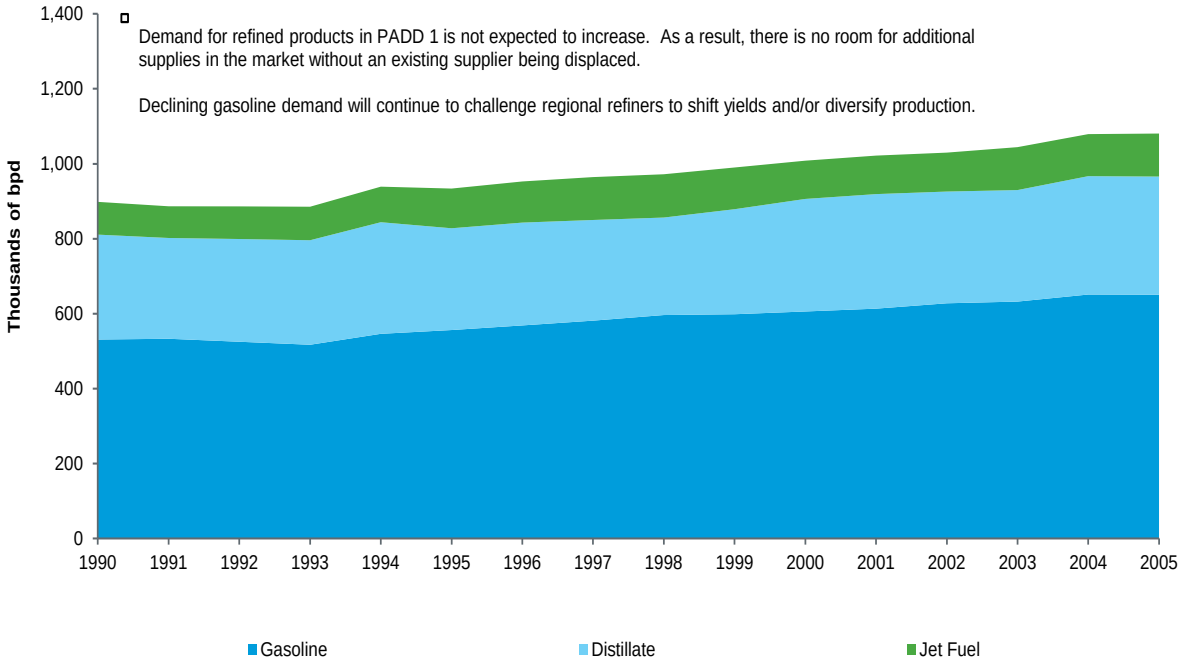
The demand for the major refined products (gasoline, jet fuel, and distillates) has been falling since the middle of the last decade due to rising oil prices and maturing demographics. High oil prices are continuing to push oil demand in the region lower through increasing efficiency and the substitution of lower-cost natural gas for distillates in residential and commercial markets.

Demand trends for refined petroleum products in PADD 1



Source: OA, IHS

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The decline in demand, along with the substitution of gasoline with ethanol, led to a one-third reduction in refining capacity in the US East Coast market from 2009 to 2012.

Demand for refined products in the region is not expected to grow due to the continuing impacts of high oil prices, government fuel efficiency standards, and demographics such as moderate population growth rates and even lower rates of household formation. As a result, refineries in the area will be under continued cost pressure from mature or declining demand and increasing supplies from lower cost refineries located along the US Gulf Coast to improve their competitiveness. Regional refineries will need to make continuous investments to reduce costs and diversify their production and customer base.

Regional refining market

Lower natural gas prices have been a significant benefit to regional refineries. The impact of low gas prices and a decline in North American crude oil prices relative to Europe due to shale oil, has given US East Coast refiners a competitive advantage over European and Caribbean refineries. As a result, US East Coast refineries are able to export substantial amounts of distillate to Europe and other markets. US East Coast refineries exported almost no distillates in 2005. Despite significant refinery closures, exports in 2012 reached levels equivalent to 35% of refinery production, and distillate imports from all countries, except Canada, have nearly been eliminated. Some refineries that have not had the benefit of lower natural gas prices in the face of weak demand such as those in Europe and the Caribbean have been forced to close.

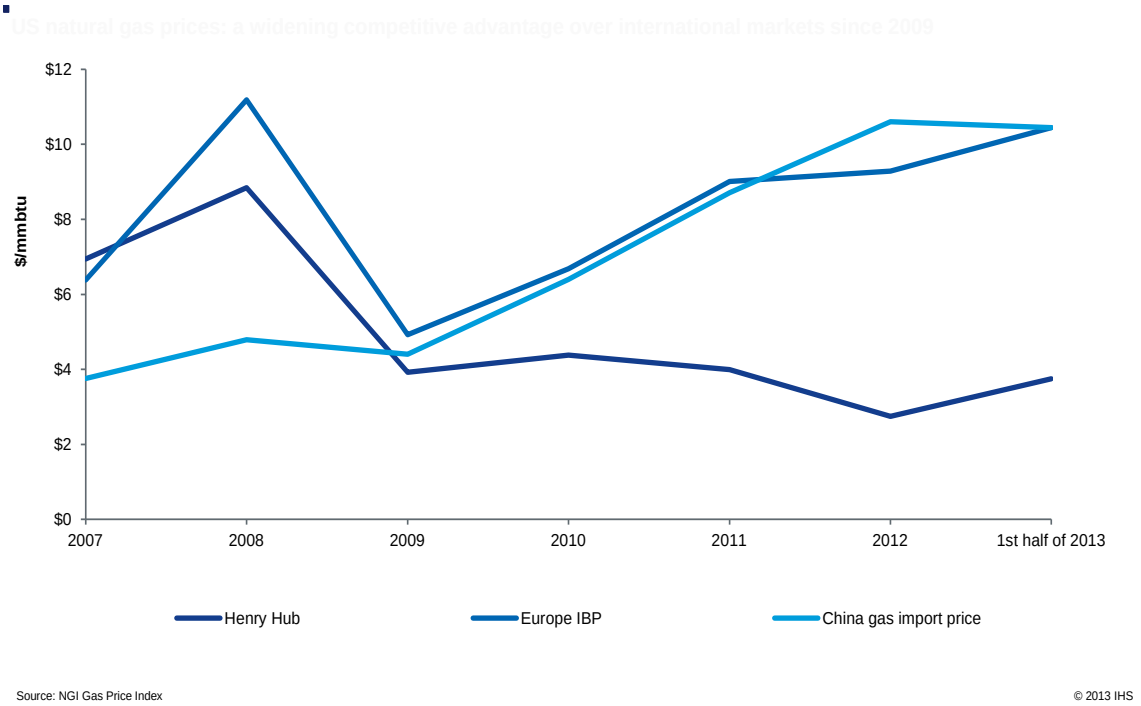
Regional refineries are of lower complexity and have lower average capacities than many of the refineries competing for market share in the region. As a result, regional refineries will continue to be challenged to reduce costs as low cost supplies from outside it increase and gasoline demand continues to fall.

Refiners in the region must be able to continue reducing their costs of production because refiners in competing regions are doing the same through lower crude oil costs and using their economies of scale that lower unit production costs.

Natural gas and electric power prices in the Greater Philadelphia Region

Since 2008, US natural gas prices have fallen dramatically relative to most other consuming countries. Natural gas prices in Europe and China, for example, are about 2.5 times higher than the US spot price for gas. US companies that use natural gas-priced based hydrocarbons for fuel or for feedstock now have a significant advantage over international competitors.

Falling natural gas prices have benefited all regions of the US regardless of proximity to low-cost shale gas resources. While natural gas prices in the three states that comprise the Greater Philadelphia Region – Delaware, New Jersey and Pennsylvania - have fallen, the three states still have higher delivered industrial and commercial natural gas prices than many other states. By contrast, the price of natural gas to the electric power sector closely matches the price to electric generators in many other states.

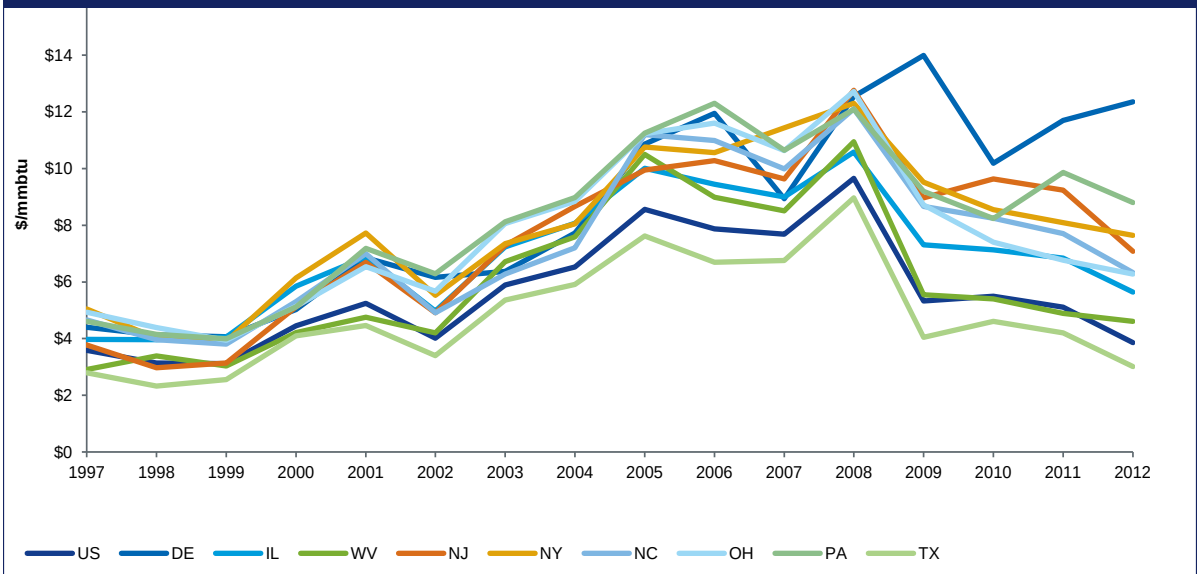


Lower natural gas prices have caused electricity prices to grow moderately in some states and to fall in many others. While power prices to the industrial sector in the Greater Philadelphia Region have fallen in the last few years on a state-wide average basis, they have fallen less and remain higher than many other states. The fact that electricity and natural gas prices for commericial and industrial customers remain higher in the three Greater Philadelphia Region states raises some key questions for policy makers to consider.

- Are the delivered, higher natural gas and power prices in the Greater Philadelphia Region states a significant barrier to the expansion of the manufacturing sector?
- Why are local gas and power costs higher than in other states? Is this due to some combination of transmission and distribution system capacity constraints, falling demand that can lead to higher unit costs as explained, or policy initiatives such as those that require higher-cost renewable energy sources to be part of the energy supply portfolio?
- Will increased supply of gas from the Marcellus area cause prices to move more in line with other regions? Pipeline infrastructure is changing to bring some increased supplies of natural gas into the Greater Philadelphia Region. Will more gas from western Pennsyolvania be price beneficial for commercial and industrial consumers?

If the levels of gas and power prices in the region are high enough to be detrimental to manufacturing development in the region, additional investment in the logisitics system or utility rate design changes may be required to reduce the unit delivered cost of energy relative to the levels in competing states and regions.

Prices of natural gas to industrial customers in the GPR states are higher than in most adjacent states



Source: EIA

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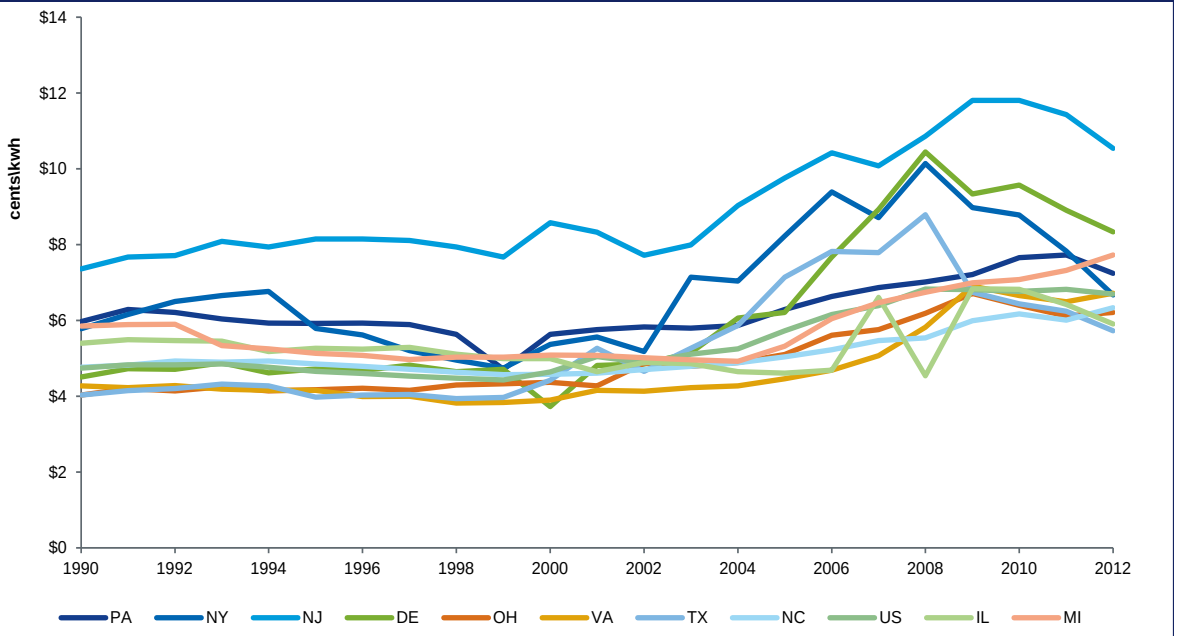
Prices of electricity to industrial customers in the GPR states than in most adjacent states



Source: EIA

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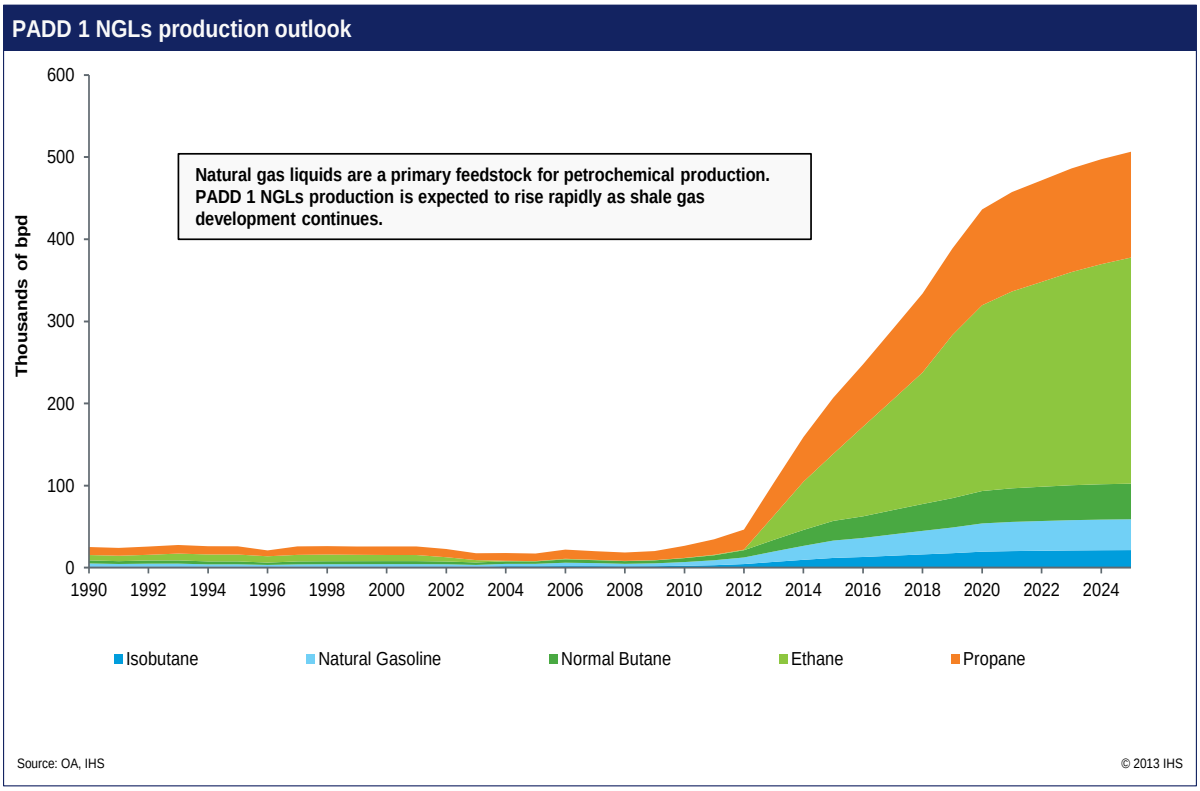
Natural gas liquids and petrochemicals

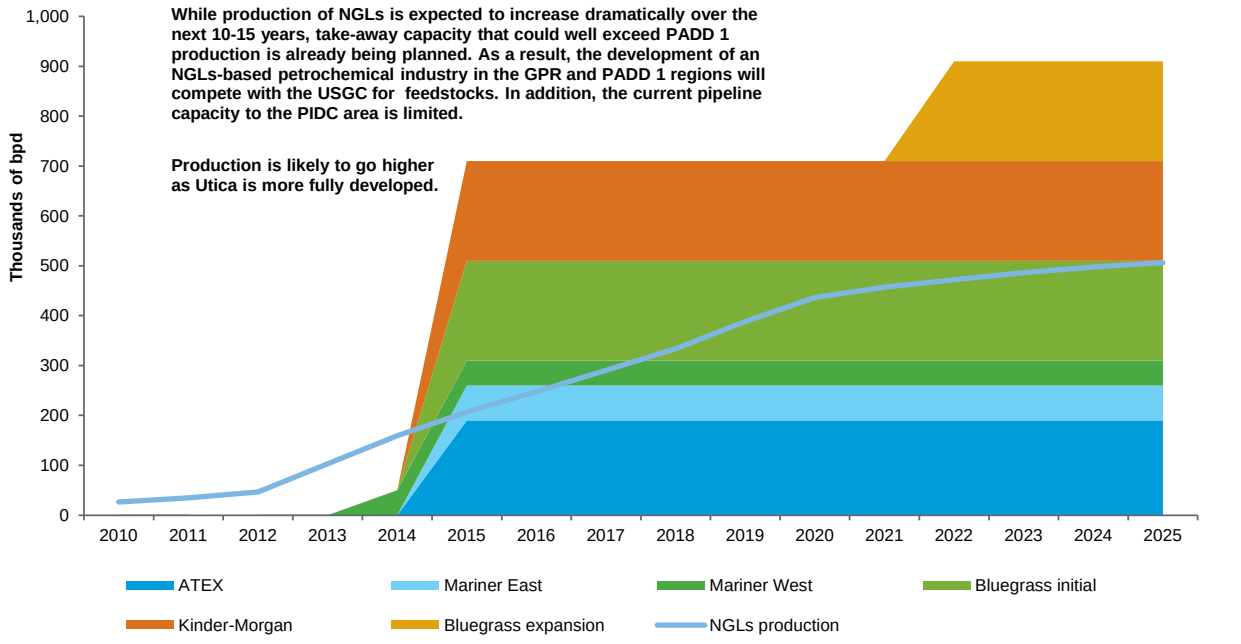
Natural gas liquids (NGLs) production is rising rapidly in the Marcellus region as natural gas production increases. NGLS are used as feedstock in the production of petrochemicals. While production is rising rapidly, the capacity of planned and proposed pipelines to take NGLs to the USGC and markets to the west exceeds expected production for years to come. One pipeline project - Mariner East - will deliver some propane and ethane to the Philadelphia area. However, the volume is designated for export and is not enough to support a robust petrochemical industry. Development of local industry would compete with exports for the marginal NGL supply.

In effect, the future supply of NGLs, which is an important petrochemical feedstock, available in the region may already be spoken for. In order for the Greater Philadelphia Region to access this supply, new NGL pipeline capacity will be needed and these projects will compete with the established chemical industry along the US Gulf Coast for the feedstock. NGLs need to be delivered to the Greater Philadelphia Region at a higher price than producers in western PA can obtain from buyers located along the US Gulf Coast; otherwise the NGLs will be sent west and south instead of east into the Greater Philadelphia Region.

A key question that should be addressed is what part of the petrochemical/chemical value chain is best for the area? Focus on base chemicals that use NGLs directly would require new infrastructure and manufacturing capacity and it would have to compete with well-established centers in the USGC. However, focus on industries and businesses that use derivatives and specialty chemicals produced in the USGC may bring a greater value to the local economy but will not directly use NGLs produced in western Pennsylvania.



PADD 1 NGLs production and proposed pipelines: What will it take to keep it from being exported out of the region?



Source: IHS

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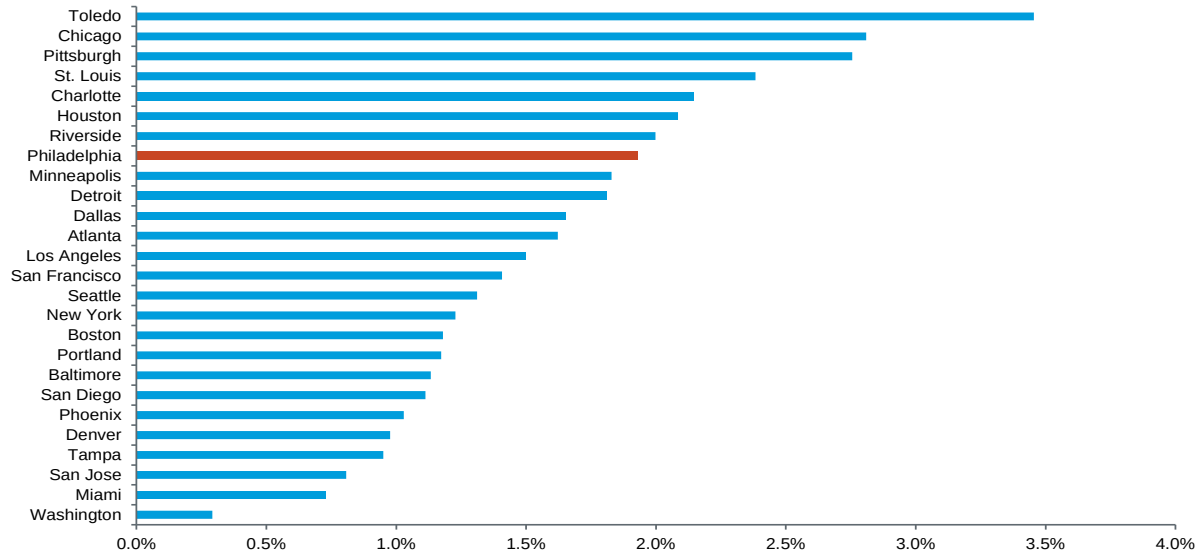
Energy-intensive manufacturing

Energy-intensive manufacturing in the region accounts for about 6.5% of sales and 2% of employment. Companies in this sub-sector, while comprising a small share of the overall regional economy, have already benefited from lower energy prices. By itself, the lower cost of energy should be an attraction for additional business and business expansion in the area. However, energy costs in other areas that compete with the Greater Philadelphia Region have also fallen and tend to be lower.

Energy intensive manufacturing employment share of total employment



Source: IHS

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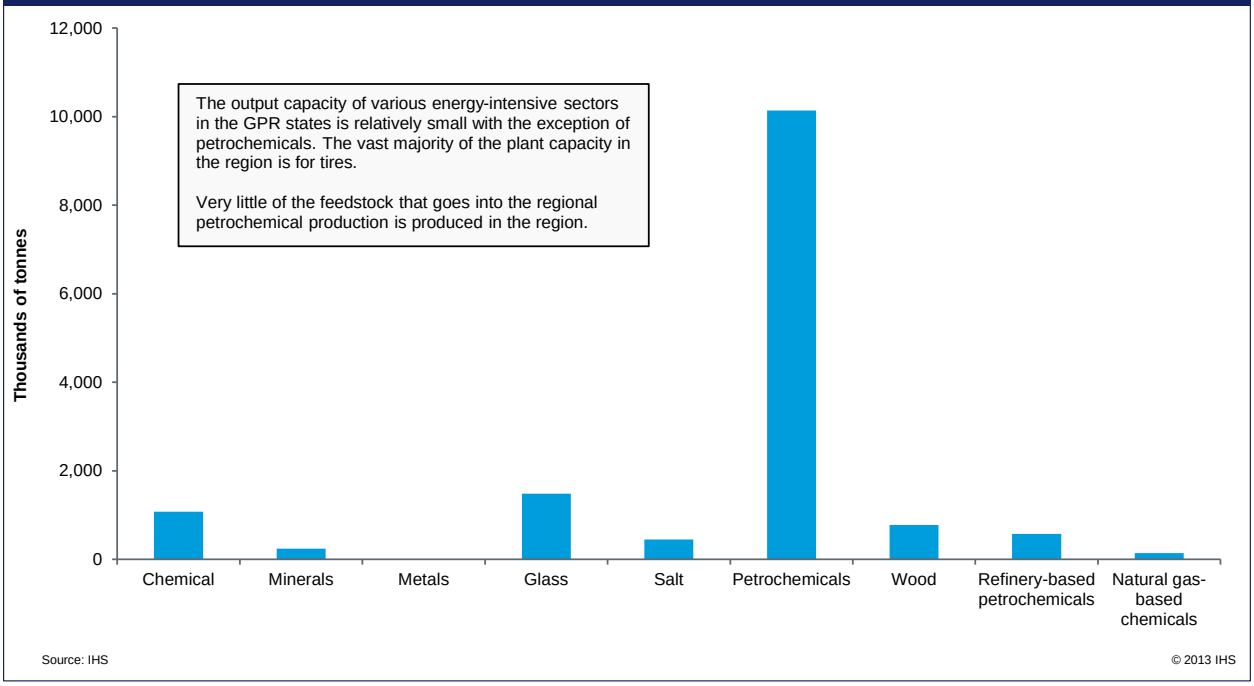
Energy-intensive industries, including chemicals and petrochemicals, are relatively small contributors to the regional economy and are highly concentrated, both in terms of location and because they are comprised of a few very large companies. These industries have a total annual production capacity of less than 15 million metric tons. Lower natural gas prices in the US have increased the competitiveness of the region's energy-intensive industries through both a lower cost of for energy used in the production process as well as lower feedstock costs for natural-gas based inputs.

GPR chemicals and energy-intensive industry capacity

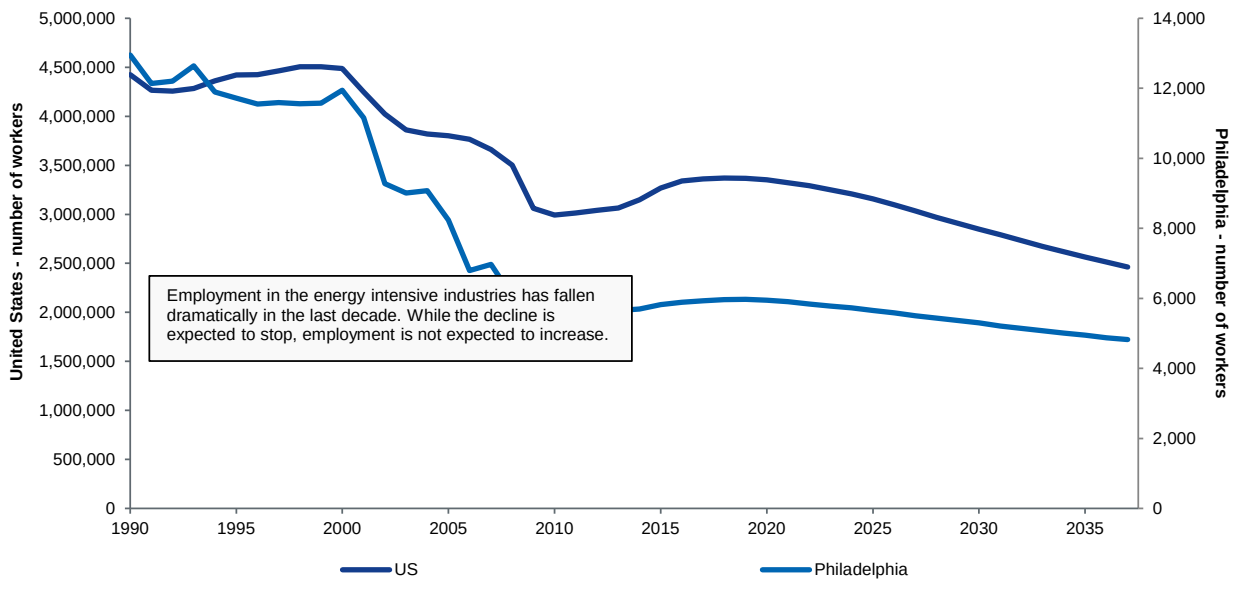


Philadelphia, like the US as a whole, experienced dramatic declines in both total manufacturing employment, and employment in the energy-intensive manufacturing sub-sectors between 2000 and 2010; this decline began long before the financial crisis and subsequent Great Recession. Natural gas and power prices were increasing rapidly across much of the US through most of this period. The conventional wisdom until late in the last decade was that energy (natural gas and electric power) prices would remain high due to the shortage of natural gas. The prevailing view at the time was that in order to meet the rising natural gas demand, incremental gas supplies would have to be imported as high cost liquefied natural gas (LNG).

The near-simultaneous reduction in demand due to recession and the explosion of supply from shale gas developments drove both natural gas and electric power prices to the lowest levels in over a decade in many parts of the US. Recently, the combined impacts of low energy prices and signs of economic recovery have contributed to a halt in the decline in employment in the energy-intensive manufacturing sub-sectors; nevertheless the rate of job growth in these industries is not expected to return to high levels. Output is expected to increase across many of the energy-intensive sub-sectors, but productivity gains are expected to keep job growth rates low. Increases in the supplies of, and reductions in the cost of, the energy supply will level the playing field for new industrial development in energy-intensive industries between the city and the Greater Philadelphia Region, and other areas of the US. However, factors other

than energy supply and costs will remain very important in determining whether potential growth in the Greater Philadelphia Region's energy-intensive manufacturing sub-sectors will be realized.

Employment trends in energy-intensive manufacturing sectors



Source: IHS

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Transportation and Logistics

The transportation and supply chain analysis focused on identifying national, inter-regional, and regional trade relationships consequential to sustaining and attracting new manufacturing. The analysis consisted of examining market relationships that exist between metropolitan areas based on the exchange of commodities and the movement of trade by different modes. This analysis illustrates Philadelphia's geographical, trade, and business line relationships with respect to the transportation services and infrastructure required to advance manufacturing.

Besides data gathering and analysis, a number of interviews were conducted with regional public- and private-sector stakeholders to solicit ideas and recommendations for further enhancing freight movement through the region and continuing to build manufacturing capacity. In summary, the key observations are as follows:

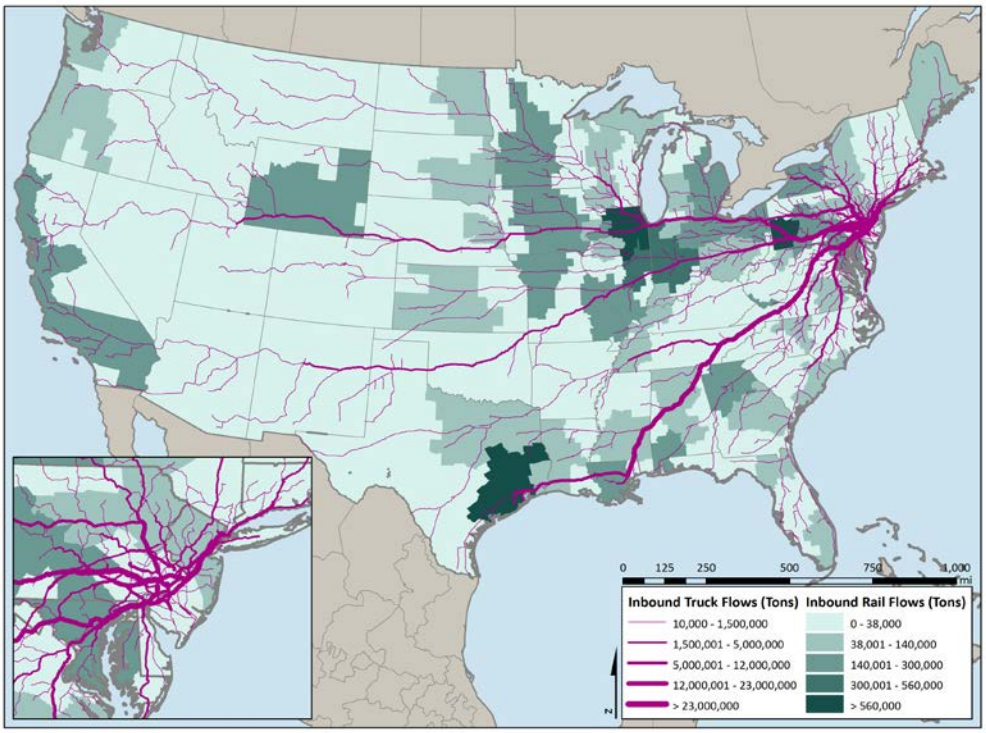
- Transportation infrastructure is largely adequate for Philadelphia's manufacturing needs in moving freight and passengers.
- The capacity of the rail network to carry crude petroleum to port is a potential area of improvement.
- There exist some concerns related to local congestion and intermodal connectivity, particularly between the port and the highway network.

- Philadelphia has strong commodity flow relationships with Houston, Chicago, and the Northeast and Mid-Atlantic U.S. regions, particularly in the shipping of chemicals and high value goods by truck.
- The Port of Philadelphia is currently served by two class 1 railroads - Norfolk Southern and CSX - that provide direct service to the facilities located on the west side of the Delaware River immediately north of the Philadelphia Navy Yard and Philadelphia International Airport.
- Some of Philadelphia's outer suburbs have significant numbers of manufacturing employees and are not served by public transit.

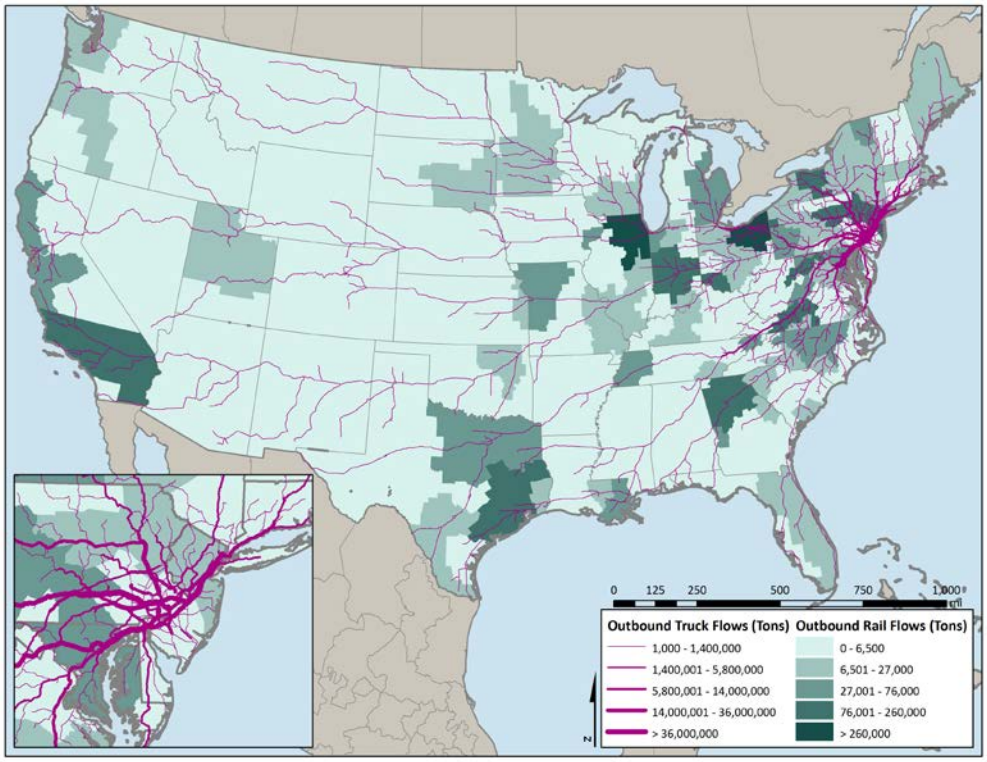
Commodity flows

The analysis of inbound commodity flows by truck and rail shows the spatial pattern of the origin of commodities that are sent into the Greater Philadelphia Region by the two modes. Rail flow origins are represented in green by the Bureau of Economic Analysis's (BEA) economic areas, and truck flows by county are assigned to the network and quantified through line thickness. The primary sources of goods coming into the Philadelphia region are Houston, western Pennsylvania, and Chicago. These regions are particularly important for the sourcing of materials for manufacturing. Truck flows, which are significantly higher than rail flows for all commodities, are heavily sourced from the Northeast and Mid-Atlantic regions. Some long-haul truck flows originate in Houston and the Midwest.

Inbound truck and rail flows



Outbound truck and rail flows



The analysis of outbound commodity flows by truck and rail shows the spatial pattern of commodities that are sent from the Greater Philadelphia Region to other markets. Whereas the inbound commodity flow map accounted for all commodity groups, the outbound commodity flow map includes only those commodity groups that are recognized as being manufactured products. Philadelphia's manufactured products are mainly shipped by truck rather than rail because of Philadelphia's position in the Northeast Corridor extending from Washington, DC to Boston. Long-haul shipment destinations by rail include Chicago and Cleveland primarily, but Atlanta, Houston, Los Angeles, and Indianapolis are also significant domestic destinations.

Top destinations for outbound truck flows from Philadelphia by value shipped (billions of $)

Destination BEA economic area	2011	Destination BEA economic area	2030
New York, NY	$ 110.6	New York, NY	$ 130.1
Washington, DC	$ 48.9	Washington, DC	$ 58.8
Boston, MA	$ 26.7	Boston, MA	$ 41.6
Harrisburg, PA	$ 11.2	Harrisburg, PA	$ 11.1
Buffalo, NY	$ 8.9	Norfolk, VA	$ 9.2
Philadelphia, PA	$ 6.7	Non-CMA, ON	$ 7.2
Norfolk, VA	$ 6.2	Philadelphia, PA	$ 7.0
Syracuse, NY	$ 5.1	Raleigh, NC	$ 6.4
Richmond, VA	$ 4.3	Syracuse, NY	$ 6.2
Pittsburgh, PA	$ 3.3	Toronto, ON	$ 5.8

BEA: Bureau of Economic Analysis
Source: IHS, 2013.

Top destinations for outbound rail flows from Philadelphia by value shipped (millions of $)

Destination BEA economic area	2011	Destination BEA economic area	2030
Chicago, IL	$ 1,100	Cleveland, OH	$ 2,300
Cleveland, OH	$ 995	Chicago, IL	$ 1,400
New York, NY	$ 284	Atlanta, GA	$ 474
Atlanta, GA	$ 257	Cincinnati, OH	$ 421
Los Angeles, CA	$ 220	New York, NY	$ 392
Washington, DC	$ 156	Los Angeles, CA	$ 363
Cincinnati, OH	$ 154	Toledo, OH	$ 308
Rochester, NY	$ 122	Pittsburgh, PA	$ 267
San Francisco, CA	$ 117	Dallas, TX	$ 214
Kansas City, MO	$ 114	Roanoke, VA	$ 208

BEA: Bureau of Economic Analysis
Source: IHS, 2013.

IHS's analyses of the metro area destinations of outbound commodity flows by truck and rail confirms that in 2011, the vast majority of outbound goods from the manufacturing sector are destined for BEA economic areas located in the Northeast Corridor: New York, Washington, and Boston are the top three. All of the destination economic areas for truck flows in 2011 are in the eastern U.S. In 2030, this will still likely be true, but Canadian destinations will account for more of Philadelphia's output. From 2011 through 2030, the New York economic area is forecast to be the top destination for manufactured goods shipped from Philadelphia by truck with a total value more than twice that for Washington, DC, which ranks number two.

Compared with the destinations by truck, the rail destinations include longer hauls. These include flows to the Midwest (Chicago, Cleveland, Cincinnati, and Kansas City), the Southeast (Atlanta), and the West Coast (Los Angeles and San Francisco). By 2030, the most significant change is that Cleveland will emerge as the top BEA destination for Philadelphia's outbound manufactured goods, which will more than double over the 2011 level. This change is in contrast to the top BEA economic area destination in 2011, Chicago, which only shows tepid growth through 2030.

The top commodity group by truck is petroleum refining products. This remains true through 2030, although the value of Philadelphia's petroleum refining product output decreases slightly in number and greatly in proportion of total flows (40% in 2011 to 27% in 2030). Outbound flows of pharmaceuticals, however, grow healthily from $21.1 billion in 2011 to $43.4 billion in 2030. Motor vehicles are not manufactured in the Greater Philadelphia Region, but are shipped here by sea as already manufactured goods and then distributed to other regions by truck.

Top commodities for outbound truck flows from Philadelphia by value shipped (billions of $)

Commodity type	2011		Commodity Type	2030	
Petroleum Refining Products	$	112.8	Petroleum Refining Products	$	106.0
Drugs	$	21.1	Drugs	$	43.4
Motor Vehicles	$	11.2	Motor Vehicles	$	23.9
Cosmetics, perfumes, Etc.	$	6.1	Cosmetics, perfumes, Etc.	$	10.5
Liquefied Gases, Coal or Petroleum	$	6.0	Misc. Electrical Industrial Equip	$	10.0
Misc. Electrical Industrial Equipment	$	4.8	Motor Vehicle Parts or Acc	$	7.2
Primary Iron or Steel Products	$	4.7	Primary Iron or Steel Products	$	6.5
Processed Milk	$	4.3	Processed Milk	$	6.0
Bread or Other Bakery Prod	$	4.3	Bread or Other Bakery Prod	$	5.9
Motor Vehicle Parts or Accessories	$	4.2	Misc. Plastic Products	$	5.4
Soft Drinks or Mineral Water	$	3.3	Solid State Semiconductors	$	4.7
Misc. Plastic Products	$	3.0	Misc. Prim Nonferr Smelter	$	4.0
Misc. Printed Matter	$	2.9	Soft Drinks or Mineral Water	$	3.9
Misc. Prim Nonferr Smelter Products	$	2.8	Paper	$	3.5
Cigars	$	2.4	Liq. Gases, Coal or Petroleum	$	3.4
All Others	$	87.9	All Others	$	141.0
Total	$	281.8	Total	$	385.3

Source: IHS, 2013.

Philadelphia's largest outbound manufactured commodity group by rail is primary iron or steel products, which almost triples from $1.1 billion (13.1% share of total) in 2011 to $2.9 billion (28.2% share of total) in 2030. In total, manufactured commodities shipped out of Philadelphia by rail will increase from $8.7 billion

in 2011 to $10.1 billion in 2030. It can be noted as well that trucks generally handle higher-cost commodities than rail.

Top commodities for outbound rail flows from Philadelphia by value shipped (millions of $)

Commodity type	2011	Commodity type	2030
Primary Iron or Steel Products	$ 1,100.0	Primary Iron or Steel Products	$ 2,900.0
Plastic Matter or Synth Fibers	$ 763.0	Plastic Matter or Synth Fibers	$ 841.0
Petroleum Refining Products	$ 553.0	Petroleum Refining Products	$ 771.0
Misc. Coal or Petroleum Products	$ 383.0	Steam Engines, Turbines, Etc.	$ 652.0
Inorganic Pigments	$ 294.0	Inorganic Pigments	$ 642.0
Misc. Fabricated Textile Products	$ 282.0	Misc. Coal or Petroleum Products	$ 528.0
Misc. Indus. Inorganic Chemicals	$ 265.0	Misc. Indus. Inorganic Chemicals	$ 522.0
Steam Engines, Turbines, Etc.	$ 209.0	Misc. Industrial Organic Chemicals	$ 335.0
Liquefied Gases, Coal, or Petroleum	$ 189.0	Candy or Other Confectionery	$ 280.0
Misc. Industrial Organic Chemicals	$ 158.0	Paper	$ 221.0
Men's or Boys' Clothing	$ 155.0	Drugs	$ 200.0
Furniture or Fixtures, NEC	$ 140.0	Furniture or Fixtures, NEC	$ 188.0
Candy or Other Confectionery	$ 126.0	Misc. Food Preparations, NEC	$ 143.0
All Others	$ 4,100.0	All Others	$ 1,900.0
Total	$ 8,717.0	Total	$ 10,123.0

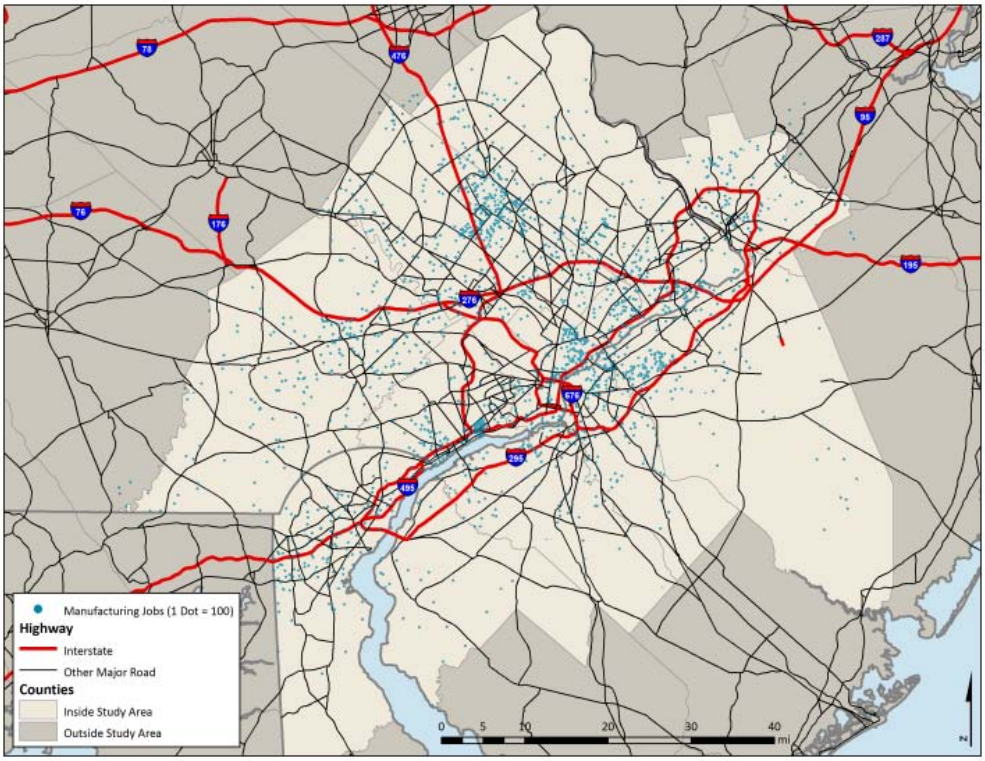
Source: IHS, 2013.

Transportation infrastructure: freight

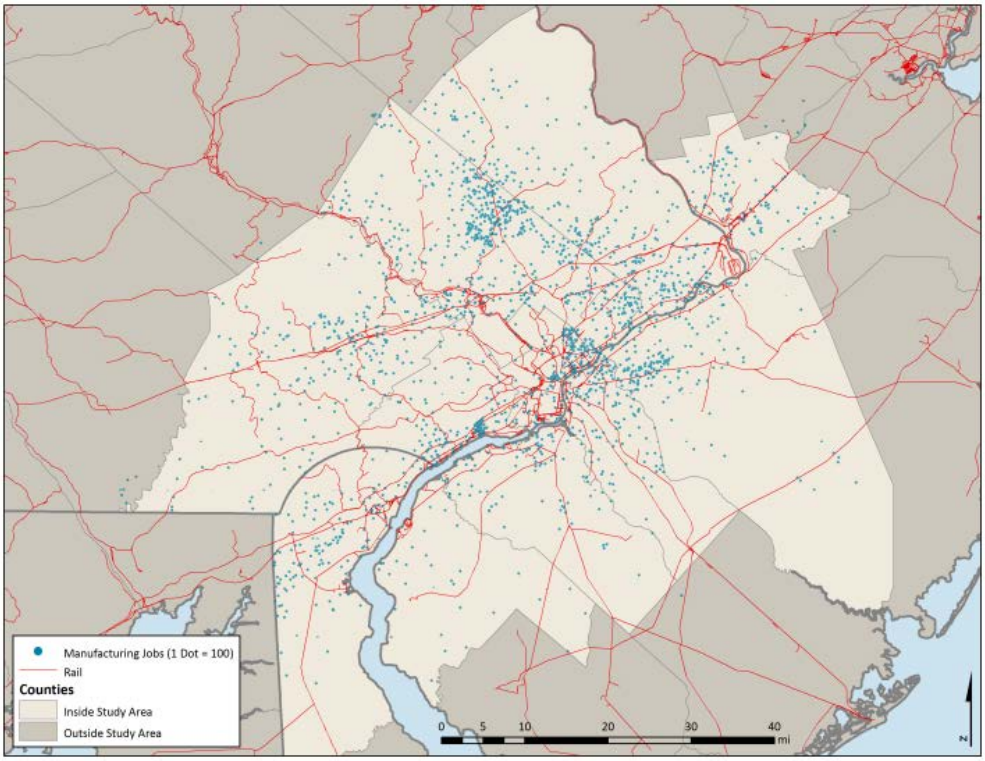
The capacity of the transportation network to serve manufacturing activity is a critical factor for a potential manufacturer to decide whether a site—or a region more broadly—is suitable for the location of a factory. The areas of Philadelphia with the largest numbers of manufacturing jobs, based on zip code tabulation areas (ZCTA), are Northeast Philadelphia, Olney, Center City, Port Richmond, and Frankford. Outside the city proper, Montgomery County and Delaware County have significant manufacturing activity, as well as Mount Laurel, New Jersey and Wilmington, Delaware.

The spatial analysis of the location of manufacturing jobs presents manufacturing jobs by ZCTA where one dot represents 100 jobs. These job data come from the U.S. Census Bureau's "On the Map" application. Manufacturing jobs are overlaid on road infrastructure and rail infrastructure. The analysis shows that Philadelphia's road and rail infrastructure generally serve the manufacturing clusters in the region adequately. Notably, the clusters along the Delaware River north and south of Philadelphia are well served by road and rail, as is the pharmaceutical manufacturing cluster in Montgomery County along I-476.

Manufacturing activity and road infrastructure



Manufacturing activity and rail infrastructure



Transportation stakeholders largely agree that Philadelphia's transportation infrastructure is generally adequate for manufacturing activity. Furthermore, there is widespread agreement that the Delaware Valley Regional Planning Commission (DVRPC)'s goods movement taskforce has galvanized key stakeholders and has been addressing freight planning and identifying infrastructure investments that would further streamline regional freight movement. Nevertheless, several actual and potential infrastructure challenges were identified by transportation stakeholders as important to address to attract manufacturers. These include:

- Maintenance and improvement of the Philadelphia region's roads and bridges is crucial for attracting manufacturers. As a state, Pennsylvania has the highest percentage of structurally deficient bridges in the U.S.[5]
- Streamlining traffic flow to the Port of Philadelphia could be beneficial to manufacturers' exporting activities. Specifically, there is room for improvement in the intermodal access between the port's facilities and the highway and rail network.
- There have been some deficiencies in rail capacity to move crude petroleum into the Port of Philadelphia, particularly from the Bakken formation in North Dakota. Given how new this supply chain is, it is unclear whether this indicates an actual infrastructure gap or a lag in operational capacity. The DVRPC has already identified some of these deficiencies and is addressing them.
- The ability of the major rail companies in Philadelphia to share physical infrastructure with SEPTA and Amtrak could pose a problem if these agencies increase operations. More oversight in the relations between passenger and freight rail companies may be necessary if problems arise.

There are already significant improvements to transportation infrastructure being carried out in the region across all modes. The Port of Philadelphia is around 60% complete in deepening the main navigation channel of the Delaware River from 40 to 45 feet. There are also plans to build Southport, a new container terminal that will be located at the east end of The Navy Yard; it would be the first new terminal in Philadelphia in 40 years. Construction of Southport is scheduled to begin in late 2014 and the first component of the project is projected to begin operating in 2018. Rail infrastructure is also being improved, mainly through adding double stack clearance to key lines into and out of the city. Some road infrastructure projects are also improving the ability for manufacturers to access the limited access highway network.

Transportation infrastructure: journey to work

Another important consideration for manufacturers is the ability of workers to access their facilities. Adequate road access is crucial for the freight activities of most manufacturing companies, but it is also necessary for the movement of workers to their job sites. Public transit access is important for manufacturing sectors that employ low-income workers who may not own automobiles. Additionally, there is a growing trend among younger, highly educated people to choose not to own an automobile and rely on either public transit or active transportation (or a combination of the two). This is particularly true in denser cities with robust public transit systems like Philadelphia. This trend could be true for some of

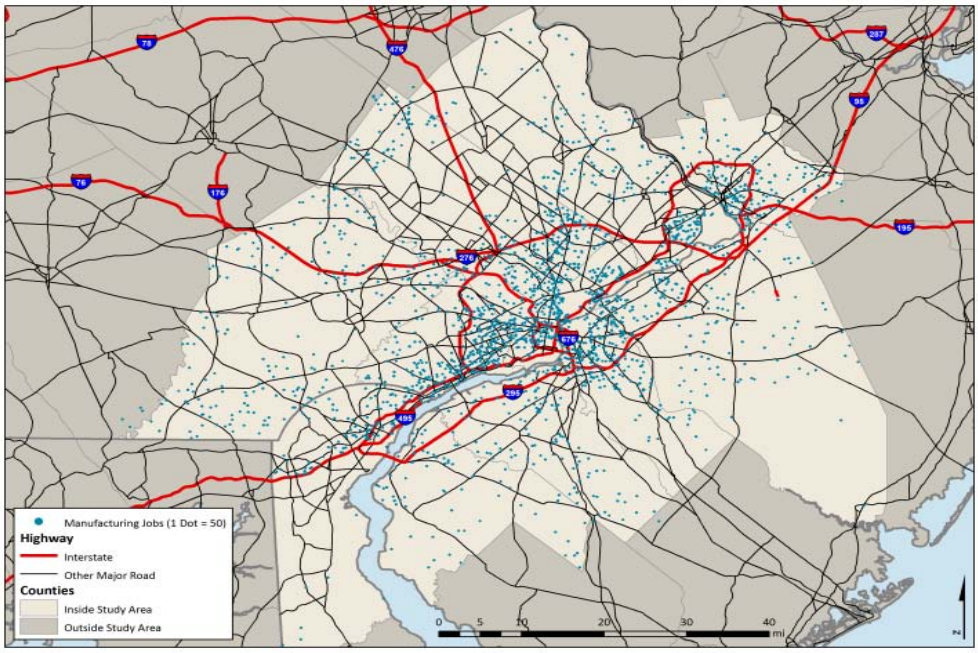
[5] Pennsylvania Department of Transportation, 2013. http://www.dot.state.pa.us/

Philadelphia's manufacturing sectors that employ this demographic, such as pharmaceuticals and high-tech manufacturing.

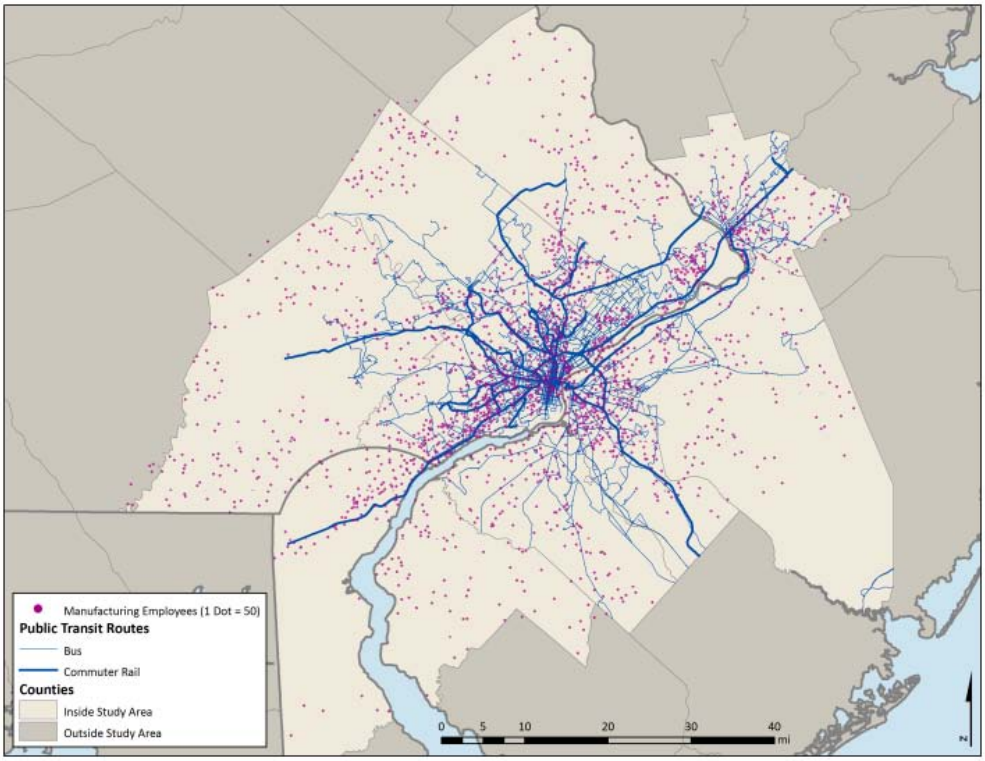
IHS analyzed the spatial distribution of high concentrations of manufacturing workers' residences in relation to road and public transit infrastructure. In these two analyses, one dot represents the residences of 50 persons employed in manufacturing. These employment figures were obtained from the U.S. Census Bureau's "On the Map" database. In the public transit infrastructure analysis, the thick blue lines represent passenger rail lines and thin blue lines represent bus routes. The public transit map represents the infrastructure of both SEPTA and New Jersey Transit.

In Philadelphia, the neighborhoods with the highest concentrations of residents employed in manufacturing in a ZCTA are Olney, Fox Chase, Port Richmond, Frankford, and Mayfair, all of which are in North and Northeast Philadelphia. These inner-city clusters of manufacturing employee residents are well served by road and public transit given Philadelphia's robust transportation infrastructure. However, given the nature of available data, it is uncertain whether workers' destinations are accessible by public transit.

Place of residence of manufacturing workers and road infrastructure



Place of residence of manufacturing workers and transit infrastructure



In the surrounding region outside Philadelphia proper, the towns with the highest populations of persons working in manufacturing are Lansdale, Coatesville, Quakertown, and Bensalem; all of them are in Pennsylvania situated west and north of the City of Philadelphia in Montgomery, Chester, and Bucks Counties. Some areas outside Philadelphia are well served by public transit. There are commuter rail lines serving some of these inner suburbs, but Quakertown is one that is not served. Other clusters of manufacturing workers exist in outer suburbs (e.g. northeast Montgomery County and southwest Chester County) that have no access to public transit.

Conclusions

Philadelphia's central position in the Mid-Atlantic region—with its close geographical proximity to the New York, Washington, Baltimore, and Boston markets—provides the region with a unique advantage for attracting and retaining manufacturing activity. Furthermore, Philadelphia has robust transportation infrastructure as a result of its important role in the industrial revolution in the United States. These transportation assets, including a major seaport, an international airport, rail infrastructure, several major interstate corridors, and an extensive public transit system, give Philadelphia a good competitive standing for manufacturing, all other considerations aside. We have included a comparative analysis of the primary advantages and disadvantages of each of the City's and the Greater Philadelphia Region's primary transportation modes.

The Port of Philadelphia is a major advantage to the region for manufacturing given its ability to handle container ships and food, two shipping modes that are consequential to Philadelphia's current

manufacturing makeup. The Delaware River channel provides the possibility for privately operated ports as well, such as those found south of Philadelphia in Marcus Hook. The Philadelphia Airport similarly gives the region an advantage as an international port with a United Parcel Service (UPS) cargo facility, particularly for Philadelphia's manufacturing sectors that ship products by air (e.g. pharmaceuticals, technology). Although plagued with congestion in recent years, the airport is undergoing a major expansion, part of which includes the movement of the UPS facility.

The presence of two major railroad operators in the Philadelphia region, CSX and Norfolk Southern, affords manufacturers competitive options for shipment by rail. Although some track sharing tension arises in those operators' relationships with Amtrak and SEPTA, the physical infrastructure in the Philadelphia region is extensive. Manufacturers in the Philadelphia region have found success in developing goods for consumption in local markets, which are served primarily by truck. The region's highway infrastructure has been adequate in moving these commodities.

TASK THREE: DEVELOP STRATEGIES FOR GROWTH

Manufacturing Growth Strategies

After substantial consideration of both the foundational assessments and testimony by the Task Force and Advisory Group members, the following 13 priority strategies are being recommended and are described in detail below. The recommendations focus on 6 broad categories – 4 of which represent the foundational issues analyzed by the Task Force in the previous section of this report and 2 which reflect themes that emerged during the work of the Task Force, specifically Access to Capital and Advocacy, Networks & Business Development. In each of these broad categories there are brief descriptions of a number of supporting recommendations that reflect issues of concern to the Task Force as well. It should be noted that while these recommendations are described individually, they are intended to be deployed as part of a comprehensive strategy to support and grow the manufacturing sector in the Philadelphia region. As such, many of the recommendations will interact with and reinforce the other recommendations.

Talent

The City of Philadelphia increasingly faces a skills mismatch for manufacturing workers with the skills required by employers in three distinct dimensions. The first is a relatively low level of basic skills and job readiness possessed by a large number of applicants for entry-level production manufacturing jobs, as evidenced by the 40% dropout rate from the Philadelphia School District, and by the high unemployment rate and the low labor force participation rate of young, working-age adults. The second is the low level of penetration (5% or less) of existing workforce programs into the region's manufacturing base, due in part to the level of government funding involved versus private-sector funds. The third dimension of the problem is the relatively low take-up rates by students where manufacturing-oriented education and training programs are offered. The low take-up rates become an issue as many of the region's most skilled manufacturing production workers are approaching retirement. Without an adequate supply of younger employees to replenish and sustain them, manufacturers in the region will face a workforce shortage in the coming years that will threaten their competitiveness. This crisis and the demand for skilled technicians it will create also represent an opportunity to re-align technical training in the region to meet the demands of industry.

Expand technical training opportunities provided by community colleges that are aligned to the needs of the manufacturing sector.

Establish a manufacturing training program at the Community College of Philadelphia and expand the number of programs offered by the other community colleges in the region that are directly aligned to the manufacturing sector. This is envisioned as similar to the numerous technically-focused certificate and degree programs community colleges offer to support the healthcare sector. These manufacturing technician programs should focus on both students enrolled in degrees or those seeking certification in specific skills, techniques or equipment. The existing curricula should be updated as needed and new

courses developed in close coordination with manufacturers to identify the competencies needed, and to determine the level of demand for the students. The Pennsylvania College of Technology in Williamsport, PA represents a best-in-class model for the industrial training programs necessary to support manufacturing that should serve as a guide for the types of training needed.

Community colleges are well-positioned to meet the needs of both students matriculating from high schools and adult workers looking to acquire new knowledge and competencies. To the extent practical, educational opportunities should be provided at, or close to, work sites, or at centrally located, easily accessible facilities such as public schools and municipal buildings. Locally, the Collegiate Consortium for Workforce and Economic Development (a partnership of Drexel University and five regional community colleges to provide advanced technical training) represents a model for leveraging existing programs and assets to delivering customized manufacturing training. Using the Consortium model, employees receive can training on-site or at one of the participating schools depending on the specific equipment or processes involved.

This strategy would be led by the 10 community colleges in the region, especially those serving urban areas where entry-level jobs in the manufacturing sector offer career paths. Other participating organizations would include industry trade associations; manufacturers; public school districts with large career and technical education programs and STEM/technical high schools; and manufacturing industry associations. Support would be required from community colleges to develop the curricula, fund, and administer the courses, and from industry partners who would provide industry knowledge, funding, and other types of in-kind assistance.

Focus high school career and technical education schools in STEM subjects and competencies needed in manufacturing.

High school career and technical education are becoming increasingly important sources of skilled, manufacturing workers for entry-level production positions. Older models of providing extensive on-the-job training for new hires are becoming increasingly burdensome to manufacturers in response to competitive pressures to operate at high levels of efficiency. While company- and job-specific training will always continue, employers increasingly need entry-level employees to possess a baseline level of skills in order to remain competitive. Better aligning the foundational skills of graduates from high school career and technical education programs will meet manufacturers' needs by providing them with a pool of new hires that will be able to efficiently operate increasingly complex machinery and equipment upon hiring, or shortly after.

The region is not starting at ground level. Existing career and technical education programs currently offer a wide range of technical courses and National Occupational Competency Testing Institute certifications. Adjustments to the content of existing courses will be required to ensure they are capable of meeting rising employer need for technical competencies in production positions. In addition, the scale of existing programs will need to increase to meet the increased demand for skilled graduates.

The academic content of career and technical education courses should be maintained and enhanced, as this will improve the ability of graduates to advance in their careers and to attain higher certificates and degrees if they desire. Based on market demand, new courses and accompanying National Occupational

Competency Testing Institute certifications should be added that provide knowledge and competencies in technical disciplines needed to maintain and improve manufacturing processes, as well as participate in manufacturing companies' research and development, product development, and other non-process activities. These programs should also offer practical opportunities for the students enrolled to receive on-the-job training opportunities through formal internships and apprenticeships at area manufacturers. One model for this type of education is the Lehigh Career & Technical Institute located near Allentown, PA which offers high school students training ranging from electronics nanofabrication to welding to precision machine tooling on state –of-the-art equipment, with instructors who have significant experience applying these same skills and processes in the private sector.

Innovation

The Philadelphia region has long been a major center for discovery and innovation in the United States. Important discoveries and inventions from ENIAC (one of the first practical computers), to advanced materials like Kevlar, and even basic tools used every day such as the revolving door and the pencil with an eraser were made in the region. Fast forwarding to 2013, the Region continues to remain an important source of innovation for the US economy. Greater Philadelphia consistently ranks among the top seven of the nation's largest metropolitan statistical areas (MSAs) in such innovation metrics such as total patents generated, patent award rates, innovation research awards, presence of major R&D university, number of certificates and degrees in STEM disciplines awarded by college and university, and in R&D spending by the public and private sectors. Nevertheless, the region has begun to lag the nation as a whole, and in particular, other large MSAs such as Boston and San Francisco, as centers of innovation in developing and commercializing new technologies and ideas. The City specifically has fallen off substantially over the last 20 years.

Philadelphia's ability to remain competitive in the "knowledge economy" requires increased focus and attention on expanding both the potential for innovation and entrepreneurs' ability to turn new products or processes into new ways to bring additional revenue to the region. As creating a technology or leading innovation is not the same as capturing its economic value, an area's capacity to capture the commercial value of innovation depends largely on the presence of institutional technology transfer framework, the ability to attract venture funding new business start-ups, and a supportive environment for entrepreneurs. In each case, Philadelphia performs at or slightly below the nation. Innovation-focused strategies in Philadelphia must do more, not only to launch new businesses, but also to help existing firms come up with more efficient, creative, and cost-effective ways to design, manufacture, and sell their products.

Expand linkages between university design programs and manufacturing firms for product development and innovation.

Interviews and research conducted during this study identified a wide cohort of companies where product and process innovation were critical components to their competitive advantage. However, their small size and limited development budgets have made continual product innovation difficult. To remedy this, university product design programs should be formally linked with local manufacturing companies. Such an effort will provide Philadelphia with an opportunity both to develop manufacturing talent and provide low-cost, novel ideas to the existing manufacturing sector. Philadelphia already has a handful of industrial

and product design programs, including Philadelphia University, Drexel University, the University of Pennsylvania and the University of the Arts that should be integrated into this effort. Students in these programs would benefit from working with seasoned manufacturing professionals and have a chance to apply classroom learning in a real-world environment. Philadelphia's manufacturers would benefit from the innovative product or process ideas generated, while also getting a first pick of the region's product development talent.

Regional associations of manufacturing companies could play a convening role and involve other local business membership organizations, as well as representatives from the area's colleges and universities. Taking the steps described above will provide smaller manufacturers access to additional product development and design assistance that can increase their competitiveness, improve their operating margins, and/or create new business opportunities.

In addition, we recommend expanding opportunities for manufacturing companies to partner with colleges and universities to support, participate in, and commercialize the results from applied R&D. This would include maintaining and establishing new innovation centers or incubators in facilities where manufacturing entrepreneurs and university researchers can meet to discuss potential teaming arrangements. Examples of models for this more formal collaboration range from include the Delaware Valley's Industrial Resource Center's Advanced Manufacturing Accelerator program focused on transportation equipment manufacturing and the use of composites in fabrication.

Access to Capital

Capital is the lifeblood of any business. Companies interested in diversification, product development, or geographic expansions need financial capital to make the initial investments or support the "carrying costs" of new strategies. Most of the companies interviewed for this study shared that their ability to pursue growth opportunities is constrained by providing their own working capital to meet their regular cash flow needs, as well as when making investments in new products, markets, or facilities. As a result, new sources of capital are required, both to help existing manufacturing businesses remain sustainable through growth periods and to support the development of manufacturing start-ups. Providing venture capital for the start-ups and younger companies that are performing research and development, developing new products, and scaling up production to commercial scale that do not yet have a financial track record is an especially important need. The Delaware Valley's Industrial Resource Center's Regional Manufacturing Fund is an example of a current working model.

Create new loan and/or equity funds targeted specifically to small and mid-sized manufacturers investing in product development and innovation.

Providing growth capital is critical to the long-term sustainability of the Philadelphia's entrepreneurial community, particularly existing, small, product-based businesses and tech start-ups. Venture or growth debt is a rapidly emerging field. Venture debt fills the gap between conventional bank lending and venture equity investments. It is not for early-stage companies. Venture debt is flexible growth capital for companies that have a demonstrated customer base, generate revenue, and/or are cash flow positive. It does not dilute ownership levels. Typical uses for this type of financing tool include development of pilot facilities, or scaling up of production lines, among other uses. Typically these are secured interest-only

term loans of less than five years, with balloon payments. Sometimes convertible warrants are included. Legal covenants regarding uses and requirements tend to be less restrictive than conventional lending, private equity, and governmental loan programs. Nationally in 2012 an estimated $2 billion in venture debt was provided to 280 companies.[6] The Small Business Administration's Small Business Investment Company program reported $3.2 billion in financings for 1,094 companies.

Growth capital is a particular need of any business. The ability to fully maximize a business opportunity may be limited by the availability of capital, particularly risk capital. During the interviews for this study most small manufacturing firms are funded through their cash flow, major investment in new products or technologies is difficult if there is a substantial upfront capital requirement. These types of targeted funds would offer an alternative to funding major investments in new products or technologies from cash flow alone. For late-stage venture firms, venture debt provides the ability to build out the business without seeking additional dilutive capital.

Expand access to flexible business loans for small equipment purchases and working capital.

Philadelphia has a robust and active lending community; however, a gap appears between the demand for small and medium-sized enterprise credit and the requirements to access traditional capital, usually the result of the company's inability to meet one or more prerequisites that most banks require. Low debt service coverage ratio, insufficient equity, and weak collateral are some of the obstacles these businesses confront when trying to access capital from commercial banks and are turned down. Current market forces have heightened these challenges and many small businesses cannot access sufficient private capital and subsequently face financing gaps or interruptions. To address these shortfalls, small manufacturing enterprises will often use business/personal credit cards or home equity loans to finance small equipment purchases or working capital.

A May 2006 study by the National Community Reinvestment Coalition examines lending performances of financial institutions and illustrates that small businesses in minority and low-moderate income census tracts have unmet credit needs. The Community Development Financial Institutions (CDFI) Fund was established in 1994 to promote economic revitalization in low-income communities lacking access to affordable financial products and service. CDFIs are a source of low-cost capital in the form of senior debt, subordinated debt, and equity investments for projects in low-income communities. Their investment dollars from larger commercial or investment banks who lend to CDFI's to fulfill their Community Reinvestment Act requirements. CDFIs are in a unique position to provide working capital and/or smaller loans to businesses that may be commercially viable but do not meet the stringent credit and collateral requirements of traditional banks. Examples of CDFIs currently operating in Philadelphia are Finanta, the Women's Opportunity Resource Center, Entreprenur Works, The Reinvestment Fund, and the Philadelphia Industrial Development Corporation. Expansion of these and other organizations' lending capacities under the CDFI programs would be healthy not only for small manufacturers but for the entire business community.

[6] Joe Spinelli, *Venture Debt as Growth Capital, You Bet*. Xconomy.com 5/21/2013

The City of Philadelphia should continue to proactively market itself to potential Community Reinvestment Act investors, using the considerable resources of the banking. Goldman Sachs investment in PIDC as part of its *10,000 Small Businesses* (10KSB) program is an example of the type of capital needed by manufacturers. While not limited to manufacturing firms, the 10KSB program has included Philadelphia-based manufacturers and provides access to capital, a practical business education, and business support services. Attracting more investment to the city's CDFIs will provide more capital to be geared towards small businesses and in this case, manufacturers. With more access to flexible capital, growth in manufacturing can occur.

Advocacy, Networks and Business Development

The long-term decline in the size of the city's and the Region's manufacturing sectors has been well documented, especially the loss of high-paying jobs to other states, and to other countries through off-shoring. This decline has created the misperception, both locally and nationally, that manufacturing is no longer important to the economy, and that the sector does not have enough well-paying jobs with career potential. In response, some US regions have begun informing residents about the economic importance of manufacturing and the benefits of supporting it through "buy-local" programs as manufacturing typically has high economic multiplier effects through its backward or supplier linkages. As noted previously, rising productivity per worker generated by technological innovation, and the use of more complex equipment, manufacturing production jobs increasingly require highly skilled workers with a broader set of technical competencies and more knowledge in the STEM disciplines. As a result, advocacy programs, conducted in partnership with educational institutions, inform secondary students about the complex, high-technology job opportunities, wages, and career pathways that can be expected within the manufacturing sector.

Conduct an image campaign to educate students, parents, teachers, and guidance counselors about employment opportunities in manufacturing.

Develop a series of outreach programs to inform students, parents, teachers, guidance counselors, and workforce professionals about the job opportunities that exist in today's manufacturing industry. The programs should emphasize aspects such as the high level of skills now required from manufacturing workers; the career paths that extend from entry-level jobs to high-paying positions; that the current manufacturing workplace is very different from that of the past; and the opportunities that exist to make interesting, high-tech goods. The image campaign should also show that choosing jobs in the manufacturing sector does not prevent students from eventually obtaining bachelor's degrees and higher. Opportunities to familiarize students in Philadelphia middle and high schools with the range and complexity of products made in the region through field trips to manufacturers, expos, and in-school events should be explored to reinforce the perception that modern manufacturing is a desirable and attainable career choice. The strategy would increase the number of students considering careers in manufacturing, and over the long term, hopefully increase the supply of skilled manufacturing workers in key occupations that are in short supply.

Conduct a focused business attraction campaign to publicize Philadelphia's current competitive advantages for the manufacturing sector.

The competitive advantages of the Greater Philadelphia Region for certain types of manufacturing activities have increased because of the availability of competitively priced supplies of natural gas and natural gas liquids from unconventional energy resources such as the Marcellus Shale, especially when combined with existing assets such as accessibility to the large northeast US market, refining and petrochemical production facilities, and transportation infrastructure. The city and the 10 suburban counties should together design and perform a targeted business marketing campaign whose objectives would be to: 1) publicize current competitive advantages for manufacturing subsectors; and 2) identify specific companies in energy-intensive and petrochemical subsectors and then convince them to expand into the city and surrounding counties. The priority subsectors to be targeted by the attraction campaign were identified in Task 1 of this Manufacturing Growth Strategy Study.

The attraction campaign should emphasize Pennsylvania's emergence as a center of domestic energy production coming from unconventional energy resources, and Philadelphia's accompanying role as a center for the downstream petrochemical production. The attraction campaign would address the need to increase economic growth in the manufacturing sectors of the city and the Greater Philadelphia Region, and also to take advantage of the growth opportunities provided by energy resources being extracted from the Marcellus Shale formation.

The business attraction campaign should be designed by the Greater Philadelphia Chamber of Commerce regional economic development marketing organization, Select Greater Philadelphia, working closely with the appropriate state and county-level economic development organizations. Other stakeholder organizations should be involved in the design of the attraction campaign including chambers of commerce, business associations and trade groups, major manufacturing employers, and other nonprofits involved in economic development having specific expertise in the manufacturing sector. The attraction campaign should be implemented by the regional economic development marketing organization, using as needed the resources and expertise of the stakeholder organizations. The first analysis required to implement the attraction campaign is to review the results of Task 1 of this Manufacturing Growth Strategy Study and to identify a group of priority or target manufacturing subsectors at the four-digit NAICS level.

The proposed marketing campaign should take between three and six months to plan and begin to implement. Some additional funding by companies potentially benefitting and other stakeholders will be required to support the new activities of the regional economic development marketing organization. The implementation of this strategy will be measured by the identification of the target subsectors and the names of companies currently active in them, by the number of contacts made with these firms, and by the number of inquiries from the target subsectors received by the economic development marketing organization, by the other state and county economic development organizations, and by other stakeholders. Over the long term, the operational success of this strategy will be measured by the amount of economic activity in the target subsectors that is attracted into the Greater Philadelphia Region as measured by numbers of jobs and companies, investment, and the increase in output.

Energy

Energy is critical in the development of a robust manufacturing industry as it is used in two ways: 1) as a fuel consumed during a production process, and/or 2) as a feedstock required as an input to make another good. In the City and the Region, the first use is the most important one in the manufacturing industry, excluding oil refining. The Marcellus Shale resource has the potential to lower the cost of energy used as a fuel or as a feedstock in the chemical, primary metal, and refining subsectors. Delivering Marcellus natural gas and natural gas liquids (NGLs) to the Philadelphia area at a cost below the current price and competitive with competing regions of the United States will be a challenge. Nevertheless, lower-cost energy and feedstock s are needed to increase the importance and profitability of energy-intensive industries in the Philadelphia area.

Delivered natural gas and electric power costs to industrial and commercial customers in the City and the Region are higher than those in adjacent states, indicating that there are additional costs imposed on the current distribution systems. NGLs are not currently available in a large-enough quantity to support a significant expansion to reach the city and the Region's petrochemical industries due to the lack of adequate delivery capacity. If additional supplies of natural gas and NGLs are not available at competitive delivered costs, then growth strategies will have to focus on subsectors that have both lower energy intensity and those that utilize petrochemical derivatives and specialty products to manufacture high-value products.

Increase the supply of natural gas and natural gas liquids available at a competitive, delivered price to industrial users by building new pipeline capacity.

To take full advantage of the opportunity provided by the Marcellus Shale formation, existing infrastructure must be expanded or new systems constructed to increase the supply of natural gas and natural gas liquids (NGL) available in the Philadelphia market for use in energy production or as a feedstock by the manufacturing sector. While the current price of the Marcellus Shale natural gas is low at the wellhead, what really matters is its delivered cost to customers in the city and the Greater Philadelphia Region once transmission and distribution costs are added. A recent analysis by the US Department of Energy in September 2013, projects that the price of natural gas at the West Pennsylvania Hub will soon be less than the Henry Hub price used by the New York Mercantile Exchange. To expand the supply of natural gas and NGLs a major investment in new pipelines, as well as repurposed existing lines, will be required, including the local distribution lines that deliver the gas to the major customers.

All subsectors will benefit from the increased supply, especially the energy-intensive ones (e.g., food, primary and fabricated metals, nonmetallic minerals, power generation, chemicals, petrochemicals, refining) and those that use natural gas as a feedstock (e.g., refining, chemicals, and primary metals). The Energy foundational assessment found that the Philadelphia region has a competitive advantage in attempting to attract downstream manufacturers of complex, higher value added, petrochemical products sold as intermediate inputs or final products than it does for producers of the major commodity petrochemicals such as olefins, methanol, and ammonia. The commodity petrochemicals are made in large, established low-cost locations such as the Gulf Coast, making it more difficult for these activities to be attracted here. However, to take full advantage of this strength, the supply of NGLs available in the city

and the Greater Philadelphia Region must be increased to support the expansion of the region's petrochemical manufacturing base. The specific types of activities that will benefit from an increase in the supply of NGLs include: ethane cracking to make ethylene and its derivatives and propane dehydrogenation to make propylene and its derivatives.

Existing pipeline projects, such as Sunoco Logistics' Mariner East Pipeline which while they would expand the supply of natural gas in the region, do not appear to have the capacity to support significant expansion of the region's petrochemical industry. Therefore, new pipeline capacity will be needed.

Organizations needing to implement this strategy include: companies in the energy-intensive sub-sectors noted earlier; manufacturers of petrochemicals that use NGLs as a feedstock; regional chambers of commerce and related organizations; associations of major companies and institutions promoting regional economic development; regional business marketing organizations; and natural gas distribution utilities. The Pennsylvania Public Utility Commission would also be involved because of its authority to approve the construction of new pipelines, including the acquisition of new rights-of-way.

Expanding the existing pipeline systems to deliver more natural gas and NGLs to the Greater Philadelphia Region will be required. A subsequent increase in the capacity of port facilities on the Delaware River to handle larger volumes of energy and related chemical products for export will need to occur as well.

Promote the use of energy efficient technology, distributed energy systems, and smart grid technology to improve energy efficiency of large of manufacturing campuses and districts.

Manufacturing sub-sectors use significant amounts of energy in their processes, so reducing energy's share of the cost of production would boost profitability and free financial resources for other purposes such as R&D, product development, and investment. Energy used as a fuel ranges from under 1.0% of production costs for such sub-sectors as machinery, computers and electronics, and transportation equipment to above 2.5% for primary metals, food, chemicals, wood, and nonmetallic minerals. Three sectors use large amounts of fuel as a feedstock: petroleum refining, chemicals, and primary metals. The purpose of this strategy is to encourage the use of equipment and systems that will increase the efficiency of energy use by manufacturing establishments in both their production processes and as a feedstock.

There is a wide range of equipment and systems that can reduce energy use and raise efficiency, such as installing more energy-efficient pumps and compressors, using smart energy systems to manage and minimize consumption, using insulation, installing co-generation facilities at production plants, and participating in demand-side management (DSM) programs.

The wider use of distributed energy systems should be strongly encouraged and supported through the use of loans, grants, and incentives. Distributed energy/generation consists of small-scale technologies (e.g., cogeneration facilities, fuel cells, batteries, wind turbines, etc.) to produce electricity energy on-site or close to the location of power use. The advantages of distributed energy generation include gaining efficiency and reliability (i.e., decrease in the number and duration of power outages), and potentially lowering electric power costs from generating power on-site. The use of distributed energy is the most attractive to large industrial customers in the energy-intensive subsectors. Companies in these sectors also

often consume multiple types of energy at their production facilities, so they would also be more likely to benefit from combined heat and power applications. The potential economic benefits from increasing reliability are very large as the Electric Power Research Institute reported power outages and quality disturbances cost US businesses $119 billion per year. Implementing this strategy would help manufacturing companies reduce energy costs and increase their energy efficiency. Promoting the wide use of distributed energy systems would be especially beneficial to small manufacturing enterprises and start-up companies that would not need large amounts of energy until they begin producing their goods at a commercial scale.

Policy & Regulatory Environment

The profitability of a manufacturing firm depends significantly on controlling both: 1) costs of production that vary with the level of output (i.e., labor compensation, intermediate inputs, sales and distribution, administrative overhead, utilities, maintenance and repair, investment), and 2) other costs of doing business that are not directly related to the level of production such as taxes, debt service, regulatory compliance, and fees. For the most part, local communities have little ability to affect the level of production costs as they are determined by market conditions and by the level of output, but they can affect the level of other costs of doing business through the setting of tax rates and by the complexity of the local regulatory system. The local regulatory system can affect operating costs in several ways:

- Require a firm to invest significant time and effort to obtain required permits and approvals
- Create uncertainty over the likelihood of receiving an approval in a reasonable period of time
- Implement regulations that directly raise the cost of doing business such as by requiring the payment of benefits to workers, or mandating improvements to mitigate environmental impacts.

Manufacturing firms that typically sell high shares of their output outside of their host cities and states can receive lower effective tax rates when the weight given to the sales factor is increased; but they could face higher costs if real property tax rates are raised. Taxes and the costs imposed by the regulatory system can also affect a company's decision on where it decides to expand. The challenge for all manufacturers is to let production costs be determined as much as possible by market conditions, and not to impose high other costs in the form of taxes and regulations that would decrease the competitiveness of manufacturing firms.

Decrease tax and regulatory burden on manufacturing companies.

Identify ways in which the local taxes and fees for manufacturing companies can be reduced, either directly by decreasing the applicable rates, or indirectly by offering new, or expanding existing incentives, such as tax credits, tax exclusions, and deductions that would reduce the size of a company's local tax liability. The uniformity clause of the Pennsylvania Constitution requires that all classes of real property be taxed at the same rate, so reducing real property taxes on manufacturing real property would require excluding a portion of a property's assessed value from taxation. The Government Policy foundational assessment made the following recommendations for reducing the tax burden on manufacturing companies located in the City of Philadelphia.

- Reduce or eliminate the net income portion of the Business Income and Receipts Tax.
- Consider ways to exempt property engaged in manufacturing activity from the Use & Occupancy Tax.

Additionally, manufacturers in Philadelphia are significantly affected by local regulations and initiatives such as the City's recent stormwater management program. While this effort represents an important public policy to protect the environment, an expansion of efforts to mitigate its impact on this sector should be explored.

Sufficient evidence already exists showing tax reform as envisioned in Philadelphia will have a positive effect on the local economy and on the competitiveness of the city's manufacturing sector. It is important to note that this study occurred immediately prior to the expected implementation of the City of Philadelphia's new tax reform legislation, which will effect on January 1, 2014. The most sweeping of these tax structure changes, starting in tax year 2015, includes basing the net income portion of Philadelphia's business tax solely to sales that occur in Philadelphia, rather than calculated from a company's sales, property, and payroll. This will provide significant tax relief to manufacturers who predominately sell goods to customers outside of the City.

Continue to preserve by-right zoning in industrial corridors and upgrade existing industrial districts and facilities to support modern manufacturing.

Industrial development within Greater Philadelphia, especially in the city, is constrained to a significant degree by the lack of supply of large, vacant, developable land parcels with the appropriate zoning and utilities needed for manufacturing activities. This strategy would build on the groundwork established by *Industrial Land Use & Market Strategy for the City of Philadelphia* (2010) which identified a set of existing industrial districts that support extensive industrial facilities and which have the characteristics to support modern manufacturing. Within the city, the focus of this strategy would be to preserve the characteristics (industrial zoning, adequate infrastructure, and separation from non-industrial uses) of land parcels and buildings that support modern manufacturing suitable for use by small and start-up manufacturing establishments that do not have significant environmental effects on adjacent properties such as noise, vehicular traffic, emissions, light, and vibrations. Preserving by-right zoning in identified industrial corridors will protect manufacturing users from being priced out of the City or from land speculators.

Additional strategies to protecting industrial infrastructure include:

- Promote additional investment in regional transportation infrastructure in all modes that will maintain or increase the efficiency of moving raw materials, supplies, and finished manufacturing products into, across, and out of the City and the Region. A particular area of focus should be improving connections between different modes of transportation. Protect and maintain access into and out of industrial corridors located along major transportation routes and lines. Work with municipal and county planning commissions, and regional development organizations to ensure that scarce, existing land parcels, brownfield or greenfield, vacant or occupied, with high development potential for manufacturing, are held for future development and not converted to other land uses. Also review existing zoning and land-use regulations to ensure that the approval

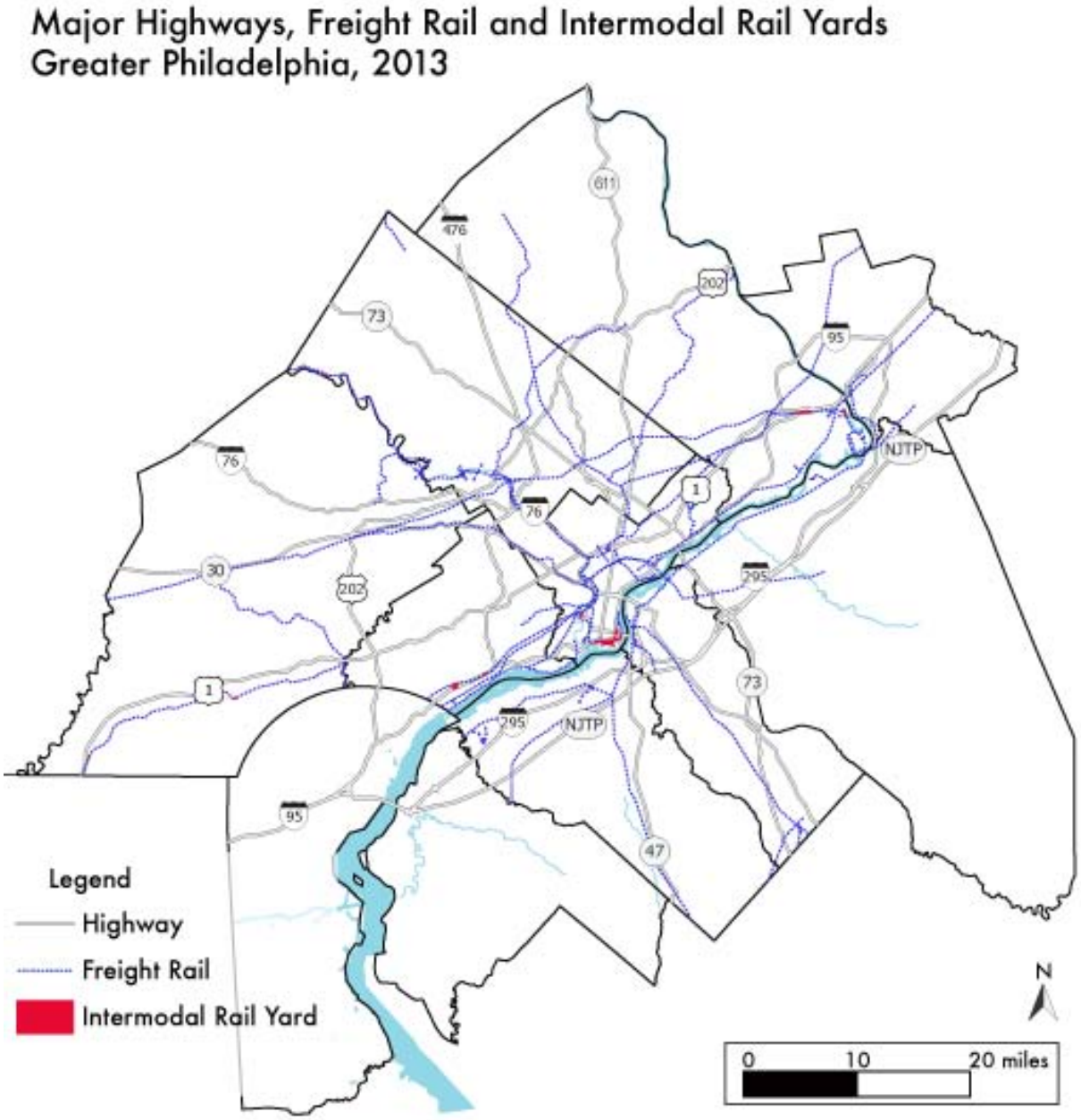
requirements for manufacturing uses are not too burdensome and that ordinances will accommodate modern manufacturing activities.

- Complete the proposed expansion of Philadelphia International Airport, including establishing a direct flight to Asia which would make it easier to attract Asian manufacturing firms to the Region.
- Increase the capacity of the port facilities along the Delaware River to export energy and related products, and to receive energy and related products such as petrochemicals, including the deepening of the main navigation channel of the Delaware River to 45 feet and construction of supporting shipping infrastructure such as the Southport Complex.

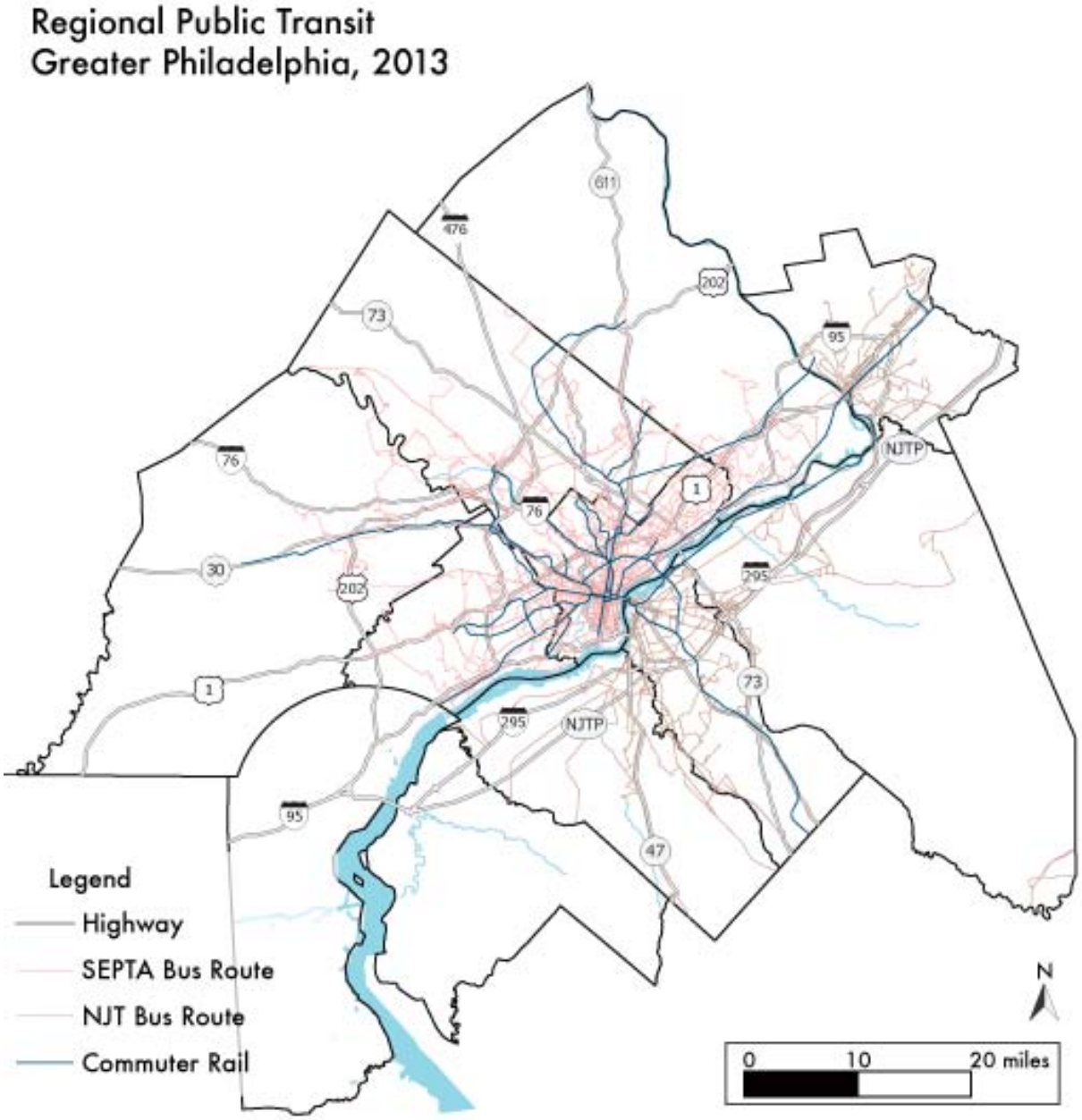
Enhance communications between government and manufacturers while providing services to the industry.

The Department of Commerce will form and regularly convene a working group consisting of those actively engaged in the manufacturing community to coordinate the implementation of recommendations outlined by the Task Force, and further publicize the availability of the Director of Industrial Development to resolve issues related to regulation, taxes, permitting and approvals. This will provide specialized support to manufacturers in navigating the City's regulatory system, and build, connect, and help organize the manufacturing community to address common issues or concerns.

Appendix A: Study area maps



Source: 2010 TIGER/Line Shapefiles, US Census Bureau, 2010; Delaware Valley Regional Planning Commission, 2013.



Source: 2010 TIGER/Line Shapefiles, US Census Bureau, 2010; Delaware Valley Regional Planning Commission, 2013.

Appendix B: Comparison of shift-share results

Comparison of the 2000 to 2013 Shift Share Analysis

	City of Philadelpha			GPR excluding Philadelphia			
Sector	Allocation Code	2013 Employment	2013 LQ	Allocation Code	2013 Employment	2013 LQ	Comparison
3111 Animal Food		Less than 25 jobs		D	360	0.51	NA
3112 Grain & Oilseed Milling		Less than 25 jobs		B	26	0.03	NA
3113 Sugar & Confectionery Product	A	295	1.99	A	1,093	1.15	Same
3114 Fruit & Vegetable Preserving	B	180	0.51	D	790	0.35	City Higher
3115 Dairy Product	B	194	0.68	D	1,197	0.65	City Higher
3116 Animal Slaughtering & Processing	C	1,162	1.12	D	4,617	0.69	City Higher
3117 Seafood Product Preparation		Less than 25 jobs			Less than 25 jobs		Same
3118 Bakeries & Tortilla	C	2,929	4.82	C	4,982	1.27	Same
3119 Other Food	C	512	1.40	A	2,365	1.01	Region Higher
3121 Beverage	C	691	1.82	D	1,522	0.62	City Higher
3122 Tobacco		Less than 25 jobs		A	871	4.35	NA
3131 Fiber, Yarn, & Thread Mills	D	43	0.72	B	84	0.22	Region Higher
3132 Fabric Mills	A	177	1.58	B	565	0.78	City Higher
3133 Textile, Fabric Finishing & Coating Mills	C	80	1.20	D	103	0.24	City Higher
3141 Textile Furnishings Mills	D	88	0.81	B	253	0.36	Region Higher
3149 Other Textile Product Mills	C	196	1.45	B	752	0.86	Region Higher
3151 Apparel Knitting Mills	A	49	1.56	B	51	0.25	City Higher
3152 Cut & Sew Apparel	C	664	2.61	D	959	0.58	City Higher
3159 Apparel Accessories & Other Apparel	C	89	3.59	D	81	0.51	City Higher
3161 Leather & Hide Tanning & Finishing		Less than 25 jobs		A	89	1.69	NA
3162 Footwear		Less than 25 jobs			Less than 25 jobs		NA
3169 Other Leather & Allied Product		Less than 25 jobs		D	83	0.49	NA
3211 Sawmills & Wood Preservation		Less than 25 jobs		B	140	0.12	NA
3212 Veneer, Plywood, & Engineered Wood		Less than 25 jobs		B	664	0.76	NA
3219 Other Wood Product	B	118	0.26	B	1,292	0.45	Same
3221 Pulp, Paper, & Paperboard Mills	A	305	1.35	B	910	0.63	City Higher
3222 Converted Paper Product	C	873	1.56	C	5,335	1.48	Same
3231 Printing & Related Support Activities	C	1,234	1.29	C	10,345	1.67	Same
3241 Petroleum & Coal Products	C	995	4.14	C	2,610	1.69	Same
3251 Basic Chemical	D	227	0.75	C	2,302	1.18	Region Higher
3252 Resin, Synthetic Rubber, & Filaments	C	514	2.58	C	1,856	1.45	Same
3253 Pesticide, Fertilizer, & Agr. Chemicals		Less than 25 jobs		D	200	0.41	NA
3254 Pharmaceutical & Medicine	A	1,834	3.12	C	12,702	3.36	City Higher
3255 Paint, Coating, & Adhesive	D	55	0.46	C	881	1.14	Region Higher
3256 Soap, Cleaning Compound, & Toilet Prep.	C	248	1.13	A	4,079	2.89	Region Higher
3259 Other Chemical Product & Preparation	D	142	0.85	C	1,574	1.46	Region Higher
3261 Plastics Product	D	411	0.37	D	6,612	0.93	Same
3262 Rubber Product	D	41	0.16	B	992	0.60	Region Higher
3271 Clay Product & Refractory		Less than 25 jobs		D	327	0.68	NA
3272 Glass & Glass Product		Less than 25 jobs		B	1,134	0.96	NA
3273 Cement & Concrete Product	D	40	0.11	A	2,311	1.02	Region Higher
3274 Lime & Gypsum Product		Less than 25 jobs		C	224	1.34	NA
3279 Other Nonmetallic Mineral Product	B	103	0.73	A	1,268	1.39	Region Higher
3311 Iron & Steel Mills & Ferroalloy		Less than 25 jobs		C	1,747	1.24	NA
3312 Steel Product from Purchased Steel		Less than 25 jobs		D	675	0.99	NA
3313 Alumina & Aluminum Prod. & Processing		Less than 25 jobs		D	343	0.46	NA
3314 Nonferrous Metal (except Aluminum)	A	172	1.31	D	720	0.85	City Higher
3315 Foundries	D	25	0.09	D	378	0.22	Same

Comparison of the 2000 to 2013 Shift Share Analysis (continued)

	City of Philadelpha			GPR excluding Philadelphia			
Sector	Allocation Code	2013 Employment	2013 LQ	Allocation Code	2013 Employment	2013 LQ	Comparison
3321 Forging & Stamping	D	127	0.52	D	554	0.35	Same
3322 Cutlery & H&tool	D	14	0.15	B	596	1.00	Region Higher
3323 Architectural & Structural Metals	Less than 25 jobs			D	3,834	0.82	NA
3324 Boiler, Tank, & Shipping Container	Less than 25 jobs			A	1,458	1.21	NA
3325 Hardware	D	26	0.46	B	321	0.89	Region Higher
3326 Spring & Wire Product	Less than 25 jobs			A	665	1.17	NA
3327 Machine Shops & Turned Product	B	525	0.66	C	7,034	1.36	City Higher
3328 Coating, Engraving, & Heat Treating	D	195	0.69	D	1,310	0.72	Same
3329 Other Fabricated Metal Product	A	576	1.03	D	2,783	0.77	City Higher
3331 Agr., Constr., & Mining Machinery	Less than 25 jobs			B	595	0.18	NA
3332 Industrial Machinery	D	172	0.76	D	1,423	0.98	Same
3333 Commercial & Service Industry Machinery	B	57	0.21	A	3,084	1.81	Region Higher
3334 Ventilation, Heating, A-C, & Refrigeration	D	204	0.76	A	2,054	1.19	Region Higher
3335 Metalworking Machinery	D	107	0.28	D	1,366	0.56	Same
3336 Engine, Turbine, & Power Transmission	Less than 25 jobs			B	1,001	0.73	NA
3339 Other General Purpose Machinery	B	437	0.95	C	3,359	1.14	City Higher
3341 Computer & Peripheral Equipment	B	53	0.16	D	1,203	0.56	City Higher
3342 Communications Equipment	Less than 25 jobs			D	1,330	0.90	NA
3343 Audio & Video Equipment	Less than 25 jobs			B	132	0.48	NA
3344 Semiconductor & Other Electronics	D	158	0.18	D	3,628	0.64	Same
3345 Navigation, Measure, & Electromedical Eq.	D	60	0.08	C	9,022	1.84	Region Higher
3346 Magnetic & Optical Media	Less than 25 jobs			A	1,149	4.07	NA
3351 Electric Lighting Equipment	C	423	4.49	C	859	1.42	Same
3352 Household Appliance	Less than 25 jobs			B	495	0.69	NA
3353 Electrical Equipment	C	320	1.06	B	973	0.50	Region Higher
3359 Other Electrical Equipment & Component	A	315	1.19	D	1,654	0.97	City Higher
3361 Motor Vehicle	Less than 25 jobs			D	154	0.07	NA
3362 Motor Vehicle Body & Trailer	Less than 25 jobs			D	386	0.19	NA
3363 Motor Vehicle Parts	A	2,830	2.86	B	4,159	0.65	City Higher
3364 Aerospace Product & Parts	B	48	0.04	C	9,668	1.32	City Higher
3365 Railroad Rolling Stock	A	115	4.84	B	107	0.70	City Higher
3366 Ship & Boat Building	A	361	1.31	D	849	0.48	City Higher
3369 Other Transportation Equipment	Less than 25 jobs			B	61	0.22	NA
3371 Household & Institutional Furniture	D	173	0.40	D	1,077	0.39	Same
3372 Office Furniture (including Fixtures)	A	441	1.84	A	2,854	1.85	Same
3379 Other Furniture Related Product	A	182	2.72	D	100	0.23	City Higher
3391 Medical Equipment & Supplies	A	661	1.02	C	4,806	1.15	City Higher
3399 Other Miscellaneous	C	811	1.38	A	4,298	1.14	Region Higher

NOTE: Energy intensive sectors (where energy costs, excluding energy used as a feedstock, are above the average percent share of total production costs) are highlighted.

Source: IHS Economics

Appendix C: Cluster and discriminant attributes

The purpose of this appendix is to describe the attributes used in the cluster and discriminant analyses, specifically what they measure, why they are significant, and how the results of the discriminant analysis should be interpreted. There were a total of 26 attributes that we considered before narrowing the list because some are so broad that they capture aspects of what others are trying to measure, or that are highly correlated with other attributes, which can cause problems when running the discriminant analysis. For data that were not available at the local level, and for which we concluded that the local values would not be significantly different than the US, we used national proxies.

The first and probably the most important attribute for competitive advantage is the productivity of each worker in an industry. Productivity in our study is measured by output-per-worker from the BMI database. Another measure that we considered for productivity was value added per hour worked from the Annual Survey of Manufacturers (ASM), but we chose not to use it as it was available only at the national level. Another attribute that measures competitiveness is a region's market share in an individual industry (Hill and Brennan, 2000), expressed as the percentage of the industry's US employment that is located in the region. To capture how an industry's competitive position changed over time in the city and in the 10 suburban counties, we looked at the change in this measure between 1990 and 2013, and between 2000 and 2013. The final attribute we looked at that provides insight into the competitiveness of an industry was the average annual wage per worker from the Bureau of Labor Statistics (BLS).

The IHS industry risk rating is a broad measure of risk that incorporates historical data as well as forecast data to derive an overall risk for each industry at the national level. The criteria comprising the index are discussed in the shift-share analysis section of the main Task One report. We also considered using the LQs and the change in LQs as attributes in the cluster analysis, but eventually we used the actual shift-share classification (i.e., the A, B, C, and D sectors) as described.

From the IMPLAN model of both the city and the 10 surrounding counties, we estimated for each subsector: 1) the share of its total output sold out of the region; and 2) its share of total manufacturing sector output exported out of the region. It turned out the values for the first export share were very similar across all the industries, so it was not used in the final analysis as it did not sufficiently differentiate among the subsectors. The second export share was used as it better measured how important a subsector was to the regional economy.

From IMPLAN we also obtained two measures of centrality of each subsector—the forward and backward multipliers. The centrality concept measures the extent to which an economic sector is embedded in a regional economy in that it both buys high amounts of inputs from local suppliers and sells a significant share of its goods and services to local customers. In other words, an economic sector with a high degree of centrality has both high backward multipliers (i.e., a well-developed supplier network that produces a high indirect effect) and high forward multipliers (i.e., is a supplier for other local industries). We also considered a related attribute—how a subsector's share of total manufacturing employment in the city and the 10 suburban counties had changed between 1990 and 2013. All three of these indicators were used in the Hill and Brennan paper cited earlier in this study.

IHS also identified and estimated values for attributes that measured structural and labor force characteristics. The structural attribute applied was the number of employees per establishment as derived from our BMI database. The two occupational attributes used to identify the clusters were 1) the percent of occupations requiring at least some post-secondary education for an entry-level job; and 2) the percent of employees in a subsector in production occupations. We used US values as proxies for the two labor force attributes, reasoning that the local production functions are similar to those at the US level.

The final attributes applied measured innovation, energy intensity, transportation costs, and capital intensity, each of which measures a different, relevant characteristic of a manufacturing company. We used US estimates for these four attributes. IHS collected patent data by industry and used the annual average from 1999–2008 to estimate an award rate defined as the ratio of patents per unit of output. Energy intensity was estimated as the cost of energy used for fuel, excluding energy used a feedstock, as a share of total production costs. The national input/output use table was used to derive total transportation costs as a share of total subsector output. Finally, capital intensity was defined as the value of total depreciable assets, net of depreciation, as a percent of total sales in 2010, based on the Internal Revenue Service's (IRS) Statistics on Income (SOI).

The discriminant analysis is a necessary complement to the cluster analysis because it provides more insight into the question of why certain sectors cluster together. It also provides a way of validating the number and composition of the initial clusters because it generates a suggested group assignment for each subsector based on its aggregate discriminant score. If the suggested groups from the discriminant analysis are similar to those derived during the cluster analysis, it indicates original cluster groupings were reasonable.

The discriminant score for each subsector was determined by multiplying each attribute's normalized value by a coefficient derived during discriminant analysis, and then summing the products. The attributes with the highest coefficient values also are the most important ones in determining why subsectors were assigned to the different clusters. Discriminant analysis also provides a way of predicting how a new industry would be clustered based on its values for the attributes. This suggests if a growth strategy can change the level of an attribute with a high coefficient value, then you could determine the new cluster for each affected subsector.

Appendix D: Tax rates in Philadelphia and the comparison cities

Tax types and rates in Philadelphia and Pennsylvania comparison cities

Type of tax	Authority	Philadelphia, PA	Nottingham, PA	Downingtown, PA
Income	State	3.07%	3.07%	3.07%
	Municipality	3.924% (Res) 3.495% (Non-Res)	1% +$52	1% +$52
	School District		$10	
Sales	State	6.0%	6%	6%
	County			
	Municipality	2.0%		
Property	County		4.163 mills	4.163 mills
	Municipality	4.46%	.97 mills	7.65 mills
	School District	5.309%	30.0502 mills	27.182 mills
Business	State	9.99% (CNIT) 1.89 mills (CS&FT) 4 mills (Corp Loans)	9.99% (CNIT) 1.89 mills (CS&FT) 4 mills (Corp Loans)	9.99% (CNIT) 1.89 mills (CS&FT) 4 mills (Corp Loans)
	Municipality	6.45% (NI) and 1.415 mills (GR) or 2.34% (Manufacturer ART)		
Use and Occupancy	Municipality	5.51%		

Source: Econsult Solutions, Inc. (2013)

Tax types and rates in non- Pennsylvania-Based comparison cities

Type of tax	Authority	Houston, TX	Cleveland, OH	San Diego, CA	Dallas, TX	Fort Worth, TX	Minneapolis, MN	Boston, MA
Income	State		Progressive	Progressive			Progressive	5.250%
	Municipality		2.00%					
	School District							
Sales	State	6.25%	5.50%	7.50%	6.25%	6.25%	6.875%	6.25%
	County		2.25%	0.50%			0.15%	
	Municipality	2.00%			2.00%	2.00%	0.50%	
Property	County	0.73377%	1.0914%	1.00%	0.643412%	0.6609%	2.00%	
	Municipality	0.63875%	1.0340%	1.11153%	0.797%	0.855%		3.192%
	School District	1.1567%	0.60128798%	0.10303%	1.290347%	1.322%		
Business	State	1.00%	Progressive	8.84% / Progressive	1.00%	1.00%	9.80%	8.00%
	Municipality		2.00%	Progressive				

Source: Econsult Solutions, Inc. 2013.

Appendix E: Tax burden methodology and comparative results

To better understand the effects of each locality's tax policies on businesses, a number of illustrative business archetypes were developed. A review of manufacturing activity in each comparison city was conducted, and industries of particular shared importance were selected as archetypal business models for the tax burden analysis. The characteristics of these illustrative businesses are generally based on national averages for these industries,[7] but are modified to portray a range of realistic archetypes that experience tax burdens differently, and that cities may compete for from the standpoint of business formation, growth, retention, and attraction. For example, industry average data for business archetypes were modified so that tax burden could be estimated for a larger firm versus a smaller firm, a more capital-intensive firm versus a more labor-intensive firm, and a higher margin-firm versus a lower-margin firm.

Using these constructed business models, a review of tax rates and policies in each location was conducted to approximate an annual "tax return" for each model business. By looking at the state, county, and city tax structures for each comparison locality, a generalized tax burden was estimated, considering all identifiably relevant taxes at each level of taxation not common across all locations (i.e., federal taxes are excluded from this analysis, since all firms are subject to the same tax burden at the national level). This analysis includes local and state taxes that manufacturing businesses do not pay, such as personal income and sales taxes.

The characteristics of these illustrative business archetypes can only be roughly estimated for purposes of comparison; they do not represent actual firms, and in reality, tax bases and tax burdens will be more complicated to calculate.[8] Nevertheless, even this simplified approach can enable a rough estimation of the tax bill for each illustrative business in each locality, and therefore a general sense of how Philadelphia compares in terms of its tax burden to those in competing locations.

[7] "Almanac of Business and Industrial Financial Ratios," Internal Revenue Service (2011).

[8] For example, this simplified approach does not make any allowance for important drivers of tax burden, such as government incentives for business attraction (which are covered elsewhere in this report) and whether and how a firm is incorporated.

Estimated tax burden in Philadelphia and comparison Cities

Estimated annual state and local tax burden for illustrative businesses in Philadelphia and comparison cities

Industry	Type	Philadelphia, PA	Houston, TX	Cleveland, OH	San Diego, CA	Dallas, TX	Fort Worth, TX	Minneapolis, MN	Boston, MA	Nottingham, PA2	Downingtown, PA
Food	Median	$ 10,840	$ 3,068	$ 4,927	$ 7,759	$ 3,079	$ 3,086	$ 5,840	$ 4,485	$ 4,207	$ 4,221
Drink	Median	$ 62,428	$ 22,829	$ 23,540	$ 38,215	$ 22,917	$ 22,963	$ 28,120	$ 21,835	$ 21,703	$ 21,802
Chemical	Median	$ 155,011	$ 46,173	$ 59,737	$ 107,446	$ 46,350	$ 46,444	$ 85,861	$ 67,138	$ 69,198	$ 69,399
Aerospace	Median	$ 42,999	$ 9,949	$ 19,083	$ 32,483	$ 9,987	$ 10,007	$ 25,604	$ 19,762	$ 19,052	$ 19,095
Medical	Median	$ 21,324	$ 4,465	$ 9,313	$ 15,568	$ 4,482	$ 4,491	$ 12,228	$ 9,415	$ 8,957	$ 8,977
Food	Average	$ 267,894	$ 94,962	$ 91,074	$ 167,596	$ 95,327	$ 95,520	$ 133,317	$ 105,222	$ 113,420	$ 113,834
Drink	Average	$ 4,777,062	$ 1,003,865	$ 1,860,306	$ 3,444,823	$ 1,007,716	$ 1,009,763	$ 2,840,515	$ 2,215,005	$ 2,252,901	$ 2,257,287
Chemical	Average	$ 1,185,824	$ 385,533	$ 425,212	$ 784,693	$ 387,012	$ 387,798	$ 630,532	$ 495,993	$ 526,320	$ 528,004
Aerospace	Average	$ 4,547,227	$ 1,619,770	$ 1,383,233	$ 2,826,613	$ 1,625,985	$ 1,629,287	$ 2,369,118	$ 1,892,674	$ 2,156,504	$ 2,163,580
Medical	Average	$ 834,122	$ 192,824	$ 336,636	$ 611,916	$ 193,564	$ 193,957	$ 498,212	$ 387,974	$ 391,860	$ 392,702
Food	Big	$ 84,123,708	$ 24,095,395	$ 36,021,987	$ 57,795,526	$ 24,187,842	$ 24,236,973	$ 45,500,331	$ 35,729,419	$ 37,604,158	$ 37,709,417
Drink	Big	$ 437,617,192	$ 84,379,724	$ 174,375,597	$317,919,391	$ 84,703,464	$ 84,875,516	$ 252,304,583	$ 197,847,931	$ 206,930,217	$ 207,298,824
Chemical	Big	$ 166,859,993	$ 48,692,486	$ 70,142,785	$121,742,904	$ 48,879,304	$ 48,978,589	$ 90,624,801	$ 71,380,091	$ 76,231,363	$ 76,444,073
Aerospace	Big	$ 508,319,957	$ 179,581,361	$ 194,973,903	$354,958,398	$ 180,270,361	$ 180,636,531	$ 264,540,639	$ 211,718,047	$ 243,135,949	$ 243,920,438
Medical	Big	$ 210,698,374	$ 41,479,278	$ 95,779,293	$169,995,540	$ 41,638,422	$ 41,722,999	$ 133,566,444	$ 104,167,204	$ 106,031,966	$ 106,213,165
Food	Small	$ 30,923	$ 11,472	$ 14,706	$ 23,470	$ 11,516	$ 11,540	$ 17,365	$ 13,381	$ 12,773	$ 12,823
Drink	Small	$ 4,936	$ 1,114	$ 2,647	$ 4,144	$ 1,118	$ 1,120	$ 3,215	$ 2,464	$ 2,284	$ 2,288
Chemical	Small	$ 155,011	$ 46,173	$ 59,737	$ 107,446	$ 46,350	$ 46,444	$ 85,861	$ 67,138	$ 69,198	$ 69,399
Aerospace	Small	$ 2,147,982	$ 883,037	$ 796,148	$ 1,458,759	$ 886,425	$ 888,226	$ 1,151,102	$ 909,518	$ 985,317	$ 989,174
Medical	Small	$ 427,420	$ 88,575	$ 148,799	$ 284,783	$ 88,915	$ 89,095	$ 238,451	$ 186,902	$ 195,039	$ 195,426

Estimated tax burden in Philadelphia and comparison Cities

Estimated annual state and local tax burden for illustrative businesses in Philadelphia and comparison cities

Industry	Type	Philadelphia, PA	Houston, TX	Cleveland, OH	San Diego, CA	Dallas, TX	Fort Worth, TX	Minneapolis, MN	Boston, MA	Nottingham, PA2	Downingtown, PA
Food	Capital	$ 33,628,976	$ 16,723,910	$ 14,055,133	$ 18,291,399	$ 16,832,285	$ 16,889,881	$ 12,946,487	$ 10,742,718	$ 12,029,611	$ 12,153,005
Drink	Capital	$ 23,307	$ 8,578	$ 9,742	$ 14,947	$ 8,633	$ 8,663	$ 11,047	$ 8,725	$ 8,304	$ 8,367
Chemical	Capital	$ 154,628	$ 21,640	$ 52,290	$ 104,900	$ 21,780	$ 21,855	$ 91,986	$ 72,745	$ 76,396	$ 76,556
Aerospace	Capital	$ 30,788	$ 10,112	$ 13,387	$ 20,719	$ 10,178	$ 10,213	$ 15,458	$ 12,119	$ 11,316	$ 11,391
Medical	Capital	$ 12,109,122	$ 2,380,850	$ 4,704,180	$ 8,410,373	$ 2,396,278	$ 2,404,477	$ 6,913,415	$ 5,426,452	$ 5,388,287	$ 5,405,854
Food	Labor	$ 102,889	$ 21,054	$ 45,717	$ 78,161	$ 21,134	$ 21,177	$ 61,883	$ 47,682	$ 45,544	$ 45,636
Drink	Labor	$ 5,150	$ 1,114	$ 2,885	$ 4,445	$ 1,118	$ 1,120	$ 3,410	$ 2,602	$ 2,350	$ 2,355
Chemical	Labor	$ 30,441	$ 9,644	$ 13,585	$ 21,288	$ 9,681	$ 9,701	$ 15,636	$ 11,990	$ 11,138	$ 11,181
Aerospace	Labor	$ 43,645	$ 9,949	$ 21,171	$ 34,838	$ 9,987	$ 10,007	$ 26,949	$ 20,664	$ 19,213	$ 19,256
Medical	Labor	$ 21,390	$ 4,465	$ 10,095	$ 16,388	$ 4,482	$ 4,491	$ 12,652	$ 9,686	$ 8,926	$ 8,945
Food	High Margin	$ 1,459,431	$ 340,064	$ 489,818	$ 964,364	$ 341,368	$ 342,062	$ 814,683	$ 641,825	$ 686,411	$ 687,896
Drink	High Margin	$ 13,199,047	$ 2,445,813	$ 4,124,532	$ 8,527,842	$ 2,455,197	$ 2,460,184	$ 7,426,857	$ 5,865,149	$ 6,346,033	$ 6,356,717
Chemical	High Margin	$ 167,182	$ 20,886	$ 55,904	$ 115,374	$ 20,966	$ 21,008	$ 101,714	$ 79,969	$ 84,739	$ 84,830
Aerospace	High Margin	$ 47,386	$ 8,068	$ 14,764	$ 31,091	$ 8,099	$ 8,116	$ 27,504	$ 21,758	$ 23,734	$ 23,769
Medical	High Margin	$ 16,071,276	$ 2,693,278	$ 6,227,539	$ 12,032,090	$ 2,703,611	$ 2,709,103	$ 10,219,694	$ 7,987,767	$ 8,222,159	$ 8,233,924
Food	Low Margin	$ 1,943,682	$ 525,292	$ 979,312	$ 1,536,122	$ 527,308	$ 528,379	$ 1,137,181	$ 865,670	$ 771,505	$ 773,800
Drink	Low Margin	$ 463,548	$ 150,580	$ 209,913	$ 332,374	$ 151,158	$ 151,465	$ 244,136	$ 187,202	$ 173,908	$ 174,566
Chemical	Low Margin	$ 805,456	$ 315,175	$ 352,396	$ 572,233	$ 316,385	$ 317,027	$ 422,059	$ 326,652	$ 319,158	$ 320,535
Aerospace	Low Margin	$ 320,005	$ 118,590	$ 161,676	$ 255,516	$ 119,045	$ 119,287	$ 187,185	$ 143,565	$ 133,537	$ 134,055
Medical	Low Margin	$ 60,577	$ 20,119	$ 26,145	$ 41,870	$ 20,196	$ 20,237	$ 30,992	$ 23,867	$ 22,711	$ 22,799

Ranking of estimated annual state and local tax burden for illustrative businesses in Philadelphia and comparison cities

Industry	Type	Philadelphia, PA	Houston, TX	Cleveland, OH	San Diego, CA	Dallas, TX	Fort Worth, TX	Minneapolis, MN	Boston, MA	Nottingham, PA	Downingtown, PA
Food	Median	10	1	7	9	2	3	8	6	4	5
Drink	Median	10	4	7	9	5	6	8	3	1	2
Chemical	Median	10	1	4	9	2	3	8	5	6	7
Aerospace	Median	10	1	5	9	2	3	8	7	4	6
Medical	Median	10	1	6	9	2	3	8	7	4	5
Food	Average	10	2	1	9	3	4	8	5	6	7
Drink	Average	10	1	4	9	2	3	8	5	6	7
Chemical	Average	10	1	4	9	2	3	8	5	6	7
Aerospace	Average	10	2	1	9	3	4	8	5	6	7
Medical	Average	10	1	4	9	2	3	8	5	6	7
Food	Big	10	1	5	9	2	3	8	4	6	7
Drink	Big	10	1	4	9	2	3	8	5	6	7
Chemical	Big	10	1	4	9	2	3	8	5	6	7
Aerospace	Big	10	1	4	9	2	3	8	5	6	7
Medical	Big	10	1	4	9	2	3	8	5	6	7
Food	Small	10	1	7	9	2	3	8	6	4	5
Drink	Small	10	1	7	9	2	3	8	6	4	5
Chemical	Small	10	1	4	9	2	3	8	5	6	7
Aerospace	Small	10	2	1	9	3	4	8	5	6	7
Medical	Small	10	1	4	9	2	3	8	5	6	7
Food	Capital	10	6	5	9	7	8	4	1	2	3

Ranking of estimated annual state and local tax burden for illustrative businesses in Philadelphia and comparison cities

Industry	Type	Philadelphia, PA	Houston, TX	Cleveland, OH	San Diego, CA	Dallas, TX	Fort Worth, TX	Minneapolis, MN	Boston, MA	Nottingham, PA	Downingtown, PA
Drink	Capital	10	3	7	9	4	5	8	6	1	2
Chemical	Capital	10	1	4	9	2	3	8	5	6	7
Aerospace	Capital	10	1	7	9	2	3	8	6	4	5
Medical	Capital	10	1	4	9	2	3	8	7	5	6
Food	Labor	10	1	6	9	2	3	8	7	4	5
Drink	Labor	10	1	7	9	2	3	8	6	4	5
Chemical	Labor	10	1	7	9	2	3	8	6	4	5
Aerospace	Labor	10	1	7	9	2	3	8	6	4	5
Medical	Labor	10	1	7	9	2	3	8	6	4	5
Food	High Margin	10	1	4	9	2	3	8	5	6	7
Drink	High Margin	10	1	4	9	2	3	8	5	6	7
Chemical	High Margin	10	1	4	9	2	3	8	5	6	7
Aerospace	High Margin	10	1	4	9	2	3	8	5	6	7
Medical	High Margin	10	1	4	9	2	3	8	5	6	7
Food	Low Margin	10	1	7	9	2	3	8	6	4	5
Drink	Low Margin	10	1	7	9	2	3	8	6	4	5
Chemical	Low Margin	10	1	7	9	2	3	8	6	4	5
Aerospace	Low Margin	10	1	7	9	2	3	8	6	4	5
Medical	Low Margin	10	1	7	9	2	3	8	6	4	5

Index of estimated annual state and local tax burden for illustrative businesses In Philadelphia and comparison cities (Philadelphia = 100)

Industry	Type	Philadelphia, PA	Houston, TX	Cleveland, OH	San Diego, CA	Dallas, TX	Fort Worth, TX	Minneapolis, MN	Boston, MA	Nottingham, PA	Downingtown, PA
Food	Median	100	28	45	72	28	28	54	41	39	39
Drink	Median	100	37	38	61	37	37	45	35	35	35
Chemical	Median	100	30	39	69	30	30	55	43	45	45
Aerospace	Median	100	23	44	76	23	23	60	46	44	44
Medical	Median	100	21	44	73	21	21	57	44	42	42
Food	Average	100	35	34	63	36	36	50	39	42	42
Drink	Average	100	21	39	72	21	21	59	46	47	47
Chemical	Average	100	33	36	66	33	33	53	42	44	45
Aerospace	Average	100	36	30	62	36	36	52	42	47	48
Medical	Average	100	23	40	73	23	23	60	47	47	47
Food	Big	100	29	43	69	29	29	54	42	45	45
Drink	Big	100	19	40	73	19	19	58	45	47	47
Chemical	Big	100	29	42	73	29	29	54	43	46	46
Aerospace	Big	100	35	38	70	35	36	52	42	48	48
Medical	Big	100	20	45	81	20	20	63	49	50	50
Food	Small	100	37	48	76	37	37	56	43	41	41
Drink	Small	100	23	54	84	23	23	65	50	46	46
Chemical	Small	100	30	39	69	30	30	55	43	45	45
Aerospace	Small	100	41	37	68	41	41	54	42	46	46
Medical	Small	100	21	35	67	21	21	56	44	46	46

Index of estimated annual state and local tax burden for illustrative businesses In Philadelphia and comparison cities (Philadelphia = 100)

Industry	Type	Philadelphia, PA	Houston, TX	Cleveland, OH	San Diego, CA	Dallas, TX	Fort Worth, TX	Minneapolis, MN	Boston, MA	Nottingham, PA	Downingtown, PA
Food	Capital	100	50	42	54	50	50	38	32	36	36
Drink	Capital	100	37	42	64	37	37	47	37	36	36
Chemical	Capital	100	14	34	68	14	14	59	47	49	50
Aerospace	Capital	100	33	43	67	33	33	50	39	37	37
Medical	Capital	100	20	39	69	20	20	57	45	44	45
Food	Labor	100	20	44	76	21	21	60	46	44	44
Drink	Labor	100	22	56	86	22	22	66	51	46	46
Chemical	Labor	100	32	45	70	32	32	51	39	37	37
Aerospace	Labor	100	23	49	80	23	23	62	47	44	44
Medical	Labor	100	21	47	77	21	21	59	45	42	42
Food	High Margin	100	23	34	66	23	23	56	44	47	47
Drink	High Margin	100	19	31	65	19	19	56	44	48	48
Chemical	High Margin	100	12	33	69	13	13	61	48	51	51
Aerospace	High Margin	100	17	31	66	17	17	58	46	50	50
Medical	High Margin	100	17	39	75	17	17	64	50	51	51
Food	Low Margin	100	27	50	79	27	27	59	45	40	40
Drink	Low Margin	100	32	45	72	33	33	53	40	38	38
Chemical	Low Margin	100	39	44	71	39	39	52	41	40	40
Aerospace	Low Margin	100	37	51	80	37	37	58	45	42	42
Medical	Low Margin	100	33	43	69	33	33	51	39	37	38