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Follow the money: Aggregate, sectoral and spatial effects of an energy boom on local earnings☆

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A B S T R A C T

Many U.S. towns reportedly boomed after new technologies in oil and gas extraction led to rapid development of shale resources. Recent research on the expected economic impact mainly focused on the employment effects associated with new oil and gas jobs. Instead, our focus is on the impact of oil and gas industry growth on local earnings while paying attention to the spatial and sectoral effects and assessing whether an increase in earnings due to energy development seeps out due to the peculiarities of the industry. Our estimation results suggest that oil and gas earnings multipliers are modest and similar to oil and gas employment multipliers, with relatively large shares of the earnings leaving the county on average. Likewise, oil and gas multipliers tend to be smaller or comparable to the estimated multipliers for equal-sized shocks in the rest of the economy, suggesting that oil and gas is not a special industry case. Given the high wages in the sector (and potentially large royalty payments), these results may be surprising.

1. Introduction

Innovations in oil and gas extraction, specifically hydraulic fracturing and horizontal drilling, have changed the face of global energy markets. As a result of the "shale revolution", areas that were previously economically unviable for energy development became home to drilling activity. As U.S. oil and gas production from shale increased, so did direct oil and gas employment and total earnings in most states. Between 2001 and 2014, employment and total earnings in Oil and Gas Extraction (NAICS2111) and Support Activities for Mining (NAICS2131) industries has grown in 43 states with growth exceeding 100% in 25 states for employment and in 28 states for total earnings (Appendix Table A1). Hydraulic fracturing is credited with helping to keep CO_2 emissions below 2005 levels due to enhanced use of natural gas instead of coal (U.S. Energy Information Administration, 2014). The shale revolution is touted by industry supporters as providing a key source of jobs and incomes for locally affected communities.

Despite the hype, an emerging academic consensus is that modern energy development is associated with moderate local economic impacts (Weinstein, 2014; Munasib and Rickman, 2015). First, the oil and gas industry still encompasses a small share of the economy; during the shale boom, its share of total nonfarm employment in the US increased from 0.23% in 2001 to only 0.44% in 2014 (BEA), just as the recent boom subsided.[1] Second, the oil and gas industry is capital-intensive and it appears that very recent innovations (especially automation) made an already productive industry even more productive (Krauss, 2017). Although higher productivity is undoubtedly good for overall economic efficiency, it also reduces the expected labor market impacts. Third, after wells are drilled and the shale is fractured, each well requires significantly fewer workers to continue production compared to the initial construction and drilling phases (Kelsey et al., 2016).

The extant U.S. research has predominantly focused on estimating the expected *employment* effects of shale development (Fleming and Measham, 2014; Tsvetkova and Partridge, 2016; Weinstein, 2014) with less attention paid to the *earnings* effects. The studies assessing changes in local income and earnings as a result of expanding oil and gas extraction often consider only selected regions within the country. This paper adopts a comprehensive approach and, unlike the most of the existing scholarship, assesses the relationship between the energy sector growth and local earnings (total and average per job) using data on all counties in the continental United States. Acknowledging the spatial and sectoral variation in the labor market effects of energy documented

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[1] Calculated using U.S. Bureau of Economic Analysis (BEA) nonfarm employment data. Oil and gas employment the oil and gas sector.

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in the literature (Cosgrove et al., 2015; Komarek, 2016; Munasib and Rickman, 2015), we extend our analysis to separately consider subsectors of the economy and various regions of the country. Another important distinction of our approach is that we estimate earnings multipliers of each additional dollar earned in the energy sector (both oil and gas), whereas other studies largely show the effects of an additional gas well. Given very uneven productivity of the wells across regions and over time, the estimates are likely to be imprecise limiting the applicability of such research in policy design. To further put our findings in a perspective and to offer policy-relevant insights, we benchmark the local labor impacts of the recent (positive) shock in the oil and gas industry against equal-sized shocks in the rest of the economy. Finally, perhaps the most important contribution is to document a sizable leakage of the additional earnings brought to a community by the expanding energy sector. These are important issues because the ability of a resource boom to promote long-term prosperity (or, alternatively, to facilitate the development of a resource curse) at least partially depends on how much income from an expanding energy sector remains local.

One reason for the lack of studies that estimate earnings multipliers is arguably the lack of data at sufficiently disaggregated level to capture oil and gas industry earnings in order to make accurate derivations. In the publicly available sources, such detailed information is typically suppressed because of confidentiality concerns, especially in sparsely populated counties where firm identification may be easier. We use detailed annual oil and gas employment and earnings data at the county level from 2001 to 2013 provided by Economic Modeling Specialists Intl. (EMSI) to measure the impacts of shale development.

Our base findings suggest that for every dollar increase in oil and gas earnings, counties should expect an increase of about 30 cents in all other industries (a multiplier of 1.3) in the nonmetro sample and an increase of about 10 cents (a multiplier of 1.1) in the metro sample. The earnings multipliers vary across space with larger impacts observed in areas that mostly did not have an appropriate supportive infrastructure in place. The effects also differ between tradable and non-tradable industries with some evidence of crowding out of nonmetro tradable total earnings, consistent with the Dutch Disease phenomenon. By comparison, the impact of oil and gas shocks tends to be similar (or somewhat smaller) than the effects of equal-sized shocks in the rest of the economy. We also find that the added earnings that are a result of the expanding oil and gas industry mostly leave the locality they were generated in (perhaps due to the use of in-migrant workers), limiting the benefits to local residents.[2]

2. The relationship between resource endowment and earnings

The shale boom is a relatively recent phenomenon and our knowledge on the relationship between shale oil and gas extraction and earnings is very limited. It might be useful, however, to refer to the studies that looked at previous booms in the extraction of resources other than oil and gas. For example, Margo (1997) finds that the boom (and bust) of the 1840s gold rush in California left wages permanently higher. During the construction of the Trans-Alaska Pipeline in the 1970s (the world's largest privately financed construction project at the time), wages showed significant flexibility with construction experiencing higher wages in the short run but not the long run (Carrington, 1996). Although this resulted in most residents experiencing large income gains, higher prices offset the gains for workers in most industries other than construction. The demand shock also had adverse effects on many social welfare measures such as crime rates. Thus, many residents may have been worse off.

Other research shows that the impacts of resource booms and busts are not symmetric. In an analysis of the 1970s coal boom and subsequent 1980s bust, Black et al. (2005) found the short- and long-term wage impacts varied by sector. Although wages showed flexibility in both mining and non-mining sectors, migration did not eliminate the wage impacts. For mining, wages increased 27.3% during the boom and declined by only 9.7% during the bust. This was not the case for non-mining sectors where wages increased only 5.8% during the boom but decreased 9.3% during the bust. Similarly, Jacobsen and Parker (2014) examine the oil boom and bust of the 1970s and 1980s in the Rocky Mountain region. They find evidence of long run negative impacts, though their net present value calculations suggest that the increases in income during the boom outweigh the losses.

One issue that should be noted regarding the interpretation of oil and gas impacts on employment versus earnings follows from the spatial equilibrium model used by regional and urban economists. Specifically, it is *utility and profits* that are equalized across space in equilibrium rather than (say) real or nominal incomes. Thus, while positive employment effects are more unambiguously viewed as a good thing for affected communities, higher wages in themselves are not necessarily a utility-enhancing factor. Specifically, higher wages and incomes may be a simple compensating variation to offset congestion, environmental damage, crime, and other negative attributes that are often associated with energy boomtowns. While we caution that higher incomes may not be utility enhancing, we will generally ignore this issue below.

The relatively poor long-term economic outcomes for natural resource abundant areas have been termed the “natural resource curse.” Supporting empirical evidence for the natural resource curse has been found at every level from countries (Sachs and Warner, 1995; Papyrakis and Gerlagh, 2004) to U.S. states (Papyrakis and Gerlagh, 2007; Freeman, 2009) and U.S. counties (Kilkenny and Partridge, 2009; James and Aadland, 2011; Jacobsen and Parker, 2014).[3] Despite having higher levels of natural capital and a comparative advantage in extracting and exporting these resources, many of these areas don’t appear to capitalize on such an advantage in the long run. By contrast, the export base hypothesis—which is similar to a modern mercantilist point of view—asserts that continued demand for these natural resources should lead to steady economic growth.

In the U.S., early industry-funded impact studies predicted that shale development would considerably boost local earnings. For example, Kleinhenz et al. (2011) estimated that Ohio wages would increase by $12 billion by 2015 thanks to shale drilling activity. To put that number in perspective, Ohio's *actual* growth in total compensation in the oil and gas sector between 2010 (when the shale boom began in Ohio) and 2014 was $284 million. Though 2015 has not been reported in detail, total compensation in the mining industry as a whole (which is mostly oil and gas in Ohio) fell by $52 million, so it is clear that this prediction is off by a factor of about 50. Even North Dakota's total compensation in the mining sector (virtually all oil and gas) increased by only $2.4 billion from 2003 to 2014 (BEA). Although Kleinhenz et al. (2011) estimates for Ohio seem large (especially compared to North Dakota where the shale boom has

[2] This study does not directly consider the effects of oil and gas royalty payments to resource owners in oil and gas localities. Brown et al. (2016) estimate that in 2014, royalty payments to the owners amounted to $39 billion in the six major shale (drilling) plays: Bakken, Eagle Ford, Haynesville, Marcellus, Niobrara, and Permian. Their analysis suggests that *including* absentee mineral owners, the share of personal income in those plays due to royalties ranges from 3.9% to 32.9%, though when only including actual resident recipients, the share of personal income that remains in the counties of royalty rights ownership ranges from 0.9% to 7.9%. An analysis of the local economic effects of royalties is an important topic of research (combined with the existing research on the impacts of energy sector growth). However, we would need a national county-level database over the 2001–2013 period to assess this issue (which is unavailable) and we leave this topic to future research.

[3] There are, of course, exceptions. Some natural resource abundant regions seem to experience positive long-term economic outcomes (Alexeev and Conrad, 2009; Cavalcanti et al., 2011; Fleming et al., 2015; Michaels, 2011). Jacobsen (2015) finds that housing prices and wages increase in almost all occupations in nonmetro areas that experience an energy boom. He concludes “there are many monetary ‘winners’ from energy development in local communities and very few losers” (pp. 3–4).