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Job Creation from the US "Shale Gale"

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Until recently, oil and gas resources that occur within tight shale formations throughout the United States were uneconomical to recover. But technological advances—principally in horizontal drilling and hydraulic fracturing—have, since 2007, lowered production costs, which has dramatically increased the amount of oil and gas being produced in the US. According to the Department of Energy, US natural gas production increased 57% between 2007 and 2018 and is widely available at greatly lowered (by two-thirds) and stable prices. And the outlook continues to be bright: the Department of Energy projects US natural gas production to rise through 2050.

The result of this US "shale gale" has been transformational for consumers of natural gas, including industrial consumers. North American natural gas prices are significantly lower than natural gas prices in Europe and Asia, and this price gap has caught the attention of investors in manufacturing. By March 2013, for example, nearly 100 new chemical industry investments in the United States, valued at $72 billion, were announced, and roughly half were from foreign firms. Since 2010, more than $200 billion of new chemical capacity has been announced—about 70% from foreign direct investment.

Given the number and size of announced investments, it is reasonable to ask: How many manufacturing jobs have been created in the United States due to the shale gale? This question is relevant for policy makers and others concerned about the competitiveness of US manufacturing.

Natural Gas and US Manufacturing

The US shale gas boom has direct, indirect, and downstream impacts on job creation. First, it increases direct employment in oil and gas production because of the additional labor required to meet the increase in demand. Furthermore, as oil and gas production increases, suppliers to the oil and gas industry increase their output and indirect employment.

Downstream manufacturers also benefit. Manufacturers utilize natural gas and natural gas components not only as a combustion source but also as a feedstock material. For example, ethane from natural gas is used to produce ethylene, a building block material used extensively in chemical manufacturing.

The technological advances that have lowered the cost of shale gas production have lowered energy costs for industrial consumers of natural gas. Furthermore, this lowering of price is not immediately reflected in global markets because of high transportation costs; the physical properties of natural gas differentiate it from other forms of fossil energy. Because of these high transportation costs, there is a regional price disparity in natural gas between North America, Europe, and Asia. This price gap creates a competitive advantage for global manufacturers—and especially energy-intensive manufacturers—with access to North American gas. Academic research has quantified the economic impact for the early years of the North American shale revolution, which is still underway.

Empirical Studies

Four studies have utilized empirical data to estimate job creation in the US manufacturing sector due to the US shale gale. These studies relate to the competitive advantage of lower priced natural gas (& co products) rather than manufacturing gains from supply chain impacts on the production side.

The studies, and their estimates, are shown in Table 1.

Melick (2014) developed a regression model to explain manufacturing employment as a function of energy intensity and the relative price of US natural gas (compared to that of Europe). Control variables included US GDP and world oil price. The dependent variable was lagged to allow for employment to adjust to changes in energy intensity. Long-run elasticities were estimated from this regression model for 24 manufacturing subsectors and for manufacturing as a whole. The results show that industrial employment rises with a drop in the relative price of natural gas, the change is statistically significant, and the more energy-intensive industries exhibit the largest increases in employment. The results remain robust relative to different measures of energy-intensity.

Hausman and Kellogg (2015) estimated supply and demand curves for natural gas in the industrial sector from 2007-2013 to determine the counterfactual price of natural gas in 2013 in the absence of the shale gas boom. The resulting supply and demand curves are then used to estimate changes in

Table 1. Empirical Studies of Job Creation.

Reference	*Years Covered*	*% Increase in Total Manufacturing Jobs*	*Number of New Manufacturing Jobs*
Melick (2014)	2006-2013	2%-3%	240,000-361,000
Hausman and Kellogg (2015)	2007-2012	2.4%	280,000
Kirat (2016)	2006-2013	0.2% - 0.6%	24,000-72,000
Gray et al. (2018)	2007-2012	0.6%	24,000-36,000
RANGE		0.2%-3%	24,000-361,000

producer and consumer surplus. They then look at energy- intensity across 230 different manufacturing sectors from 2007-2012 and, using regression analysis, determine the impact on employment from changes in natural gas price. Employment in the most energy-intensive industries (i.e., the top decile) increased between 24,000 and 65,000 (3.4% and 9.1%) in 2012. To determine the impact on employment across manufacturing as a whole, they control for employment in 2002 and 2007 to eliminate pre-existing secular trends correlated with gas intensity and they control for fixed effects in major industry subsectors. They estimated that the shale gale raised total manufacturing employment 280,000 in 2012 (out of 11 million).

Kirat (2016) developed a regression model to estimate the impact of relative natural gas price between the US and Europe on US employment over the time period 2006-2013 for 79 industrial sectors, which differ by energy intensity. Kirat controlled for individual fixed effects (by sector) and time fixed effects (GDP, exchange rates). The decline in the relative price of natural gas is associated with a rise of 15% for the most gas-intensive sector (nitrogenous fertilizer production) but just 0.2% for manufacturing as a whole.

Gray et al. (2018) used county-level data on US manufacturing plants to estimate employment effects. Their regression model explicitly controlled for factors associated with employment dynamics, such as input costs and proximity to customers. They estimated a 0.6% and 1.8% increase in employment for manufacturing as a whole and for the most energy-intensive firms (the top 25% quartile), respectively, for the time period of interest (2007-2012). Natural gas prices explain more than half of the observed difference between the gas-intensive industries and manufacturing as a whole.

Conclusions

These studies show a remarkable consistency in terms of the direction of the job creation in manufacturing attributable enhanced US natural gas production. And because these researchers employed different methods while covering a similar time period, the results warrant greater confidence than would otherwise be the case. From these studies, we can conclude the following:

The shale gas boom has created jobs in the US manufacturing sector due to the price gap between the US and the rest of the world. The total number of manufacturing jobs created between 2006-2013 ranges from 24,000 to 361,000 (0.2%-3%).

Energy-intensive manufacturing has benefitted from a low cost plentiful supply of energy to a much greater extent than manufacturing as a whole—an employment increase of up to 30% is documented in the most gas-intensive industries. The shale gale explains more than half of net job creation in these energy-intensive sectors between 2006 and 2013.

Because manufacturing has a relatively high multiplier due to its both forward and backward linkages in supply chains, it is likely that the number of indirect jobs created could be of a similar magnitude as the number of manufacturing jobs created, though none of the empirical studies described here included an estimate of the economic multiplier.

The longer-term impact of the shale gas boom (e.g., 2013-2019) has not been studied due to a lack of available data. The trends in employment could be higher or lower than short-term estimates due to factors such as increased US exports of natural gas (in the form of liquefied natural gas, or LNG), changes in shale gas production in the rest of the world, and longer term investment decisions by US manufacturers. (Indeed, a "second wave" of major investments/expansions by energy-intensive manufacturers has been noted.)

US exports of LNG—which have been spurred by the shale gas revolution—can be expected to increase social welfare globally and US jobs in shale gas production, but it may also reduce the price disparity between regions of the world and therefore reduce the competitive advantage of US manufacturing and reduce foreign direct investment.

Nevertheless, there are no signs that LNG exports are negatively impacting US job creation nor that Europe and Asia are ramping up natural gas production similar to that of the United States. We therefore conclude that the enhanced US production of natural gas has and will in the foreseeable future have a measurable positive impact on employment in domestic manufacturing. In the long run, and presuming an economy near full employment, net employment impacts (as opposed to employment in certain sectors) should be small or nonexistent.

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Peer Reviewers: Josh Linn, Senior Fellow, Resources for the Future and Martha Moore, Senior Director, American Chemistry Council.

For Further Reading:

Wayne Gray, Joshua Linn, and Richard Morgenstern, 2018. The Impacts of Lower Natural Gas Prices on Jobs in the US Manufacturing Sector, Resources for the Future, January.

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