

## SHALE INDUSTRY'S ECONOMIC CONTRIBUTION IN OHIO, USA: IMPLICATIONS FOR FUTURE ACTIVITY IN THE STATE

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### **Abstract**

Ohio's shale industry serves as a significant facet of the state's economy, employing nearly 150,000 and contributing over \$22 billion of positive impacts as of 2015. With advancements in hydraulic fracturing techniques, and access to the Marcellus and Utica shale plays in the eastern part of the state, Ohio has noteworthy potential for future shale development despite anecdotal discussion of a potential bust of the industry. This research employed a multi-industry economic contribution analysis using IMPLAN and an input-output methodology with 2015 data to quantify the economic contribution of the shale industry across the entire State of Ohio, as well as a 26-county Appalachian Ohio region where most shale extraction activity is taking place. Strong economic impact metrics are found for shale activity, including robust multiplier effects relative to other industries in the state. Out of the six modeled shale-related sectors, Pipeline Transportation, by far, pays the highest wages. Further, in order, the top five counties by total economic contribution per capita are Noble, Monroe, Belmont, Guernsey, and Washington. In fact, roughly 90% of the gross regional product in Monroe and Noble counties is attributable to the shale industry. With these findings, economic development and policy implications are highlighted, which are important as no other shale-play region in the U.S. is so disproportionately affected by resource extraction which contributes to regional poverty and negative pollution effects. Retaining wealth in this region with the legacy of boom-and-bust resource extraction is ever important, and this paper provides a baseline for analysis when looking how the shale industry changes over time.

**Keywords:** Energy, Natural Resources, Rural Economics, Resource Policy

**JEL classification:** J68, O13, P48

### **1. Introduction**

The Appalachian region of Ohio has a history of resource extraction booms, often supplemented by subsequent 'busts' in that respective industry. For instance, the region's coal industry provides an exemplary case of a production that was once thriving with employment and opportunity, yet is now struggling due to a national shift away from coal as an energy generation resource, increased environmental regulations, and other market factors. This boom then bust cycle often pulls valuable resources from the region with only temporary positive economic impact.

One of the most recent resource extraction booms relates to the shale gas industry, where advancements in hydraulic fracturing (i.e., 'fracking') techniques have helped spur a shale boom in the region over the past decade. Fracking techniques have helped efficiently extract natural gas from the earth, and companies throughout Appalachian Ohio have increasingly been drilling wells to extract this resource. Moreover, Ohio has two of the largest nationwide shale plays in the Southeastern part of the state: the Marcellus and Utica. This paper considers these resources and works to update prior studies and their shale industry economic impact data.

To accomplish this task, the researcher used a selected subgroup of six NAICS employment codes related to the shale industry in Ohio. Specifically, the researcher used multi-industry economic contribution analysis techniques with IMPLAN version 3.1 and an input-output methodology to determine the impact of these six unique industry sectors to Ohio, as well as a pre-identified 26-county shale-heavy region in Southeastern Ohio. This research also uncovered other, ancillary industries that were affected by Ohio's shale activity, and state and local tax impacts. Finally, county-by-county models were created for each of

the 26 studied counties, highlighting both the real and per capita economic impacts. Throughout all models, employment, wages, value added, multiplier effects, and economic impact figures were generated to help analyze the value of production from Ohio's shale industry cluster.

The following sections of this paper work to define Ohio's shale industry cluster, highlighting the six specific industries investigated. Following a brief review of the existing literature related to shale's economic impact in Ohio, the specific methods and modeling techniques are delineated. Finally, conclusions and implications are discussed, offering considerations for paths forward for industry leaders and policymakers working in this arena.

## 2. Defining Ohio's shale industry cluster

Ohio's shale industry is the fourth largest in the United States (U.S.), behind only Texas, Oklahoma, and Pennsylvania, with over 275,000 wells drilled (Ohio Oil and Gas Energy Education Program 2017). The industry produces enough energy from natural gas to heat over 1 million businesses and homes in Ohio alone, and almost 70% of all the homes in Ohio are heated by natural gas (Ohio Oil and Gas Energy Education Program 2017). Moreover, shale natural gas can be processed and refined to thousands of everyday products (e.g., medical products, plastics, etc.), indicating its importance as a prominent energy resource, as well as its practical applicability as an input in the manufacturing of key goods used by numerous consumers in the region.

Table 1 displays the 6-digit NAICS codes that represent the direct shale industry cluster in Ohio. Every U.S. business is documented under a specific NAICS code, which defines its area of business operations. The researcher matched these NAICS codes to IMPLAN codes for the purposes of economic impact modeling, which are also displayed in the table.

**Table 3: Core Shale-Related Industries**

NAICS	Description	IMPLAN#	Description
211111	Crude Petroleum and Natural Gas Extraction	20	Extraction of Natural Gas and Crude Petroleum
211112	Natural Gas Liquid Extraction	21	Extraction of Natural Gas Liquids
213111	Drilling Oil and Gas Wells	37	Drilling Oil and Gas Wells
213112	Support Activities for Oil and Gas Operations	38	Support Activities for Oil and Gas Operations
237120	Oil and Gas Pipeline Construction	58	Pipeline Construction other than Sewer and Water
486210	Pipeline Transportation of Natural Gas	413	Pipeline Transportation

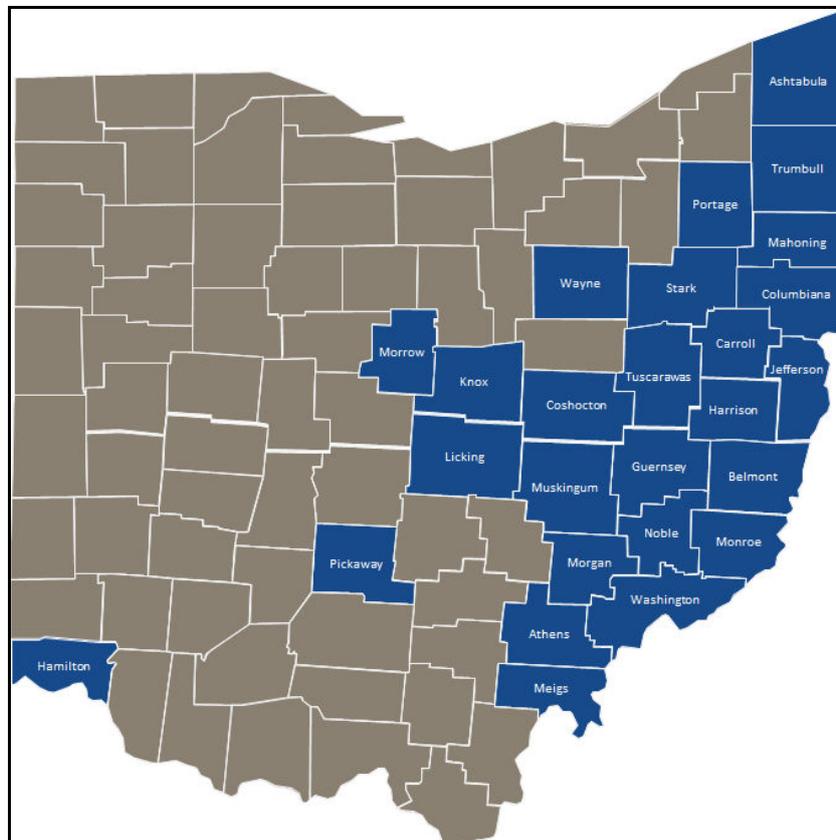
This study specifically focused on the south and eastern geographies of Ohio, where a majority of the state's shale oil & gas resources reside, as shown in Figure 1. Figure 2 consequently illustrates the specific counties included in this analysis, most of which reside directly in the Marcellus and Utica shale plays. However, one county, Hamilton, falls well outside of this region, but was included due to it meeting the criteria of having a large enough number of production and injection wells, as well as primary and secondary oil & gas workers, as derived from Ohio Department of Natural Resources data (Ohio Department of Natural Resources 2017).

**Figure 1: Ohio's Shale Oil & Gas Resources**



Source: Ohio Environmental Protection Agency. (2017). *How is drilling in the Marcellus and Utica Shales regulated?* Retrieved from <http://epa.ohio.gov/marcellusanduticashale.aspx>

**Figure 2: Shale-Heavy Counties in Ohio**



Note: Map created by author.

### **3. Prior literature**

In the U.S., shale gas extraction is a relatively recent phenomena, developing exponentially in the last decade or two due to swift technological developments in the industry. Shale natural gas, in general, is also more environmentally friendly than other fossil fuels such as coal, as it releases less carbon dioxide (CO<sub>2</sub>) into the atmosphere (U.S. Energy Information Administration 2017). Taken together, these factors have stimulated a significant uptick in extraction and production across the U.S. in recent years. In a recent study, the American Petroleum Institute found that the natural gas and oil industry supports more than 262,800 jobs nationally, with more than \$14.7 billion in wages and \$37.9 billion in economic impact (American Petroleum Institute 2017). However, it should be noted that this study defines natural gas and oil jobs in the broadest of terms, and, unfortunately, does not offer specific figures for Ohio.

A small number of prior studies have, in fact, attempted to measure the jobs and economic impact of shale in Ohio. One study, conducted by Cleveland State University, focused on the Utica shale play during 2011–2014, and found that shale-related employment has grown significantly, from just over 2,000 in 2011, to nearly 66,000 in 2014 (Thomas et al. 2012). This research found that average earnings in the industry in Ohio were roughly \$69,000 per year (Thomas et al. 2012).

A different study found that, in 2013, Ohio accounted for 7.6% of the total national employment in the petrochemical industry (the petrochemical industry is defined as the compounding, distribution, and conversion of petrochemicals (petroleum or natural gas)) with 74,753 jobs (Lendel et al. 2015). More telling, however, is that the study noted that nearly 69% of national petrochemical employment was located within a 500-mile radius centered around the Ohio, Pennsylvania, and West Virginia tristate area. Moreover, Ohio accounted for around 6% of the national gross domestic product (GDP) that is directly generated by the petrochemical industry, and 5% of the national natural gas supply, in 2013 (Lendel et al. 2015).

Since 2012, the Ohio Department of Jobs and Family Services has conducted quarterly reports on the economic implications of shale in Ohio. In quarter 4 (Q4) of 2012, it was reported that 8,781 people were directly employed in the core shale industries (Ohio Department of Jobs and Family Services 2013). However, in Q4 of 2016, it was reported that 14,669 people were directly employed in core shale industries (Ohio Department of Jobs and Family Services 2017). These reports differ from most prior shale employment research since they utilize the U.S. Bureau of Labor Statistics' Quarterly Census of Employment and Wages data, which may suffer from data suppression issues, and does not capture the ancillary job effects through the supply chain and otherwise. Taken as a whole, although a few studies have investigated the economic impact of the shale industry both nationally and in Ohio, none have addressed these impacts over the past few years, nor have they focused on the localized impacts of the state's shale heavy region.

### **4. Methodology**

The methodology employed for this analysis involved a two-step process. First, the researcher organized the relevant shale industry sectors and gathered industry sales figures from IMPLAN 3.1 software as model inputs. Next, model modifications were made so that each sector in the analysis made 100% of its primary commodity, and trade flows were also adjusted so that the local use ratio was 0 for each sector. Both are standard and necessary steps to conduct a multi-industry economic contribution analysis.

These customizations were completed before running the analysis for the 26-county study area. The 26-county shale study region in Ohio ranges from Ashtabula County in the far northeast, to Meigs County in the Southeast. Four criteria were used to select these counties, and each county that had at least one of these criteria was included in the study. A minimum threshold was used for each criteria to determine whether a significant enough amount of shale activity was happening in the county. The criteria were as follows: number of production wells [2.5% of maximum threshold], number of injection wells [30% of maximum threshold], number of primary oil and gas workers [10% of maximum threshold], and number of primary plus secondary oil and gas workers [10% of maximum threshold]. The production

and injection well data was collected by the Ohio Department of Natural Resources and employment data was collected by JobsOhio.

This method utilized allowed the researcher to assess the direct effects of the six shale industry sectors within each of the 26 Ohio counties. The researcher used 2015 data, as this was the most recent data available at the time of analysis. The following list outlines each of the industry sectors used in this analysis, categorized by their NAICS codes and associated industry name.

- **211111 - Crude Petroleum and Natural Gas Extraction:** This industry comprises of establishments primarily engaged in (1) the exploration, development, and/or the production of petroleum or natural gas from wells in which the hydrocarbons will initially flow or can be produced using normal pumping techniques, or (2) the production of crude petroleum from surface shales or tar sands or from reservoirs in which the hydrocarbons are semisolids.
- **211112 - Natural Gas Liquid Extraction:** This industry comprises of establishments primarily engaged in the recovery of liquid hydrocarbons from oil and gas field gases. Establishments primarily engaged in sulfur recovery from natural gas are included in this industry.
- **213111 - Drilling Oil and Gas Wells:** This industry comprises of establishments primarily engaged in drilling oil and gas wells for others on a contract or fee basis. This industry includes contractors that specialize in spudding in, drilling in, re-drilling, and directional drilling.
- **213112 - Support Activities for Oil and Gas Operations:** This industry comprises of establishments primarily engaged in performing support activities on a contract or fee basis for oil and gas operations (except site preparation and related construction activities). Services included are exploration (except geophysical surveying and mapping); excavating slush pits and cellars, well surveying; running, cutting, and pulling casings, tubes, and rods; cementing wells, shooting wells; perforating well casings; acidizing and chemically treating wells; and cleaning out, bailing, and swabbing wells.
- **237120 - Oil and Gas Pipeline and Related Structures Construction:** This industry comprises of establishments primarily engaged in the construction of oil and gas lines, mains, refineries, and storage tanks. The work performed may include new work, reconstruction, rehabilitation, and repairs. Specialty trade contractors are included in this group if they are engaged in activities primarily related to oil and gas pipeline and related structures construction. All structures (including buildings) that are integral parts of oil and gas networks (e.g., storage tanks, pumping stations, and refineries) are included in this industry.
- **486210 - Pipeline Transportation of Natural Gas:** This industry comprises establishments primarily engaged in the pipeline transportation of natural gas from processing plants to local distribution systems.

## 5. Findings

Table 2 displays the tax impacts of the shale industry in the region. Within the state and local areas, shale activity generated a total of \$1,009,373,536 in revenue from all different sources. Here, household income tax is comprised of personal income tax, motor vehicle license, non-tax fines and fees, property taxes, and other taxes. Tax on production and imports consists of motor vehicle license, property tax, sales tax, severance tax, S/L non-taxes, and other taxes. At the federal level, the shale industry generated a total of \$1,596,287,950 in tax revenue. The corporations' tax impact is comprised of only federal profit tax.

**Table 2: Tax Impacts of Shale in Ohio, 2015**

Description	Employee Compensation	Proprietor Income	Tax on Production and Imports	Households	Corporations
Total State and Local Tax	\$15,905,010	\$0	\$781,374,312	\$205,417,450	\$6,676,764
Total Federal Tax	\$627,431,424	\$81,671,688	\$107,065,166	\$522,233,152	\$256,885,520

As shown in Table 3, Ohio's shale industry directly employed almost 86,000 in 2015, with a total employment impact of nearly 150,000. The multiplier effect for employment is 1.71, meaning that for every direct job in the shale industry, an additional 0.71 jobs were created in the state resulting from that activity. The shale industry directly contributed over \$13 billion to the state's economy, and, when including all other impacts, more than \$22 billion to the state's economy.

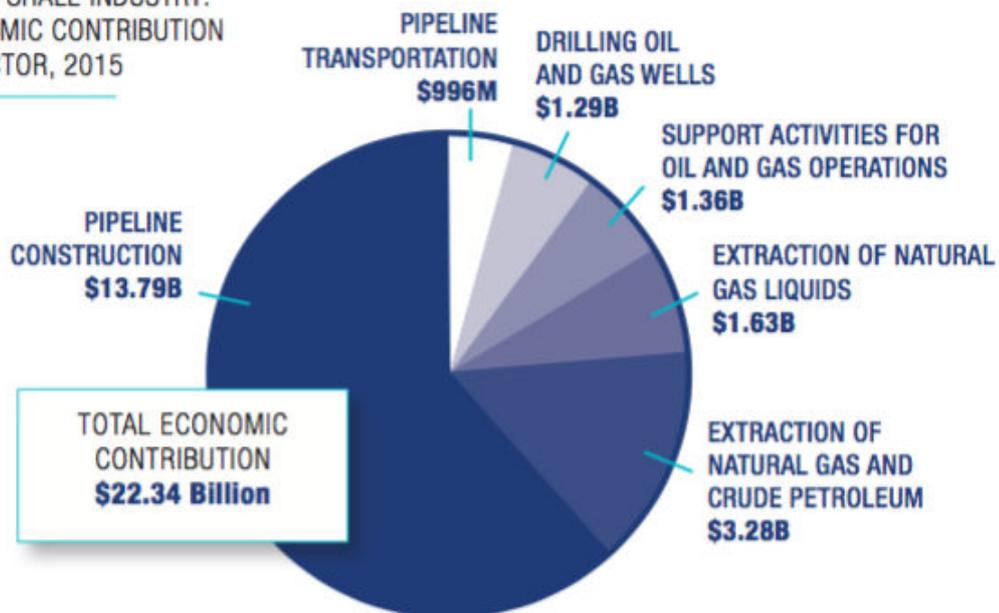
**Table 3: Contribution Summary of Shale in Ohio, 2015**

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	85,973	\$4,396,199,705	\$6,261,201,287	\$13,017,465,088
Indirect Effect	21,978	\$1,255,830,573	\$2,106,626,577	\$3,935,515,796
Induced Effect	39,175	\$1,673,994,364	\$3,071,422,985	\$5,347,882,116
Total Effect	147,126	\$7,326,024,643	\$11,439,250,850	\$22,340,863,000
<b>MULTIPLIER</b>	<b>1.71</b>	<b>1.67</b>	<b>1.83</b>	<b>1.72</b>

Figure 3 displays the economic contribution by shale industry sector in 2015, finding that roughly two thirds of its total contribution came from Pipeline Construction at nearly \$14 billion. The Extraction of Natural Gas and Crude Petroleum (\$3.28 billion) and Extraction of Natural Gas Liquids (\$1.63 billion) came in at a distant second and third, respectively.

**Figure 3: Economic Contribution by Sector**

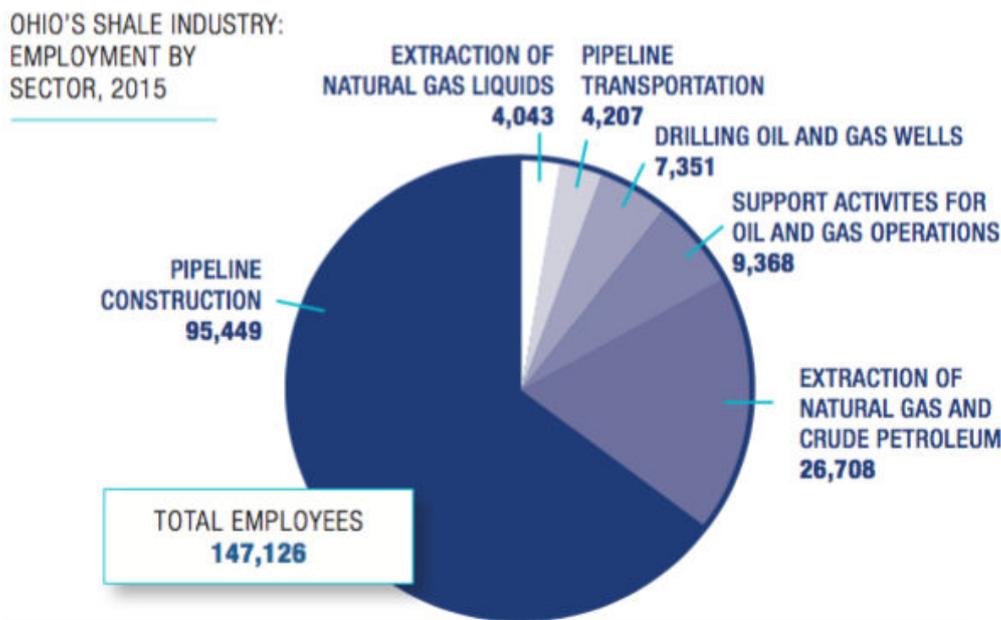
OHIO'S SHALE INDUSTRY:  
ECONOMIC CONTRIBUTION  
BY SECTOR, 2015



Note: Figure created by author.

Next, Figure 4 displays the employment by sector, which largely mimics the economic contribution data. In this case, pipeline construction accounted for over 95,000 jobs, followed distantly by the Extraction of National Gas and Crude Petroleum with almost 27,000 jobs.

**Figure 4: Employment by Sector**



Note: Figure created by author.

The researcher also examined the extent to which Ohio’s shale industry affected other, ancillary industries in the study area through the induced effects. Table 4 shows the top five industries affected outside of the direct and indirect effects, organized by employment. While Wholesale Trade represented a sizeable proportion of these impacts, positive effects were also felt in the restaurant, healthcare, and real estate industries.

**Table 4: Top Industries Affected By Shale Employment**

Sector	Description	Employment	Labor Income	Value Added	Output
395	Wholesale Trade	3,093	\$246,744,573	\$445,097,123	\$728,926,139
502	Limited-Service Restaurants	2,402	\$42,634,756	\$95,018,032	\$176,868,462
501	Full-Service Restaurants	2,343	\$48,759,072	\$51,696,191	\$103,981,664
482	Hospitals	2,226	\$158,708,056	\$176,811,987	\$323,652,177
440	Real Estate	1,986	\$71,417,864	\$334,431,514	\$436,353,413

Next, a wage ranking was created for each of the core sectors related to the shale industry, as defined in Table 1 and Section 4. As shown in Table 5, despite being the lowest economic contributor, Pipeline Transportation paid the highest wages. Pipeline Construction, which employs the most people in Ohio and sits as the highest economic contributor, had an average wage value of nearly \$51,000. These figures were calculated by dividing the labor income metric by the employment count per sector. Overall, in 2015, Ohio shale industry workers made an average annual salary of \$56,311.06. Next, a wage ranking was created for each of the core sectors related to the shale industry, as defined in Table 1 and Section 4. As shown in Table 5, despite being the lowest economic contributor, Pipeline Transportation paid the highest wages. Pipeline Construction, which employs the most people in Ohio and sits as the highest economic contributor, had an average wage value of nearly \$51,000. These figures were calculated by dividing the labor income metric by the employment count per sector. Overall, in 2015, Ohio shale industry workers made an average annual salary of \$56,311.06.

**Table 5: Wage Ranking by Sector, 2015**

<b>Sector</b>	<b>Average Wage</b>
Pipeline Transportation	\$84,049.95
Support Activities for Oil and Gas Operations	\$57,834.47
Extraction of Natural Gas Liquids	\$56,210.02
Pipeline Construction other than Sewer and Water	\$50,922.43
Drilling Oil and Gas Wells	\$50,573.39
Extraction of Natural Gas and Crude Petroleum	\$38,276.07
<b>AVERAGE</b>	<b>\$56,311.06</b>

Finally, Table 6 outlines the top shale-related counties in the State of Ohio, ordered by their economic impact per capita (i.e., economic contribution/impact divided by county population in 2015). This analysis shows that Noble, Monroe, Belmont, Guernsey, and Washington were the top performing shale counties, per capita, during the study years. Belmont County actually had, by far, the largest aggregate (non per capita) economic impact at \$1.1 billion. Number of employees per county is shown in the final column. The full list of counties ranked by economic impact per capita can be found in Appendix A.

**Table 6: Ohio's Shale Industry Clusters by County, 2015**

<b>County</b>	<b>Economic Impact Per Capita</b>	<b>Total Economic Impact</b>	<b>Employees</b>
Noble	\$25,407	\$365M	926
Monroe	\$23,074	\$334M	1,423
Belmont	\$15,841	\$1.1B	3,991
Guernsey	\$10,831	\$429M	1,713
Washington	\$9,989	\$611M	2,695

## **6. Conclusions**

The purpose of this paper was to analyze the economic impact of Ohio's shale industry. Using a 26-county region, this research shows that shale is a sizeable contributor to the state in terms of employment, wages, tax contributions, and other key metrics. As the fracking boom continues in Ohio, it is important to quantify these variables in order to provide a baseline for analysis when looking how this industry changes over time. This paper fills gaps in the suite of prior literature with a refined methodology and newer data.

Overall, the Pipeline Construction sector contributed the most to the state's economy and employed the most individuals. Despite this, Pipeline Transportation paid the highest wages across all other sectors. These data should be used in future research and future economic development work to better understand targeted sectors to retain regional wealth and productivity to mitigate the impacts of the impending resource bust. Relevant practitioners and organizations ought to consider strategies such as workforce development and education, training and re-training programs, and supply chain assistance and connectivity. This is increasingly important when considering that the 2015 figures presented in this report show a slight decline from the 2014 figures (e.g., total effect employment declined by about 10,000 jobs).

Appalachian Ohio historically – and currently – suffers from a 'brain drain' issue, and, even for lower-skilled jobs, drug testing, work habits, and basic skills remain a concern. Like many other industries in Appalachia, the shale industry situation may be another care of resource extraction with a failure to capture local value. This leaves increased pollution, infrastructure problems, etc. in the region, while higher value added activity takes place elsewhere. Perhaps workforce training, policy changes, and firm connectivity can alleviate this situation and continue to enhance these economic impact and job metrics looking toward the future.

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