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Abstract

This paper examines the economic experience of past energy booms and of current unconventional shale gas and oil development. It focuses on key economic characteristics of gas and oil development, such as its employment potential, the geography of such development, its boom-bust nature, and the economic experience with shale oil and gas development. This background is used to discuss important economic policy issues arising with unconventional oil and gas development, such as taxation, governmental use of those revenues, preemption, and equity in the distribution of costs and benefits. The paper concludes with economic policy recommendations for states and communities affected by such development.

Keywords: economic impact; Marcellus shale; Bakken shale; natural gas

JEL Codes: L71, R11, R12

1. Introduction

The combination of horizontal drilling and hydraulic fracturing has revolutionized oil and gas development in the United States and elsewhere in the world. These production technologies have greatly expanded the scale of economically viable production from shale rock formations and have dramatically expanded the world's known oil and gas reserves. For example, crude oil production from tight oil and gas formations have increased fourfold since 2008, increasing from 12 percent of total U.S. crude oil production, to 35 percent of total U.S. production in 2012 (U.S. EIA, 2014a), with total crude oil production up 45 percent since 2008 (U.S. EIA, 2014b). Indeed, Bloomberg reports that the United States is the world's biggest oil producer, surpassing production by Saudi Arabia and Russia (Bloomberg, 2014).

Production of shale gas similarly has increased dramatically, and now accounts for about 40 percent of total U.S. dry production (see Figure 1) (U.S. EIA, 2014a). As a result, the United States is expected to become a net exporter of natural gas in the next decade (U.S. EIA, 2014a), which will help its trade balance. Domestic shale gas production has the promise of energy independence (though not independence from international price fluctuations), at least until the supplies are used domestically or exported.

The suddenness of this new technology's success has been accompanied by an outpouring of optimistic rhetoric by industry and politicians about the economic implications of unconventional oil and gas development. For example, in his 2012 State of the Union speech, President Obama highlighted the development of shale gas, including its economic implications. Policymakers in states with shale deposits have enthusiastically embraced the bold promises of economic prosperity to be created by what some call the 'Shale Revolution.' In some places, the optimistic promises of economic benefits have outweighed almost all other concerns about shale development (PoliticsPA, 2011). In the wake of the Great Recession, the anticipation of jobs appears to hold great sway.

Some U.S. communities have witnessed this optimism in the past, particularly during the energy booms of the 1970s and 1980s. Their experiences during and after those booms, as chronicled by residents and numerous academic studies, suggest there is reason to be wary about the potential long-run (net) benefits of such development, particularly at the local level. In addition to raising questions about the economic, social and other impacts during energy booms, their experiences most clearly indicate that the manner in which states and communities respond during the boom has consequences for long run economic activity, and for growth or decline of communities. There is some truth behind the old Texas joke about the sign on a bar room wall which says, “Dear God, give me one more oil boom. This time I promise not to piss it away”.

One important difference between the current unconventional energy boom and past energy booms, is that much of the activity currently is occurring in areas which lack previous experience with the boom and bust cycle of energy development. Major parts of the Marcellus and Utica Shale regions, for example, including northeast Pennsylvania, New York, and parts of eastern Ohio, have little such history. In addition, prior energy activity in those communities with a history of energy development typically occurred either long before current residents were even born, or on a smaller scale than the current rush. They thus lack institutional memory of the cyclical nature of such development, and appropriate methods for managing it.

This paper examines the economic experience of past energy booms, and of the current unconventional gas and oil development. Its aim is to help policymakers and academics better understand the nature of such activity; the key economic issues that are arising with this development, and the policy issues that decision-makers should address. Energy, like a host of other sectors including education, manufacturing, agriculture and so on, is critical to the functioning of the U.S. economy. Like those other sectors, the American economy would collapse if the energy sector experienced severe disruptions. Yet, hyperbole about the potential impact of unconventional gas and oil development is not very helpful in understanding this activity. Thus we first focus on key characteristics of gas and oil development, such as its relatively low employment potential compared to its value added, the geography of oil and gas development, and its boom-bust nature. These characteristics have important implications for whether the activity is economic growth or economic development that is sustainable. We conclude the section by examining the economic experience so far with shale oil and gas development.

We use this background to discuss important economic policy issues that are arising with unconventional oil and gas development, such as taxation, and how governments distribute the tax revenues from oil and gas production. Additional issues include preemption and the locus of decision-making about this activity, and equity. One important issue related to energy development that we will only tangentially touch is its impact on the environment including climate change, leaving that important and lengthy discussion to others with more expertise on those issues. We conclude the paper with a set of economic policy recommendations for states and communities affected by such development.

2. Economic Characteristics of Gas and Oil Development

This section consists of five subsections that outline the economic characteristics of oil and gas development, focusing on the local effects. The first subsection describes the volatility of the energy sector and its relative employment role, including supply-chain effects. We also compare oil and gas to its fossil fuel cousin coal to assess the relative employment dynamics of energy. The second subsection includes a discussion of the uneven geographical distribution of oil and gas development. Third, we discuss the temporal aspects of oil and gas development, drawing the distinction from the initial drilling phase with the largest employment effects to the mature production phase with smaller employment effects. Likewise, we note differences between unconventional and conventional production and note how the time-path of energy development is quite different from other sectors. Fourth, we turn to the long-run features of energy development and how price volatility creates a boom-bust pattern. After discussing the offsetting long-run effects on local economic activity, we use Wyoming and North Dakota as case studies to illustrate the varying long-run effects following the 1970s/early 1980 boom. Fifth, we then focus on the specific economic effects of the current boom led by unconventional drilling. Because the studies we appraise have only observed the upside of the boom in this energy cycle, the effects we describe are short-run and pertain to the boom phase. This subsection also discusses some of the pitfalls and confusion in the energy impact literature.

A. Its Variability and Employment Role

The energy sector, similar to other commodities, is quite volatile, which in turn directly affects employment dynamics. The volatility arises from three factors: highly fluctuating prices; resource stocks that can be fully extracted, and technological change that can have profound effects on where drilling and extraction are viable. Volatility tends to be much greater for regions that are primarily extraction oriented because they are most likely to be affected by all three forces. Higher-ordered energy centers such as Houston or Dallas are less exposed to this variability because they play a largely headquarter, higher-order function in the industry that somewhat shelters them from the volatility surrounding a given oil and gas field. Nonetheless, energy prices and their variability frames the roles that technological change and resource availability will play, especially in the oil and gas sector.

Figure 2 respectively shows annual real oil, natural gas, and coal prices from 1970 through 2012 benchmarked to 1970=100 using the Consumer Price Index. We compare oil and gas to coal because it illustrates the considerable diversity in how the major energy sectors interact with the broader economy. The figure shows considerable volatility for the oil and natural gas price series, though bear in mind that this understates the volatility as changes within a given year can be rather dramatic.[1] For example, at the time of this writing, oil prices varied from $107.95 on June 20, 2014 to $53.45 on December, 31 2014, before falling to the $45 to $50 range in January 2015. Natural gas prices appear to be the most volatile, with coal prices appearing to experience relatively little volatility.

Some key trends stand out in Figure 2. First, real energy prices were quite low in the early 1970s and then rapidly increased during the subsequent energy boom before turning down after 1982/83 (a little earlier for coal). This new period of low prices extended until about 2000, especially for oil and natural gas. Since 2000, real energy prices have greatly increased, sharply rising and reaching cyclical peaks in mid 2008 as the Great Recession began. Real oil prices rose during the subsequent recovery, with real West Texas Intermediate oil price levels being well above those of the annual trough of $14.42 a barrel reached in 1998 (or $20.94 in 2014 real dollars using the Consumer Price Index), as reported by the Energy Information Agency. Conversely, real natural gas prices in 2012 were at levels of the late 1990s, in which the tremendous supply of natural gas from unconventional sources have greatly lowered the real

[1]During 2008, which was another particularly volatile year, West Texas Intermediate Oil Prices fluctuated from $145.29 a barrel (in nominal prices) on July 3 to $33.87 a barrel on December 19 as the Great Recession took hold (EIA).

price, even with economic recovery.

The volatility of oil and gas prices affects the profitability of new drilling for oil and natural gas. Even for large price declines, existing production is mainly unaffected because the price typically remains above average variable cost, though there are exceptions in such as places with relatively expensive production costs such as the Tar Sands in Alberta, Canada, or for older less productive wells in which average variable costs are higher.[2] Nonetheless, prices have their most immediate impact on production through new drilling activity (as will be discussed later), because most of the employment effects of oil and gas development occur during the drilling phase, meaning that employment in the sector is also very volatile.

Figure 3 reports U.S. oil, gas, and coal industry employment from a variety of data sources.[3] Industry employment tends to follow price trends with spikes in during the price run-ups of the late 1970s/early 1980s and after 2000 (with a pause for the Great Recession). The notes to Figure 3 describe how we include direct extraction employment plus closely related "support" activities. Similar to other industries, the energy sector has closely related supply-chain sectors that are supported by its activities including pipelines and certain construction work. Therefore, our reporting of "direct" includes some indirect spillovers of supply-chain employment, producing an overestimate of the actual direct effects. The same applies for direct coal employment, but the coal support employment figures are very small and so coal employment is almost entirely direct employment as typically defined.

There is clearer volatility in oil and gas employment than for coal, with higher peaks and

[2]Consistent with Hoteling's theorem, during very sharp price declines, some well owners may want to temporarily cap their well, waiting to sell at a higher price (1931).

[3]The two main employment data sources are the U.S. Bureau of Economic Analysis (BEA) (up to 2000) and the U.S. Bureau of Labor Statistics (BLS) (post 2000). The main difference is BEA data includes proprietary employment and those who are not eligible for unemployment compensation. The latter group is virtually non-existent in the oil and gas industry, while the relative number of proprietors is also quite small in the energy sector, meaning that both sources should produce very similar figures subject to survey differences.

troughs. U.S. total oil and gas employment was less than coal industry employment until the 1950s. In 1948, direct oil and natural gas employment (including support) equaled about 0.5 percent of total U.S. employment. In 1971, oil and gas direct employment totaled about 0.3% of U.S. national employment before rising to its peak of 0.7% in 1982, and then falling to about 0.2% in the late 1990s. With the recent boom, oil and gas direct wage and salary employment share equaled 0.4% of total U.S. wage and salary employment. In terms of employment levels, direct oil and gas wage and salary employment workers equaled 563,000 in 2012 compared to 707,000 in the boom year of 1982. As the economy has grown, a comparison of direct employment shares shows that the energy sector is smaller during the current boom than during the last boom of the late 1970s/early 1980s. Also, it should be apparent that the energy sector is not a large employer when compared to the overall U.S. economy. However, given its spatial concentration in oil and gas producing regions, its importance will be much larger in certain places, as described below.

Figure 4 reports the 2001 and 2012 employment levels for the three direct oil and gas industries and for five additional industries that are further down the supply chain, which would be partially stimulated from greater direct oil and gas employment. For example, geophysical surveying and mapping employment can support other sectors besides energy, but oil and gas is a key one. Another key support sector is oil and gas pipeline construction, which is a critical infrastructure in new energy-producing regions in order to bring the extracted product to be refined or manufactured. In 2012, there were 124,000 wage and salary workers employed in oil and gas pipeline construction. Again, not all of these workers are related to oil and gas extraction (e.g., they could building pipelines for utilities), but it seems reasonable to presume that a significant majority of that sector's employment *increase* of 48,000 between 2001 and 2012 is due to recent increases in drilling activity. For overall perspective, the three direct sectors employed 563,000 workers in 2012 compared to about 424,000 in these five support sectors, showing that they are also relatively small compared to the rest of the U.S. economy.

Much has been made in some quarters of the unconventional energy boom triggering a "manufacturing renaissance" (Foroohar, 2013). So far, a general manufacturing renaissance is hard to detect, at least in terms of manufacturing employment. Though modestly up from the bottom of the recession, BLS Current Employment Situation statistics show that 2013 U.S. manufacturing employment was 13.5% below its 2007 pre-recession level and more than 30% below the levels of 2000. Yet, there are two areas where an oil and gas boom would lift manufacturing. The first is through purchases of manufactured inputs. There are many manufacturing industries from which the oil and gas sector makes input purchases but a key one is oil and gas field machinery manufacturing (NAICS 333132). Figure 4 shows that this sector's employment rose by 30,000 workers between 2001-2012, to almost 78,000 wage and salary workers, which is one of the few manufacturing employment "successes" during this period. Perhaps not surprising given the history of the industry, oil and gas field machinery manufacturing is concentrated in the oil patch, with about 90% of the nation's employment. In 2012, Louisiana and Oklahoma each had between 9,000-10,000 oil and gas field machinery manufacturing employees, whereas Texas had nearly 53,000. By contrast, manufacturing belt stalwarts such as Ohio and Pennsylvania respectively had only 355 and 432 wage and salary workers in this sector in 2012, even as they both had oil and gas drilling activity. On the positive side, there is room to grow in those Rustbelt states, but given their tiny size and remoteness from the Plains and oil patch, it is hard to see how growth in this sector can make a tangible dent in overall Rustbelt manufacturing performance, at least in terms of overall employment.

The other chief way that the energy boom would lift manufacturing is through the lower prices of the energy fuel stock that manufacturers intensely use. While lower input prices are profit-enhancing, there are some reasons to be skeptical of this playing a large role. Foremost, shale resources are found throughout the world, meaning the advantages experienced today in the United States could be negated as American competitors also experience lower energy costs. Likewise, the share of manufacturing industries that intensively use energy is relatively small. Using the most recent BEA input-output data for 2002, only five out of forty manufacturing industries have direct or indirect energy costs that total at least seven percent of their total costs, with most sectors have a share near two to three percent. These five high-energy cost manufacturing industries collectively employed just 374,000 wage and salary employees in 2010, which represented only 3.3% of total U.S. manufacturing employment and only 0.3% of total U.S. wage and salary employment.[4] Even in a traditional manufacturing state such as Ohio, high-energy intensive manufacturing accounts for just 0.3% of total wage and salary employment. Thus, only a small portion of manufacturing such as fertilizers is in position to tangibly benefit from lower energy costs. Even there, keep in mind that even if energy costs became zero for these manufacturers, they would only gain a one-time seven to twelve percent edge, which is relatively small when considering how fast this would be offset by productivity growth differentials between emerging markets like China and the United States. Our conclusion is that while small niches in U.S. manufacturing will notably greatly benefit from the current energy boom, a broad-based manufacturing renaissance is unlikely, at least in terms of employment.

[4]The following manufacturing industries have a direct and indirect energy cost share that is greater than seven percent (with the share in parentheses): Pulp, paper, and paperboard (0.08); Basic Chemical (0.099); Agricultural chemicals (0.121); Nonferrous metal production (0.076); and Iron and steel from purchased steel (0.079).

B. Geography of Oil and Gas Employment.

Oil and natural gas employment is geographically concentrated in a variety of ways, mostly due to the geographical distribution of the resource as well as other factors. First, given its environmentally messy attributes, we would expect mining to be more prevalent in more sparsely populated rural areas. For the broader mining sector that includes oil, gas, coal, and other mining activities such as gravel, BEA data from 2012 indicate that about 799,000 mining jobs were in metropolitan areas versus 530,000 in nonmetropolitan counties. Yet, in terms of percentage of total employment, mining represents just 0.5 percent of total metropolitan U.S. employment versus 2.2 percent in nonmetropolitan areas. The types of employment can also vary between rural and urban areas. While extractive mining activity can take place on the fringes of urban areas, much of metropolitan mining employment is headquarter and higher-order support occupations including supply-chain functions in finance and engineering, which some may view as more desirable economic activity.

Figure 5 is a map of the U.S. states showing their 2012 direct oil and natural gas wage and salary employment. Specifically we again consider "direct" oil and gas employment in the three sectors including support.[5] Note that the U.S. Bureau of Labor Statistics did not report all of the data if there were confidentiality concerns. The states that are affected have an asterisk by their names, where we only report the sum of disclosed employment in those three sectors. However, fully disclosed data represent 98.6 percent of total U.S. oil and gas employment in

[5]The specific sectors we consider as direct and support are: NAICS 21111-Oil and gas extraction NAICS 213111 - Drilling Oil and Gas Wells NAICS 213112 - Support Activities for Oil and Gas Operations. The following sectors are closely related to the oil and gas industry through the supply chain but are not included in our numbers because their business operations are further away in the supply chain and/or have considerable portion of their business is not linked to new oil and gas drilling and production (e.g., for example for utility generation not oil and gas production or even entirely different industries): NAICS 541360 - Geophysical Surveying and Mapping Services NAICS 238912 - Nonresidential Site Preparation Contractors NAICS 333132 - Oil and Gas Field Machinery and Equipment Manufacturing NAICS 486210 - Pipeline Transportation of Natural Gas NAICS 237120 - Oil and Gas Pipeline Construction.

these three sectors (we miss about 7,500 oil and gas workers across the U.S.), so the actual numbers are rather trivially affected in most cases. The only state that is meaningfully affected by nondisclosure is North Dakota, in which sector 213111 employment is not disclosed. Hence, rather than the 16,000 direct and support employees listed in the map, the actual figure for North Dakota is likely between 17,000-21,000. In all other states with asterisks, the number of "missing" non-disclosed workers is rather small, typically under 100 per state.

Figure 5 shows that with over 259,000 employees, Texas accounts for nearly half of the nation's total in direct energy employment. Louisiana and Oklahoma, each with over 50,000 direct oil and gas jobs, also have considerably larger oil and gas economies than other states, illustrating the continuing importance of the historic oil-patch. However, even in these three states, the direct oil and gas share of the state total (covered) wage and salary employment for Louisiana, Oklahoma, and Texas are respectively: 2.7%, 3.6%, and 2.4%, which are still relatively small shares of their total employment. With oil and natural gas direct employment accounting for 6.2% of total wage and salary covered employment, Wyoming is likely the most dependent on the oil and gas sector in a relative sense. However for most states, oil and natural gas employment is a very small part of their economy. For example, even though Pennsylvania had more than 20,000 direct oil and gas sector jobs in 2012, which placed it near the top of the U.S., direct oil and gas employment accounted for less than 0.4% of its total employment.

After the oil patch states, Plains and Rocky Mountain states such as New Mexico, Colorado, Wyoming, and North Dakota have the next largest cluster of oil and gas employment. Most regions have considerably less activity in which the main exceptions include Alaska, California, and the Marcellus region centered in Pennsylvania.

As noted above, the oil and gas sector is more intensely located in nonmetropolitan areas. However, America's unofficial headquarters of the oil and natural gas sector is Houston, though there are large high-ordered operations in locations such as Dallas, Denver, Oklahoma City, and Tulsa. Figure 6 shows that Harris County alone, home to the city of Houston, had nearly 20% of the nation's oil and gas (direct) employment in 2001 (just over 60,000 employees) and it had just over 15% of the sector's total employment in 2012 (just over 86,000 workers).[6] Obviously, the vast majority of these employees are not actively engaged in drilling activities in metropolitan Houston, but are typically employed in headquarter and higher-ordered scientific operations that sustain the sector's worldwide activities.

C. Temporal Nature of Energy Development

Both "old" conventional and newer unconventional oil and natural gas (drilling) development have considerably different economic impacts than most other industries including their fossil-fuel cousin coal. For simplicity, the oil and gas drilling stages of development include (1) initial exploration/land acquisition; (2) drilling and construction of supporting infrastructure; (3) drilling and filling in supporting supply chain; (4) mature stage of production. Stage 1 may be associated with considerable local "buzz" with lease acquisition and payments, but it is not linked to tangible levels of economic activity. Stage 2 and to a lesser extent Stage 3 are associated with the greatest local economic growth.

For example, a workforce needs assessment in Pennsylvania indicated that the initial pre-drilling phase of development accounts for 18 percent of the employment associated with unconventional gas development, while the drilling and infrastructure development phases

[6]To give a feel for outsized importance of Houston, Dallas and Tarrant Counties that include Dallas and Ft. Worth, Texas together had just under 17,000 direct oil and gas employees in 2012, which is less than one-fifth of the size of sector's presence in Harris County (Houston), Texas.

account for 80 percent of such employment. Once wells are drilled, production, compression, and processing generate only 2 percent of total employment associated with well development (Brundage, et al. 2011). On a per well basis, these authors found that the first Marcellus gas well drilled on a well pad requires the equivalent of 13.1 - 13.3 full time employees during the year drilling and well completion occurs (and 9.65 to 9.85 FTEs for each additional well drilled on that pad), spread across more than 420 individuals and 150 different occupations. In contrast, each well requires only 0.2 to 0.4 full time job equivalents annually once the wells began producing. This means that the employment effects from unconventional oil and gas development almost exclusively occur during the drilling phases; once that activity ends, most of the employment similarly will wind down, even though the wells may remain actively producing for decades afterwards.

The final mature stage is associated with most of the industry moving on to new locations because producing wells do not need the supporting workforce. Unconventional drilling will likely have more long-term economic impacts because producing wells may need to be "re-fracked" which would require additional work on the drill pad. However, because the drill pads have already been prepared, and roads and supporting infrastructure such as pipelines are constructed, the mature stage in unconventional drilling is still likely to be associated with declining local economic activity for the industry.

Because employment in oil and gas industry field development follows this cycle, economic growth in an affected location is considerably more variable, with rapid growth typically followed by steep decline, which gives rise to the boom/bust cycle that is discussed more below. In the initial energy boom stages, workers move in, wages rise for affected workers, land owners receive their lease and then royalty payments (though many may be absentee landlords), and particular local firms benefit. However, this economic growth does not necessarily translate into sustainable long-term economic development. A first reason is that many of the new workers are from outside the region, which means they may remit some of their income “home” and they are more likely to leave and follow the industry when it moves onto new drilling plays. For example, Kelsey et al. (2011) found that nearly two-thirds of the influx of workers into the Pennsylvania Marcellus shale play are from out of state.

A second reason for oil and gas development to possibly limit long-term growth is potential environmental degradation through water pollution (which supporters of the industry argue is remote or nonexistent), air pollution (both dust and other pollutants), congestion, and ecosystem changes. In certain places, unconventional drilling is also associated with some small earth quake activity as well. Such changes (or even public perception of such changes, whether they actually occur) have the potential to affect peoples’ attitudes towards the community, including all important amenities which attract new residents and economic activity.

The third reason for oil and gas development not producing sustainable economic growth is the strains it can place on local governments. The initial surge of residents and the need for new roads and other supporting infrastructure can lead to a surge of government expenditures. As the boom dissipates, the real fiscal stress begins. Local governments still need to maintain the new infrastructure, but they have fewer residents to pay for it and local governments may have some additional social expenditures as the economy cools down. Not only does the tax base of the local government dwindle as the number of residents falls, but those who remain may not be able to pay the taxes necessary to meet the revenue requirements necessary to support the new infrastructure.

In the subsection below, we will discuss other reasons for energy economies to struggle after the initial boom phase, but the main point is that it is far from certain that an initial energy boom translates into sustainable long-term prosperity. For communities to benefit in the long-run, they need to channel the additional initial gains in agglomeration economies from new people, workers, and wealth into future economic activity without letting too much of this wealth leave the community. Also, the boom may have disruptive effects that produces crime, alters income distribution, and changes the way the local community functions, which also need to be managed for long-term prosperity.[7] Illustrating the problem, in a study of six western states during the late 1970s-early 1980s energy boom, Haggerty et al. (2013) found that the places that quickly diversified from energy into other industries did much better during the subsequent energy bust. However, the general pattern was that boom towns suffered more during the bust.

D. Boom-Bust and the Natural Resource Curse

"We've been so poor for so long, then all of a sudden, we won the goddamn lottery. You know what happens to lottery winners ... you read about them three years later. They're in court, or they're in bankruptcy, or they're divorced ... that's the way we are."

> Jim Fuglie, a former North Dakota state tourism director, in Center for Public Integrity (2014)

The volatility of energy prices produces wide fluctuations in energy-intensive economies (Partridge and Rickman, 2003, 2006). High prices promote drilling and exploration and rising employment. In periods of low prices, energy exploration decreases, which reduces economic growth in oil and gas producing regions. Likewise, growth slows when the energy region is

[7] Komarek (2014) finds that areas undergoing unconventional oil and gas development experience no significant difference in property crimes compared to non-boom areas, but they experience statistically significant increases in violent and sexual criminal activity.

saturated with wells or the resource is near exhaustion. New technologies such as recent unconventional innovations also increase the volatility as competiveness of affected regions may increase or decrease. In either event, when the boom inevitably ends, affected energy-intensive regions enter the bust phase as drilling all but ends, the construction of associated infrastructure such as pipelines greatly slows, and the need for higher-level oilfield services and other supply-chain effects diminish. Again, this is not the same as saying that oil and gas production ends, because production in existing wells will continue during the bust (as long as a well is economical), but that employment and associated investment greatly decline.

Even without such volatility, local economic activity based upon its development by its nature is unsustainable in the long run because oil and gas are non-renewable natural resources. At some point the resource becomes exhausted. This may take several decades, yet is inevitable. Closely related is that technological change could affect the relative costs in certain regions, altering production patterns. For example, the shale revolution has put pressure on producers in the Tar Sands of Canada.

The key question is whether the boom is worth the bust, or alternatively, how can the pain of the bust be minimized? These questions tie into the "natural resource curse" which is the notion that long-run growth in natural resource intensive economies tends to lag otherwise equal economies that are less intensive in natural resources (Sachs and Warner, 1995, 2001; Van der Ploeg, 2011; Van der Ploeg and Venables, 2012). There are many reasons for a possible natural resource curse to develop. First the aforementioned boom-bust cycle is not attractive to businesses outside of the energy sector wanting to invest in such locations due to the heightened risk and costs. Likewise, overconcentration in any sector—including energy—is not conducive to growth as diversified economies outperform local economies concentrated in a few sectors

(Hammond and Thompson, 2004). A third reason for a potential natural resource curse is that the natural resource sector can crowd out other economic activities because land and labor costs are bid up during boom periods. This process is akin to the "Dutch Disease" phenomenon which was originally described by the *Economist* (1977) as an unintended consequences of a natural gas discovery in the Netherlands. At the country level, natural resource booms are prone to appreciate the currency that further accelerates the crowding out of other traded-goods (Cordon and Neary, 1982; Beine et al., 2012 for a discussion regarding modern Canada) Yet, offsetting this crowding out is the increase in local demand for nontraded products and demands of oilfield producers for manufactured goods (Allcott and Keniston, 2014).

A related fourth reason for growth to lag is that large scale mining and manufacturing regions are not associated with entrepreneurship and small business development (e.g., in the case of coal mining, see Glaeser et al., 2012 and Betz et al., 2014). The loss of entrepreneurship and small business development can limit local economic growth (Rupasingha and Goetz, 2013), especially in lagging regions (Stephens and Partridge, 2011). Similarly, Polèse (2009) and Polèse and Shearmur (2006) describe what they call the "intrusive rentier syndrome," in which rent extraction and crowding out in resource regions dominate new entrepreneurial activities. Another possible reason for a natural resource curse is that high wages in the resources sector for less-skilled workers reduces the incentives for further education and training (Black et al., 2005b; Freudenburg 1981, 1984), which puts those less-skilled workers (and the region as a whole) in a vulnerable position when the energy economy inevitably turns down. The employment which does occur in booms largely is in the extraction sectors, and in non-tradable sectors like construction, services, and the retail sector (Carrington, 1996; Black et al, 2005a; Marchand, 2012), which have little sustaining power once the boom ends.

A fifth reason for the natural resource curse is that natural-resource intensive economies may be susceptible to weak institutions, bad governance, rent-seeking, and corruption—e.g., Nigeria or stereotypes of say Louisiana (Acemoglu et al., 2004) or possibly modern North Dakota (Sontag and McDonald, 2014). Closely related is that local public sector expenditure policies become unsustainable during the boom phase, which limits the local government's flexibility when a bust sets in.

The evidence somewhat supports the natural resource curse at the international level (Bunker, 1984; Dunlap et al., 2002; Papyrakis and Gerlagh, 2004). Yet, the research is less pervasive for North America regarding energy's long-term effects on regional economies. On the positive front for energy development, Michaels (2010) examined how southwestern U.S. oil counties fared over the 20th Century by comparing those with large oil reserves (at least 100 million barrels) to those without such reserves. He finds that counties sitting on top of large reserves fared better in terms of employment and population growth, though this advantage waned after about 1960.[8,9]

Michaels speculates that the reasons for his findings are that energy booms enhance local agglomeration economies and that energy booms provide the wealth for the building of local infrastructure that further enhances growth. Regarding the latter, he found "oil" counties had a higher likelihood of having U.S. interstate highways. Yet, Michaels (2010) rationale for infrastructure leading the way in oil counties is not as sound. First, the U.S. interstate highway system was primarily funded by federal revenues with much smaller state-level support.

[8] Michaels' (2010) treatment was whether the county sat on significant oil reserves of at least 100 million barrels, not the size of the economic impact (changes in production or preferably changes in energy sector employment), which is what directly drives the magnitude of the ensuing economic boom or bust. Likewise, he cannot ascertain the beginning or the end of a boom for a location using just initial reserves. Thus, it cannot be determined whether the positive effects he observed are primarily from the positive initial construction effects or long-term effects that would shed light on the natural resource curse.

[9] Peach and Starbuck (2010) find oil and gas extraction had a similar positive long-term correlation with income, employment, and population in New Mexico between 1960-2000.

Virtually none of the funding comes from local sources, which would include those counties whose budgets were supposedly augmented by energy revenues. Likewise, the interstate highway system's original purpose was to promote national defense—i.e., the original 1956 law that enacted the construction of the system was publically titled the "National Interstate and Defense Highways Act." Duranton and Turner (2011) note that the original World War II era proposed highway system by the military planners looks remarkably similar to the core system ultimately created.[10] Thus, oil counties in Texas having a higher density of interstate highways seems to be more of a coincidence of being on the routes that maximized the military transportation needs of the World War II era rather than an outcome of the natural resources boom providing the funding to local governments. Indeed, given the institutional realities of the U.S. highway system, the added interstate infrastructure could be the cause of some of Michaels' favorable growth results rather than the other way around.

Michaels (2010) agglomeration argument seems to have more merit. Specifically, energy development would allow affected localities to gain people and businesses during the boom phase, making them more attractive for other higher-ordered businesses, perhaps setting off a virtuous round of growth, such as in some New Economic Geography models (Brakman et al., 2009). One of the key barriers facing lagging rural communities since at least the mid 20th Century is sparse population and the lack of access to larger urban areas for jobs and markets (Partridge et al., 2008; Wu and Gopinath, 2008). With most energy-boom counties being rural and somewhat remote, gaining agglomeration economies is an important element of future growth.

[10] U.S. National Interregional Highway Committee's (1944) report shows maps of the proposed "military" highway system, which is remarkably similar to what was eventually constructed in the 1950s, 1960s, and 1970s.

In general, the literature suggests that counties and states that are initially more intensive in mining tend to grow less over the long-term (Papyrakis and Gerlagh, 2007; Freeman, 2009; Kilkenny and Partridge 2009; Lobao, 2013; James and Aadland 2011). Many of the reasons for mining-intensive regions to lag in the long-run are discussed above. Yet, another reason is simple labor-saving technological change in the goods sector means that declining numbers of workers are needed to extract the same resource (Kilkenny and Partridge, 2009). Much of the literature has focused on the institutional and governance problems for mining-intensive regions that lead to corruption and rent-seeking (Papyrakis and Gerlagh, 2007; Van der Ploeg, 2011), though Michaels (2010) suggests that U.S. local institutions are strong enough to avoid the resource curse. Nonetheless, understanding the specific channels of how resource extraction can affect long-run *local* economic growth is an area that demands further research. Haggerty et al.'s (2013) approach to study the aftermath of the late 1970s/early 1980s energy boom seems to be a promising way to understand how the current energy boom will unfold *after* the inevitable bust sits in. Indeed, to understand long-term effects of an energy boom, one needs to study both the boom and bust periods to identify the total *net* effect. Because we have not observed a full bust phase for the current boom phase, it is hard to speculate about the expected effects of a natural resource curse from this wave of drilling.

The experiences of Converse County (Wyoming) and Williams County (North Dakota) illustrate the volatility involved with the boom-bust cycle. Converse County had just over 14,000 residents in 2012 with Douglas being its county seat. Historically, its energy economy has been diversified in coal, uranium, and oil and natural gas. Williams County is in the Bakken Shale area of North Dakota, with just under 27,000 population in 2012, with Williston as its the county seat. Williams County's energy economy is virtually all oil and natural gas. These two counties fully participated in the booms of the latter 1970s-early 1980s and the subsequent boom that began sometime around 2005-2006.

Figure 7 shows the mining sector's share of wage and salary income for the two counties and the U.S. as a whole to illustrate the relative importance of the mining sector (which includes energy).[11] Note that this share does *not* include closely related industries in the supply chain such as pipeline construction or engineering support for workers not directly employed by the mining (energy) industry. Thus, one might view these shares as an underestimate of region's dependence on the energy industry. In 1969, when the series begins, the mining share of U.S. wages and salaries was just over 1%, but it was about 12% in Converse County and 17% in Williams County, which illustrates that these local economies were highly resource intensive even before the 1970s energy boom began. For the entire U.S., the mining sector (including energy) is such a relatively small sector that is very difficult to detect the energy boom-bust pattern, but there is a clear cyclical pattern for the two case-study counties. During the energy boom of the late 1970s/early 1980s, the wage and salary share peaked at over 62% in Converse County in 1980 and at 44% in 1981 for Williams County. During the subsequent bust, the mining-sector wage and salary shares bottomed out in the late 1990s at about 17% in Williams County and 30% in Converse County before beginning to rise in 2004 with the most recent energy boom. These shares respectively reached 45% and 52% in 2012 for Converse and Williams counties. Clearly, these two counties are heavily reliant on the energy sector and would be heavily exposed to its volatility.

The volatility is reflected in the population over the period. Figure 8 shows population benchmarked to 1969=100 for Converse and Williams Counties and for the U.S. For the U.S., annual population growth averaged about 1% over the period. For Converse County, population

[11]The source of the data for the case study is the U.S. Bureau of Economic Analysis (BEA).

growth soared during the earlier energy boom, peaking in 1982 at more than 250% of its 1969 total before losing about one-fourth of its population by 1990. After a slow but steady increase, Converse County's population began to sharply increase in about 2004, though its 2012 population was still below its 1982 peak.

For Williams County, population growth soared during the first energy boom of the late 1970s/early 1980s, peaking in 1982 and then rapidly falling during the ensuing bust, bottoming out in 2001 at almost the same population as in 1969. With the most recent energy boom, population began to rapidly increase after 2005, though William's county's population in 2012 remained below the 1982 peak.[12]

Converse County's experience in Wyoming may reflect some positive agglomeration effects from the late 1970s/early 1980s boom. Converse County, with less than 6,000 people in 1969, would have been a good example of a remote rural community at risk of losing population due to lack of agglomeration economies for its residents and businesses. However, with the onset of the energy boom, its population more than doubled between 1974 and 1982. Though its population declined by 26% between 1982 and 1990, Converse County's population remained 89% above its 1969 level, compared to 40% growth for the U.S. as whole. During the 1990s, Converse County population grew an additional 9%, even though there was an energy bust. While Converse County still has not regained its 1982 peak, Figure 8 shows that its population growth has far exceeded the U.S. average since 1969 and the additional agglomeration economies it gained from the energy booms are a possible cause for it retaining some of the energy-boom population gains during energy busts.

[12]For 2013, the U.S. Census Bureau estimates that Williams County's population hit 29,995, which would surpass its previous peak population of 27,598 in 1982. The U.S. Census Bureau reported that both Converse and Williams counties were among top 100 fastest growing counties in the U.S. between 2012 and 2013. Even so, both counties remain very sparsely populated with Williams County having less than 15 people per square mile and Converse County having just over 3 people per square mile.

By contrast, Williams County did not seem to experience any permanent gains from the earlier boom, as its population nearly returned to its late 1960s values by the early 1990s, followed by virtual stagnation. While each location has its idiosyncratic effects and there are differences over time, Williams County's poor performance after the late 1970s/early 1980s boom may not bode well for how it will fare after the end of the current energy boom.[13]

E. The Shale Oil and Gas Development Experience So Far

We now assess the more narrow impacts of the recent boom centered around unconventional production. Hence we are discussing the short-term impacts of the upswing as the more recent studies have not assessed the bust part of the commodity cycle. Much of the early economic analysis of recent unconventional oil and gas development were Input-Output based studies attempting to estimate the employment and income effects of the activity. Among the earliest were a series of annual analysis of the Barnett Shale in the Fort Worth area, conducted by the Perryman group using a proprietary Input-Output model (Perryman Group, 2007; 2008; 2011), which optimistically estimated that the shale development accounted almost 89 thousand jobs in the region, and $8.2 billion in annual output. Similar studies, often relying upon the software IMPLAN, have been conducted regarding unconventional gas development, including in the Haynesville in Louisiana (Scott and Associates, 2009), Fayetteville in Arkansas (Collins and Deck, 2006; Deck and Riiman, 2012), Marcellus in Pennsylvania (Considine, Watson and Blumsack, 2010; and 2011; Considine, Watson, Entler, and Sparks, 2009; Kelsey et al, 2011) and in West Virginia (National Energy Technology Lab, 2010).

[13]One key difference between Converse and William Counties is Converse County's energy economy is more diversified across oil and gas, as well as coal and uranium, whereas it is virtually all oil and gas in Williams County. Thus, during a bust phase, there will be a larger permanent workforce that would stay in the traditional mining operations in Converse County compared to Williams County in which relatively few workers are needed to maintain oil production from existing wells.

Such use of Input-Output models has drawn strong criticism (e.g., Kay, 2011; Kinnaman, 2011; White, 2012) because the changes potentially violate critical assumptions of IO analysis and the lack of forming a valid counterfactual. In addition, many of these studies were funded by industry, so their results have been viewed with suspicion, particularly because of some of their assumptions, and the pro-drilling perspective some have taken. For example, the Considine et al (2010) study of Marcellus Shale in Pennsylvania generated significant positive and negative publicity, in part because it was released at the height of debate in the Pennsylvania General Assembly regarding Governor Rendell's proposal to levy a severance tax, and took a strong pro-drilling stance. Academics (Kay, 2011; Kinnaman, 2011) and citizens (such as Bogle, 2011) responded with critiques of the analysis, pointing out major issues with the analysis and tone, and raising questions about Penn State University's involvement with the report. In a subsequent letter to a citizen's group, the Dean of Penn State's College of Earth and Mineral Sciences, said that the researchers "may well have crossed the line between policy analysis and policy advocacy," and that they should have been "more scholarly and less advocacy-minded" (PressConnects, 2010). The Governor's severance tax proposal ultimately failed regardless of these critiques, with some claiming the Considine study was a major cause for that defeat (Bloomberg, 2012).

In a Pennsylvania state agency funded study, prompted in part by state agency skepticism over the earlier Considine study, Kelsey et al (2011) used survey and GIS data to address some of the weaknesses in the Considine et al (2009) prior analysis, and intentionally used IMPLAN so their results would be directly comparable to that earlier study. This included taking into account how much of the lease and royalty income immediately leaves the state due to absentee mineral owners, how much of this income is saved (rather than spent), and the relatively large proportion of workers from out-of-state. Their findings that Marcellus Shale development in Pennsylvania in 2009 created or supported about 23,884 total jobs (including 9,372 directly or indirectly related to industry spending) were about half of what Considine et al estimated. Several other studies conducted at the same time, including descriptive analysis of state employment data (Herzenberg, 2011) and interviews with gas companies regarding employment requirements for drilling (Brundage, et al, 2011), found modest employment impacts consistent with the Kelsey, et al results.

Other studies have relied upon econometric analytical methods to examine economic effects associated with shale oil and gas development. Weinstein and Partridge (2011) similarly found that employment effects of natural gas development are modest, particularly in relatively large states. As part of a study predicting impacts of gas development in Ohio, they used U.S. Bureau of Economic Analysis data to compare employment and income in six high drilling Pennsylvania counties to six non-drilling counties in PA. They found employment effects in the heavily drilled counties were not large enough to be detected when compared to non-drilling counties. Based upon U.S. Bureau of Labor Statistics data, they estimated an Ohio statewide gain of 10,000 direct and 10,000 indirect jobs in the natural gas industry by 2015 using the Pennsylvania experience between 2004 and 2010 as a benchmark. Confirming Weinstein and Partridge's results, Paredes, Komarek, and Loveridge (forthcoming) likewise find mixed employment and income effects in the Marcellus region using propensity score matching and panel approaches. These studies raise the question whether the right counterfactual can be formed using matching approaches or instrumental variable approaches (e.g., Weber, 2012, 2013; Brown, 2014).

Other studies found modest employment increases associated with drilling, including in Colorado, Wyoming and Texas (Weber, 2012), four states in the Southwest (Weber, 2013), nine states in the central U.S. (Brown, 2014), and in the lower 48 states (Weinstein, 2014). Weinstein found these employment impacts are transitory, with the growth effects waning over time.[14] In addition to employment impacts, there is evidence that such development also positively affects the wealth of farmers in areas with such development (Weber, Brown and Pender, 2013), at least during the boom. These effects are most marked during the leasing phase. From a more long term perspective, Jacobsen and Parker (2014) looked at the 1970's and 1980s oil boom-and-bust cycle in the western U.S., and found positive local employment and income effects during the boom, yet in the aftermath, incomes per capita decreased compared to what they would have been if the boom had not occurred.

There has been some confusion in the literature regarding the threshold value of the multiplier to suggest whether the local economy is becoming more or less dependent on energy production. For example, Weber (2013) found a multiplier of about 2.4, which being above 2, he argued that implied that energy producing regions were becoming *less* dependent on energy production. Generally, dependence of a local economy on a particular industry is related to its share of total employment (or total production). Hence, falling dependence would imply that the energy share of total employment declined. It is a matter of arithmetic to show that the multiplier

[14]Even within the econometric estimates of multipliers, there is some heterogeneity. For example, Weinstein (2014) used the standard approach of estimating multipliers by regressing changes total employment on changes in oil and gas employment. By contrast, Weber (2012, 2014) and Brown (2014) indirectly estimate the multiplier by regressing the change on total employment on the change in production and regressing the change in mining employment on the change in production and then taking a ratio of the two effects. Yet, as we described above in the stages of production, oil and gas production is a very noisy signal of changes in employment, and thus the ratio represents taking one noisy indicator divided by another. When directly estimating the multiplier, Weinstein (2014) finds smaller multipliers that are fairly consistent using instrumental variable approaches or OLS. The upshot is that estimates of energy development multipliers, even in carefully done studies, can vary, suggesting more work is necessary to sort out best practice.

would have to be greater than the ratio of one over the initial energy share such that a change in energy employment would reduce the energy employment share. Weinstein and Partridge (2014) note that the average oil and gas growth county in 2001 had an oil and gas employment share equal to 1.3%, requiring a multiplier of at least 77 (1/.013) in order to keep the share of oil and gas employment constant (or falling). Thus, it would be remarkable feat for an increase in oil and gas employment to not increase a local economy's dependence on that sector (which would apply to growth in about any sector).

3. Economic Policy Issues

A. Taxation

There are several reasons that justify taxation of natural resources. First, taxes have the potential to mitigate the boom-bust cycle and allow locations to avoid the natural resource curse discussed at length in Section 2 D. Taxes can dampen increases in land and labor costs, thereby reducing the potential for crowding out. Revenues generated from extraction taxes may be used to diversify industry and enhance education. Second, taxes can be used as an instrument for internalizing negative social and environmental externalities that tend to accompany natural resource extraction. [For a thorough discussion, see Hampton (2014).] Third, tax revenues set aside in permanent funds that allow current generations to compensate future generations for depleting a natural resource.

In this section, we focus on energy taxation and the allocation of tax revenues, using Pennsylvania and North Dakota as case studies. We use North Dakota and Pennsylvania because they demonstrate considerable variation in how states have formulated tax policy in response to current shale energy extraction. Pennsylvania, a leading supplier of natural gas, opted to impose an impact fee rather than a severance tax. North Dakota, second only to Texas in oil production, is of particular interest because of the manner in which it allocates its considerable revenues from the severance tax, including a new permanent fund.

Natural resource taxation in the United States has historically been the domain of state governments. In nearly all other countries, subsurface mineral rights were retained by the central government; however, in the United States, these rights may be held by either the private or public (federal or state lands) sectors. As Rabe (2014) points out, the American governance of oil and gas has been decentralized, with state-based policies prevailing since the late 19th and early 20th centuries.

In the 1970s and 1980s, state policymakers increased their influence over taxation of resources, which was precipitated by global and national events. Cuciti, et al. (1983) point out that both oil consuming and producing states had difficulty with national energy policy of that time. In 1973, the federal government responded to oil price increases following the OPEC oil embargo by passing the Emergency Petroleum Allocation Act (EPAA), which established a two-tiered price for domestic oil. Oil wells that were producing at or below their 1972 levels were subject to a price ceiling, while oil from new wells could be sold at market prices. The price controls from EPAA were lifted in 1981 and oil prices rose (U.S. EIA, 2001).

Lifting the price controls set in motion lively policy debates about the role of state governments in energy policy. Producing states, for example, were opposed to “becoming an ‘energy colony’ for the rest of the nation.” These states argued for the ability to set their own policies that would not “force development detrimental to their environment and way of life.” Oil consuming states were concerned that lifting price controls would shift the burden of higher prices to them without participating in the gains associated with revenues generated by resource extraction. These states argued that producing states would export their production taxes to them, erode their economic bases, and create differences in the ability to raise tax revenues with a more limited set of policy instruments.

In the early 1980s, the federal government responded to budget deficits by diverting some public sector functions to state governments while energy producing states were enjoying the benefits of an oil boom. Taxes on natural resources were a way for these states to meet additional budgetary demands, which caused widespread changes in state energy tax policies. A landmark ruling in 1981 facilitated the transition. The U.S. Supreme Court in ***Commonwealth Edison Co. v. Montana***, 453 U.S. 609 (1981), upheld Montana's 30% severance tax on coal, deeming that it was not in violation of the Commerce Clause of the U.S. Constitution. Other states followed Montana, increasing the role of state governments in crafting energy policy. Following Commonwealth v. Montana and federal energy policy of the time, researchers focused on topics such as inter-regional inequity in the ability to raise taxes, severance tax incidence, and tax exportation (e.g., Morgan and Mutti (1981); McLure (1978); Shelton and Morgan (1977)).

Rabe and Hampton (2014) discuss a notable difference in the political economy of state tax policy issues in the shale era. In the past, energy producing states, especially those with low population and large deposits of resources, have typically set the highest extraction tax rates. Kunce, et al. (2003) argued that in the earlier era, policymakers in those states understood that production was inelastic with respect to tax rates. Therefore, higher tax rates caused little lost production and generated revenues, and the tax was primarily exported to consumers and mineral rights holders who were out of state residents. However, today's policymakers seem to believe that locations must compete for today's unconventional drilling activity by maintaining a pro-industry business climate. While it is clear that changes in technology have made it possible to extract resource deposits in many locations that were not profitable in the past, extraction does appear to be occurring in intensively drilled "sweetspots" irrespective of tax rates. We will demonstrate the considerable variation across state energy taxation. These differences can be attributed to factors such as the size of the extractive industry relative to the state's economy, whether the state has a sustained history of resource extraction, views of government and its relationship to the individual, the role of taxation in financing investments in public education, infrastructure, diversification, and planning for the future.

Many states' tax structures include severance (production) taxes, property taxes, and corporate income taxes. In addition, states earn mineral-lease receipts (royalties). (For a comprehensive description of state oil and gas taxes in the U.S., see Brown (2013)) We focus on production taxes, which dominate other forms of state natural resource taxation, and offer brief definitions of property and corporate income taxes.

A severance tax is an excise tax on a specific mineral such as coal, oil, or natural gas. Severance taxes are so named because a resource is "severed" from the earth. Severance taxes may be either specific or ad valorem. Severance tax revenues from a specific severance tax would consist of a base, measured by the number of units produced, multiplied by a set amount per unit produced (e.g., $0.10 per ton). The base of an ad valorem tax is generally the production value of the resource to which a percentage tax rate is applied (e.g., 5% of market value of production). Most major energy producing states levy a severance tax; however, as our examples will demonstrate, definitions of production and the composition of allowable tax deductions and exemptions vary greatly across states.

Real property taxes are traditionally levied by local governments, where a property would include land, buildings, equipment, and the discounted value of the income stream from future sales. However, as Cuciti, et al. (1983) point out, appraisal of reserves is a difficult task, which requires estimates of reserves, costs of extraction, and future prices. As a consequence of its administrative complexity and the associated costs of levying this tax, states have sought other approaches to the valuation of reserves. One alternative to the property tax on reserves has been for counties to levy what is essentially a severance tax (e.g. Colorado).

In addition, most of the major energy producing states levy a corporate tax (e.g., Wyoming is an exception). There is widespread variation in the calculation of corporate tax liability for the extractive industry.

A comparison of the tax structures for North Dakota, the second largest crude oil producing state, and Pennsylvania, the third largest natural gas producing state, illustrates the variation in the taxation of oil and gas production. North Dakota levies an ad valorem oil extraction tax at a rate of 6.5% on the market value of production that occurs on private land (North Dakota Office of State Tax Commissioner, 2014). A lower rate of 4% would be assessed if the price of oil fell to the trigger price, which is currently $52.06 (North Dakota Office of State Tax Commissioner, 2013a). Low production wells, so-called “stripper wells” are preferentially taxed. For example, average daily production of oil not exceeding 30 barrels per day during a 12 month qualifying period, from a depth of more than 10,000 feet, is exempt from the oil extraction tax (North Dakota Office of State Tax Commissioner, 2013b). Some new horizontal wells were taxed at a preferential rate of 2% if the wells were completed within the time period in which production incentives were in effect. For example, if a well was new and completed between July 1, 2007 and June 30, 2008, it was eligible for a reduced oil extraction tax rate for the earlier of 18 months or 75,000 barrels (North Dakota Office of State Tax Commissioner, 2013b).

In addition to the oil extraction tax, North Dakota levies a 5% gross production tax in lieu of a property tax on oil and gas production property. Gross production value is defined as the market value of oil before post-production deductions and exemptions such as transportation costs. There are no exemptions from the gross production tax for stripper wells and no production incentives associated with this tax.

Pennsylvania currently does not levy a severance tax, and similarly exempts natural gas from the property tax. In March 2012, the state legislature approved an impact fee, born of Act 13. In section 23 of Act 13, the state provided for a per-well "fee" on natural gas that varies with the number of years of production activity, the price of natural gas, and inflation rather than volume of production. The fee begins the year the well is "spud," which is defined as the year that drilling a well began. The fee is adjusted for inflation using the consumer price index if the number of wells spud in a given year is greater than the number in the prior year. For calendar year 2013, the fee for a horizontal unconventional well was $50,000 for the first year, $40,000 for the second year, and $30,000 for year 3, decreasing to zero at the maximum of 15 years. The above fees are in effect when the range of natural gas prices is from $0-2.25/mcf. There are four additional price categories: $2.26 – 2.99/mcf; $3.00-4.99/mcf; $5-5.00/mcf, and $6 or more/mcf, for which the impact fee increases in $5000 increments as prices rise. Conventional wells come under the impact fee, but are taxed at a lower rate and for a shorter time period (PA Public Utilities Commission, 2013).

Both North Dakota and Pennsylvania levy corporate income taxes. North Dakota's marginal tax rate varies from 1.48% - 4.53%. There are three tax brackets. The highest bracket amount begins with taxable income of $50,001. Federal income tax is deductible against North Dakota's corporate tax. In Pennsylvania, oil and gas companies chartered as corporations are subject to a flat rate 9.99% corporate net income tax on profit earned in the state. However, profits earned by limited liability companies or limited partnerships are subject to the lower personal income tax rate, which is 3.07%.

An argument used to defeat a severance tax on natural gas production in Pennsylvania was that a severance tax, in combination with the state's corporate income tax, would tangibly deter natural gas extraction in the Marcellus Shale region of the state. This is a questionable argument for several reasons. First, as was pointed out above, limited liability companies and limited partnerships are subject to a lower rate.

Second, according to Chakravorty (2010) and Kunce, et al. (2003), the oil and gas industry, unlike an assembly plant, locates its production operations where the reserves of the resource are located; they are constrained by the unique features of geology. Furthermore, natural resource extraction is capital intensive; in the short run, the fixed capital costs mean the industry tends to drill intensively in a given location with proven reserves rather than selecting a more distant location to avoid taxation.

Pennsylvania's recent shift in production of dry gas to wet gas offers an example. Dry gas, mostly methane, is produced largely in the Northern Tier of Pennsylvania. Wet gas consists of methane in addition to evaporated liquids such as ethane, butane and pentane. In mid-2012, the number of rigs directed to production of "wet" gas in the southwestern counties of Pennsylvania exceeded the number of "dry" gas directed rigs in the Northern Tier counties. During the week of August 19, 2011, there were 83 active rigs in the dry gas producing counties of Pennsylvania, while during the week of August 16, 2013 there were 26 rigs. While productivity enhancing technological change may be responsible for some of the reduction in the number of rigs, it is likely that most of the shift to wet gas was driven by the profitability of wet gas relative to dry gas. According to the U.S. Energy Information Administration (2013), Southwestern Pennsylvania and West Virginia constitute an "integrated natural gas production region." The fact that West Virginia levies a 5% severance tax on oil and gas has not deterred the production of wet gas in the areas of West Virginia that border Pennsylvania. A likely reason is that taxes are simply too small relative to the benefits of locating in areas with proven reserves or to shifting to the production of a more profitable resource. As Chakravorty et al. (2010) point out in a study of oil production and the severance tax, if production is insensitive to a severance tax, the severance tax "serves mainly to redirect rents earned in the oil industry to the public sector." Therefore, a state can increase its revenues from the severance tax without reducing production; conversely, as Montana learned in a costly lesson of lowering extraction taxes in an effort to provide a stimulus to oil and gas production, states that lower tax revenues decrease revenues from oil and gas without affecting production (Headwaters, 2008).

Third, nominal marginal tax rates are not an appropriate method to determine how heavily producers are taxed. A more appropriate measure for comparison across states is an effective tax rate, which is a ratio of gross production value to tax revenue. An effective tax rate takes into account the considerable variation across states in the features of their tax structures, including the composition of taxes levied on the industry, the tax preferences associated with oil and gas production. As shown above, both Pennsylvania and North Dakota offer tax preferences for low producing, "stripper wells." North Dakota does not levy a property tax on oil producers and allows federal income tax payments to be deducted from state corporate tax liability. Producers that pay severance and corporate income taxes can deduct these expenses from federal income tax liability. (See Headwaters Economics (2008) for a comparison of the effective tax rates for five states in the U.S. West).

Fourth, the economic incidence of a tax refers to the party that actually pays the tax. The statutory incidence of a tax refers to the party that has legal responsibility for paying the tax to the relevant government agency. The difference between the statutory and economic incidence is the degree of tax shifting or in the case of interstate commerce across political jurisdictions, the degree of tax exporting. Standard analysis of the economic incidence of the severance tax concludes that the party which ultimately pays the tax is the one which cannot readily alter behavior to avoid the tax. In the long run, it is generally concluded that producers can alter royalty and lease contracts through royalty and lease payments to shift the tax to the mineral rights holders who are unable to avoid the tax.

Issues have arisen in Pennsylvania that illustrate the role of contracts and the potential for tax shifting. Pennsylvania's Minimum Royalty Act, 58 PA. Stat. 33, states that a lease to extract natural gas "shall not be valid if such lease does not guarantee the lessor at least one-eighth royalty" of all natural gas removed from the property. However, the term "royalty" is not specifically defined nor does the statute specify whether at what point in the production of natural gas the royalty is to be assessed. The industry has generally argued that Pennsylvania law does not prohibit passing on a share of post-production costs to mineral rights holders. Pennsylvania courts have yielded no consensus on the matter (Jochen and Pifer, 2009).

Lastly, taxes are not the only policy instrument available to state governments to foster an economic climate that is favorable or unfavorable to business location decisions. Pennsylvania provides a recent example. Shell Oil was offered tax preferences of $1.7 billion over a period of 25 years to build an ethylene plant in Monaca, PA. It was been reported recently that there is no guarantee that Shell will build the plant. The state is awaiting a decision from Shell within the next 1-2 years (Begos, 2014).

B. Use of Revenues

The overall effect of taxes on the well-being of citizens cannot be determined independently of the disposition of the tax revenues that are generated by those taxes. Oil and gas are non-renewable resources. States cannot depend on a stream of revenues from oil and gas production in perpetuity. They can, however, convert the tax and non-tax revenues from resource extraction to financial assets that serve that purpose. To do so requires a delicate balance between current state and local expenditures associated with government operations, mitigating of extraction costs (e.g., education and infrastructure) and planning for the future (Headwaters Economics (2008)). Planning takes two forms: diversification of a state's economy to sustain local economic development, and developing permanent funds as compensation to future generations for the loss of the resource. Greenwood and Holt define economic development as "a broadly based, *sustainable increase in the overall standard of living for individuals within the community.*" As the previous section discussed, many of today's locations with natural resource extraction are rural. Irwin, et al. (2010) define *rural* development as "more varied nonfarm rural industry and land uses, new rural occupations, and higher income per capita." Therefore, for state fiscal policy to enhance economic development, the loss of natural resource stock must be compensated by an increase in the stock of physical, social, or human capital; otherwise, the quality of life is diminished.

A comparison of the allocation of Pennsylvania's new impact fee revenues and North Dakota's severance taxes, particularly their new permanent fund, further illustrates variations in shale era tax policy. Revenues collected from Pennsylvania's impact fee are earmarked to a mix of state and local purposes. The initial distribution is to specific state agencies affected by the development activity, such as the Fish and Boat Commission, the Department of Environmental

Protection, and the Emergency Management Agency, and to develop uses of natural gas, such as conversion of vehicle fleets to CNG, and affordable housing projects. After these state earmarks are met, 60% of the remaining revenues are distributed to local governments for locally determined infrastructure or mitigation projects, emergency preparedness, social services, worker training, or to provide tax reductions. The remaining 40% of revenues is allocated to a state Marcellus Legacy Fund, where authorized uses include local bridge improvements (25%), water and sewer projects (25%), clean-up of acid mines, abandoned wells, and water quality (20%), parks and open space (15%), and environmental stewardship (10%) . The remaining 5% is for developing oil and gas projects through the Department of Community and Economic Development.

In addition to the impact fee revenues, the state receives revenue from leasing state forest lands for gas development. The receipts include monies from leasing the land, plus royalties on gas production. Since 2009, when leasing brought $160 million into the state, under both Democratic and Republican administrations such funds have been viewed as a means of plugging state budget deficits (Patriot News, 2014), and have been diverted into the state's General Fund. The result, as testified by John Quigley, the DCNR Secretary under Governor Rendell, was the department was directed to lease however much land was required to meet state budget goals (Patriot News, 2014).

North Dakota's revenues from the oil and gas production tax and the oil extraction tax are allocated to many funds set by a complex arrangement of legislated percentages and formulas. The largest share of distributions of 2013-15 oil and gas tax revenues were to the following: the Legacy Fund (32.4%); strategic improvement and investments fund (12.0%); political subdivisions (11.2%); resources trust fund (10.6%); property tax relief sustainability fund

(6.5%); the general fund (5.7%); the foundation and aid stabilization fund (5.3%); the common schools trust fund (5.3%); tribal share (5.2%), and the oil and gas impact grant fund (4.5%). (See North Dakota Legislative Council report, July 2013)

The North Dakota Legacy Fund is a permanent fund established in 2010 with an amendment to the state's constitution. On April 21, 2014, total deposits equaled $1.9 billion. The purpose of the Legacy Fund is clearly stated in the Fund's mission statement: "The Legacy Fund was created, in part, due to the recognition that state revenue from the oil and gas industry will derived over a finite timeframe. The Legacy Fund defers the recognition of 30 percent of this revenue for the benefit of future generations."

Spending from the Legacy Fund is restricted in two ways. First, the principal and interest from the Fund cannot be spent until after June 30, 2017. After that date, expenditures from the principal of the Legacy Fund must be approved by at least a two-thirds majority vote of the Legislative Assembly. Second, not more than 15% of the principal can be spent in a biennium. A state Legacy Fund Advisory Board has set policies on investment goals and the asset allocation of the Fund. The State Investment Board is responsible for investing the principal of the Legacy Fund.

At the state level, this use of impact fee revenues may make sense in a state such as Pennsylvania, which has more economic diversity and for which the gas industry is a smaller percentage of state output than a state such as North Dakota. However, a very important question for Pennsylvania is whether the impact fee will generate revenues that will mitigate damages to local communities and provide revenue for diversification. In unconventional shale plays, the propensity for sustained production means sustained drilling, which creates localized impacts on roads, bridges, water, and other physical infrastructure. Most of Pennsylvania's impact fee distributions are aimed at mitigating impacts and developing infrastructure, with little concern for economic diversification or leaving a permanent fund for when natural gas is depleted or no longer economically feasible to extract. The Commonwealth's on-going actions using funds from leasing state lands to balance the state budget, started under a Democratic governor and continued under the current Republican governor, suggest that there may be financial difficulties when the boom ends, and that policymakers are not thinking about the long term.

In states such as North Dakota, where energy is a dominant sector of the state's economy, the disposition of oil and gas tax revenues is of paramount importance for the future, especially in dampening the effects of volatility in both energy and commodity prices. An interesting question for North Dakota is whether revenue allocations that may promote economic diversification can be successful over the long term. North Dakota has taken precautions against tapping "permanent" funds to meet current expenditures. However, the existence of a permanent fund, as Williams (2008) opines about New Mexico's permanent fund, can exist with low rankings in indicators of economic well-being. Whether North Dakota follows Alaska by eventually distributing some of the earnings to its citizen-shareholders or emulates Wyoming by allowing state policymakers greater latitude over spending is an open question. The question that remains is whether any state with permanent funds will allocate those funds to state and local government expenditures in a timely, well-coordinated manner or resort to using them in times of fiscal exigency. Having the funds is merely the first phase of a long process toward enhancing economic well-being for future generations.

C. Preemption and Locus of Decision-making

Where regulatory authority resides has important implications for the distribution of risks and for democracy. There can be little doubt that a multitude of diverse (and potentially changing) local regulations can increase the planning and investment risks of the natural gas companies, and thus potentially increasing their costs. On the other hand, recent court rulings in New York and Pennsylvania have explicitly recognized that overriding local regulations shifts major risks of the activity onto local communities and residents (see Norse Energy Corp. v. Town of Dryden; and Robinson V. Commonwealth of Pennsylvania). The locus of regulation similarly affects 'whose' voices count in decisions affecting residents and communities, and the relative strength of those voices. A consistent argument throughout the history of local land use planning and governance is that local residents best know the needs of their community, and thus such decisions should be made at that level.

Giving local governments major regulatory control over natural gas and oil drilling activity raises significant policy issues that should not be slighted. Granting authority to local governments does not by itself mean that local governments have the means or capability to use that authority. Much of the drilling activity in Pennsylvania, for example, is in very rural, small population townships who rely upon part-time supervisors, treasurer, and municipal secretary, have no zoning regulations, and lack the resources and capacity to implement robust land use planning efforts. In addition, actually using such regulatory authority at the local level can be extremely controversial and difficult to implement, even in the absence of natural gas development. The relatively large lease and royalty payments associated with Marcellus shale development can only exacerbate this controversy, since zoning decisions about where drilling activity can occur may literally decide who will (and who will not) become a millionaire.

D. Equity

Local control also potentially raises environmental justice and equity issues, similar to concerns which arise over landfills, adult bookstores, and other typical locally unwanted land uses. If few communities opt to allow drilling activity, it is possible that those with the least capability to plan will by default end up with much of this activity. For example, to what extent is it fair for communities (or states) to have the benefit of natural gas if they are unwilling to also bear the negative consequences of such activity? A notable example of this is New Jersey and New York's current statewide bans on unconventional oil and gas development activity, while simultaneously growing demand for natural gas from both states is causing major expansion of the pipeline networks delivering natural gas to those states, such as the $2 billion expansion of the Tennessee Gas Pipeline, and the $2 to $3 billion expansion of the Transco Interstate pipeline. We raise this not as an argument against local control and decision-making, but rather as something that should be monitored over time to ensure that communities do not become unwilling sacrifice zones, bearing the costs of such activity while other communities gain the benefits. The past resource curse experience of many communities dependent upon energy extraction should be a reminder that there can be long run costs to serving this role.

Similar policy issues arise regarding fairness within the communities with unconventional oil and gas development. Much of the local economic benefit of shale oil development accrues to the mineral right owners receiving lease and royalty dollars. In Pennsylvania's top drilling county, for example, real increases in lease and royalty income far exceeded increases in gross compensation received by local workers (Hardy and Kelsey, 2013). Yet the ownership of land and mineral rights is highly concentrated. For example, in Pennsylvania's top drilling counties, about half of the land area is owned by the top ten percent of resident landowners, while a little less than forty percent of the land area is owned by non-residents (Kelsey, Metcalf and Salcedo, 2012). The majority of residents, in contrast, owns a very small share of the total land area, and thus will receive only a very small share of lease and royalty dollars. Weber, Brown and Pender (2013) in their national study of farms found a similar concentration of payments among only a relatively few landowners.

Yet the spatial nature of unconventional gas development, with its major impacts on transportation infrastructure and community quality of life (Brasier, et al. 2011) mean that most residents are impacted by the activity, regardless of whether the drilling activity is occurring on their land, and similarly regardless of whether they are receiving benefit from the activity. Not surprisingly, attitudes towards such development are very positively associated with whether the landowner is receiving lease, or lease and royalty income (Jacquet, 2012). The dissimilar distribution of costs and benefits have the potential of undermining social capital in a community (Weber, Brown and Pender, 2013), which may be one factor that contributes to why one-third of local government officials in Pennsylvania's Marcellus Shale region reported greater community conflict due to gas drilling (Kelsey & Ward, 2011)

The equity issues arising relate, in part, to how communities should balance the varied interests of different residents and property owners, such as how to protect individual property owners' rights to develop their land and mineral resources as they see fit, while protecting the interests of neighbors and others; protecting other property owners' rights to enjoy the use of their land and resources without bearing risks, nuisances, and other externalities being created by others who choose to lease; protecting the quality of life of renters and others who have little claim on the benefits of development activity, while yet potentially being exposed to the costs. Likewise, considerations should include those who have found employment opportunities from energy development. Such equity considerations also include the role of non-resident property owners who live elsewhere, and thus are not exposed to the day-to-day impacts of the development activity.

4. Economic Policy Recommendations

How can the natural resource curse be avoided for regions undergoing intense energy development? Obviously, given the relatively early stage of this research at the U.S. sub-state level for the current boom cycle, any suggestions should be viewed with caution, because we have not yet seen the bust. Yet, the following can help avoid the natural resource curse and help communities maximize the gains from energy development (This discussion follows Farren et al. 2012; and Headwaters Economics, 2012).

A) Do No Harm in the Long Run. There is a common adage in medicine, "First, do no harm," which suggests physicians consider the possible harm an intervention can do. This is equally good advice for states and communities facing unconventional shale gas development, who at a minimum should ensure that the development activity does not create permanent harm in the long run, making it more difficult for the economy to adjust once the extraction activity ends. Ideally this also means that the short run money and benefits arising from activity are channeled in ways to create long run benefit for the community. At a minimum, such actions would include (1) use any financial proceeds from the activity, such as lease/royalty payments, impact fees, and tax receipts, to fund long run investments that will strengthen the community so it can better adapt when the drilling ends (e.g. not just use the monies to pay for tax cuts or expenditures which will need to be reversed once the boom is over); (2) do not make long run financial commitments (particularly for infrastructure) that may burden the community long term (a 'pay as you go' approach is better); (3) strive to maintain a diversified economy (rather than allowing the gas development to crowd out other economic activity); (4) protect important environmental and community assets and amenities so they are not harmed during the boom activity; such assets typically make important contributions to local quality-of-life (Dissart and Deller, 2000), and help provide the foundation for the local economy (Deller et al. 1999) .

B) Ensure that the hidden costs of resource extraction are adequately compensated with the industry paying the full costs of negative externalities such as pollution and congestion through setting taxes, fees, and regulations such that marginal costs equal marginal benefits. Allowing the energy industry, for example, to avoid paying for its external costs is not pro-business, but instead shifts those costs onto other sectors of the local economy and local residents (reducing the region's quality of life), which diminishes both the short- and long-term competitiveness of the region (which applies to any industry). An example of managing such hidden costs are the Road Use Agreements common in Pennsylvania, between natural gas companies and municipal governments, in which the companies agree to pay the full costs of road repairs and upgrades associated with road damage they cause.

C) Leverage the additional wealth and economic activity into permanent advantages such as a more diversified economy that is resilient to economic volatility. The point is that communities need to take advantage of the short-term agglomeration and wealth benefits during the boom so that the local area is better positioned for the bust. Waiting to diversify until the bust sets in is too late. Who wants to start new businesses in declining regions?

D) Levy severance taxes that capture resource rents that are consistent with the Hartwick-Solow rule (Hartwick, 1977) and then use the proceeds to fund public infrastructure, human capital development, and environmental enhancements to ensure long-term growth after the resource is depleted. The severance tax should fund permanent trust funds that can be used to improve the region's appeal well after the energy resource is extracted. In addition, the funds could be used by the state to assist local governments bearing the costs of boom-bust.

E) Invest strategically in workforce development to help local residents gain the skills required to successfully compete for jobs within the workforce. A critical factor affecting how much of the local economic impact of unconventional oil and gas development remains within a community is the extent to which local residents are able to successfully compete for the jobs. Heavy reliance on a transitory, non-local workforce means much of the wage income being generated by the activity quickly leaves the community. Targeted workforce training, focused on skills required during the drilling activity, such as welding, Commercial Drivers Licenses, diesel repair, and other skills, can help increase the share of employment going to residents.

The tradeoff that must be considered, however, is the time horizon of the activity within a specific community. Highly specialized skills, such as required for roustabouts or well completion crews, may not be required for very long in any one location, so training local workers to do these jobs may mean these residents have to move away to follow the drilling activity. In addition, there is major risk due to the volatility of the pace of development. There are more than a few anecdotes in northern Pennsylvania about entrepreneurs who bought tanker trucks to haul fresh water for gas companies, only to be financial difficulty when the companies began using water impoundments and temporary piping to reduce trucking costs. There is no guarantee that specific services or job skills will be needed in a community tomorrow.

F) Strengthen the capacity of local governments to understand and manage this activity. Local governments can play critical roles in how unconventional oil and gas development affects a community and residents, both in the short and long run. Even in states where local governments are prohibited from regulating the activity, they serve important public service, infrastructure, regulatory, public information, and police power roles that can protect the public and natural resources, nurture a healthy local business environment, and provide independent oversight of the impacts of unconventional oil and gas development within their jurisdiction. This can include basic decisions affecting road and other infrastructure, police and fire protection, subdivision and zoning regulation of housing and other building activity affected by the development, and provision of public information.

Much of the shale oil and gas development is occurring in very small rural communities, many of which lack the financial and human resources to adequately prepare and manage the challenges this development can suddenly and rapidly bring to a community. Many small local governments have minimal staffing, often only having part-time employees, so they have limited time for dealing with the new demands and issues, much less time to attend trainings or to update long run comprehensive, infrastructure, and other plans which can be vital to the community's future. In addition, previous to the onset of the oil or gas development in their community, they already were juggling a full range of municipal or county government responsibilities. They have little capacity to adjust to the new demands arising from the development.

State governments need to examine how to strengthen the ability of local governments to appropriately manage this activity. Helping local officials become educated about the challenges and opportunities arising with the development, and how to manage these is important, but is not enough by itself due to low staffing levels in many of the municipal governments being affected. Such officials are stressed for time to attend such trainings, much less implementing what they learn, because they are already busy with other existing local government responsibilities. States should consider strengthening regional cooperation and collaboration in the areas affected by the development, using existing regional entities such as regional planning or development organizations to help local governments coordinate their activities.

In addition, there may be need for creating trained circuit-rider shared positions that work across several local governments, spending a day or two weekly in each of their assigned jurisdictions. The positions could be focused solely on the unconventional oil and gas activity, allowing the individuals to specialize on this without having to juggle other municipal responsibilities. Such an approach would provide local governments expertise on this issue, plus help facilitate communication, cooperation, and coordination across jurisdictions. The positions could be funded directly by the state government, by contributions from the participating local governments or energy companies, or from a dedicated share of severance or impact fee dollars.

G) Increase the transparency of local government and governance institutions to help limit rent-seeking behavior of the industry, other citizens, and government entities to ensure that the long-term interests of the citizens are the primary objective. Special treatment for the energy industry—or any industry for that matter—is not pro-business, but pushes their costs onto the broader local economy. It also places government in the position of choosing winners and losers in the marketplace.

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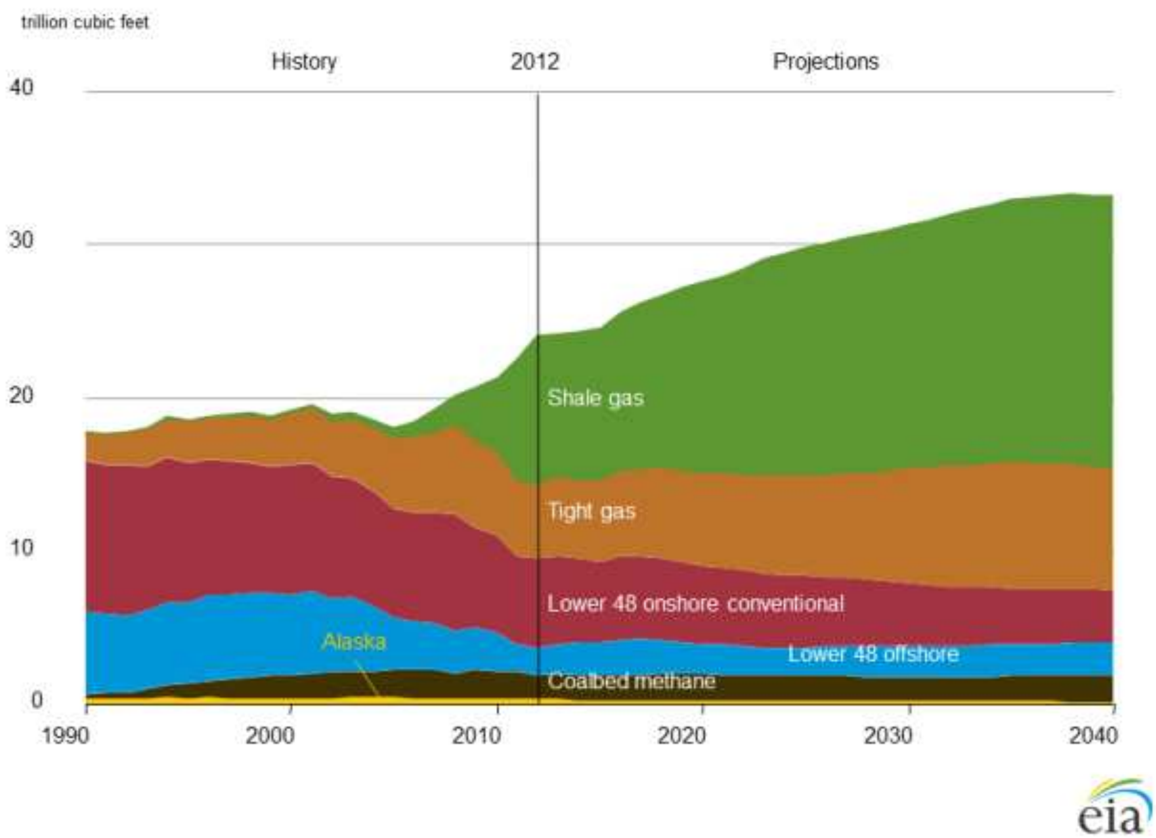
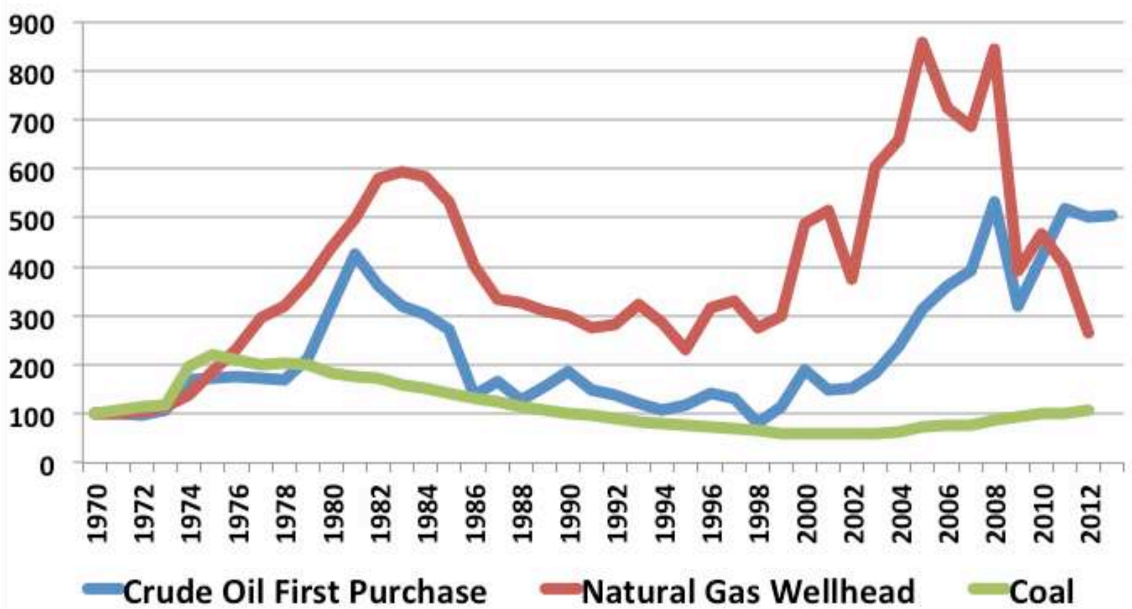
Figure 1. U.S. Natural Gas Production by Source, 1990-2040



Source: U.S. Energy Information Administration, 2014.

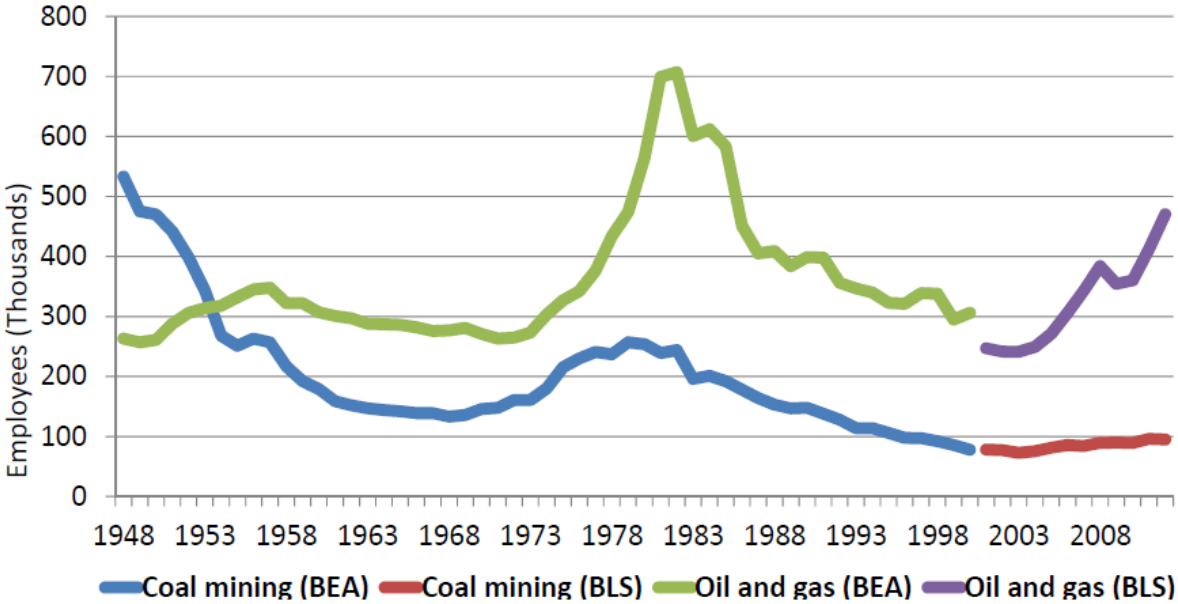
Figure 2: Real Energy Prices in 2013

(1970 = 100)



Source: U.S. Energy Information Administration (crude oil first purchase prices, dollars per barrel - http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=F000000__3&f=A; natural gas wellhead prices, dollars per thousand cubic feet - http://www.eia.gov/dnav/ng/hist/n9190us3a.htm; coal prices, dollars per short ton - http://www.eia.gov/totalenergy/data/annual/pdf/sec7_21.pdf). Prices were multiplied by the Consumer Price Index (CPI) for 2013 and divided by the CPI for each year to determine prices in 2013 dollars (http://www.bls.gov/cpi/#data).

Figure 3: U.S. Coal and Oil & Gas Employment: 1948-2012



Sources: 1. Bureau of Economic Analysis - National Income and Product Accounts Tables 6.4A-D
2. Bureau of Labor Statistics Quarterly Census of Employment and Wages: for coal mining, we use NAICS 21211 and 213113; for oil and gas, we use NAICS 213111 and 213112.

Figure 4: Employment in Direct and Key Indirect Oil and Gas Sectors

2001 and 2012

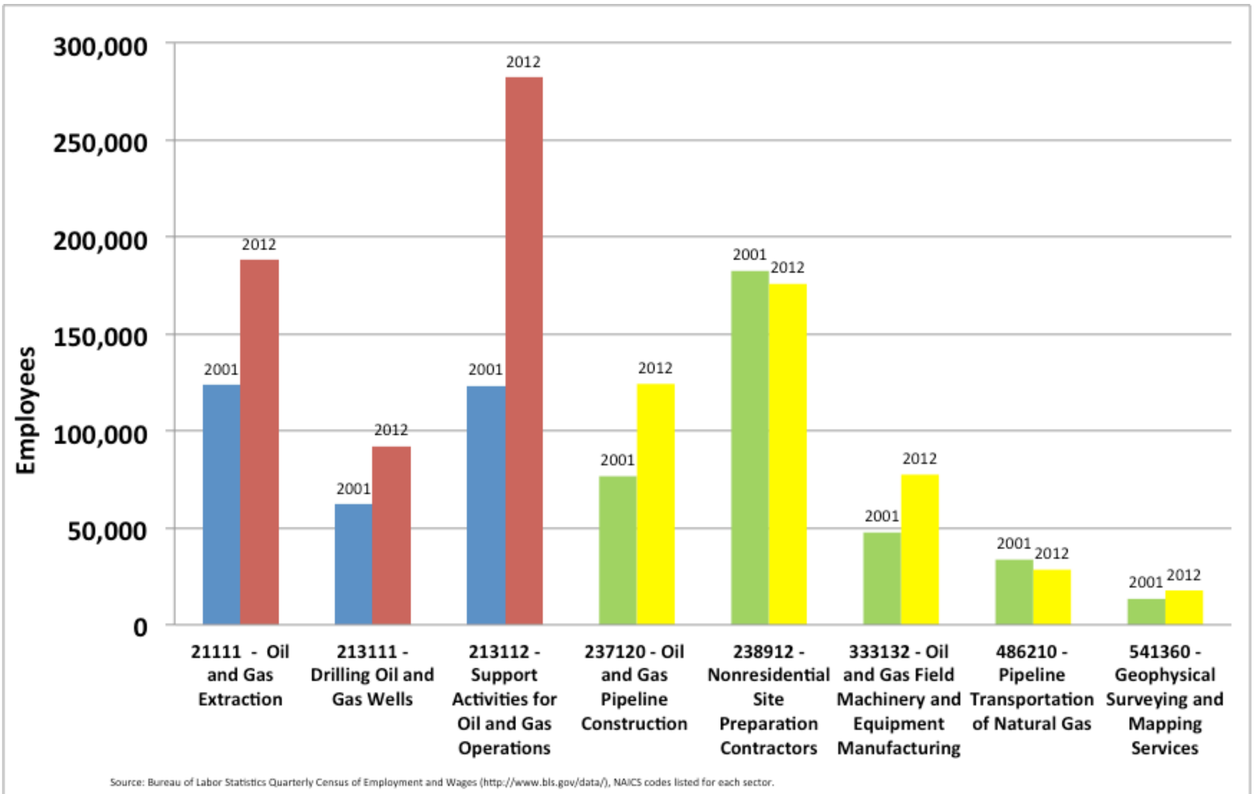
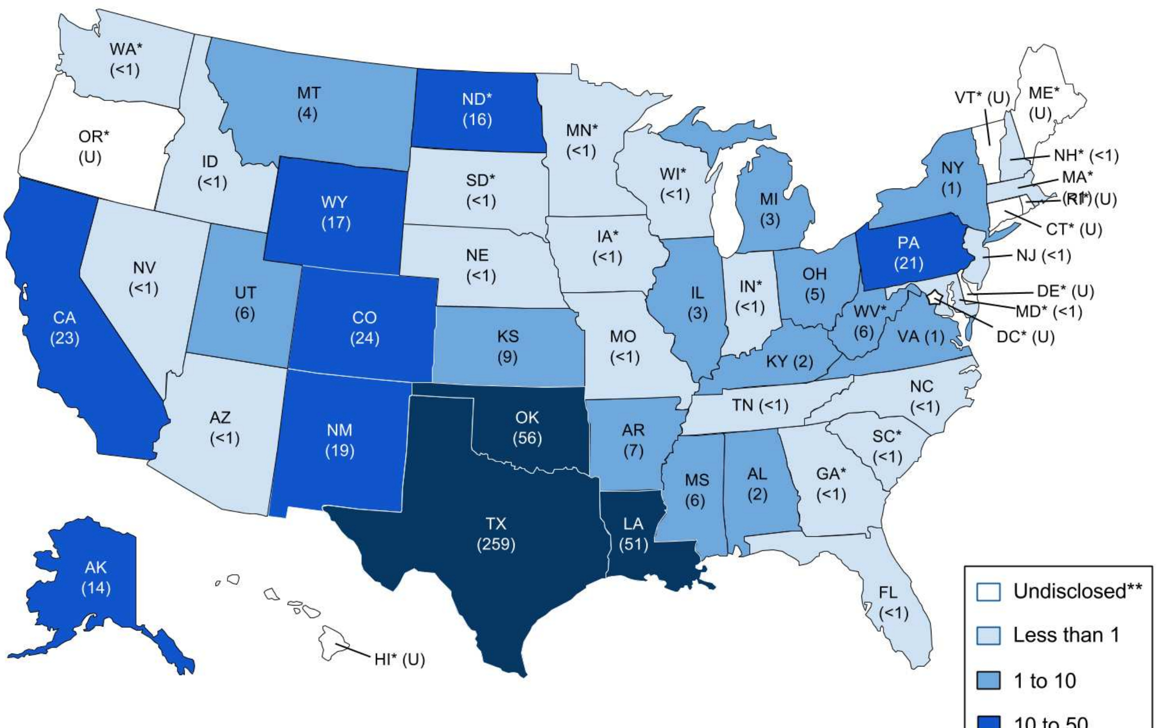


Figure 5: Oil and Gas Industry Employment by State in 2012

(in thousands)



Source: U.S. Bureau of Labor Statistics - Quarterly Census of Employment and Wages. Industries are NAICS 211, 213111, and 213112
* At least one industry was not disclosed because the data do not meet BLS or State agency disclosure standards.
** Data was not disclosed for all three industries because the data do not meet BLS or State agency disclosure standards..

Figure 6: Oil and Gas Sector Employees in Harris County, TX

2001 and 2012

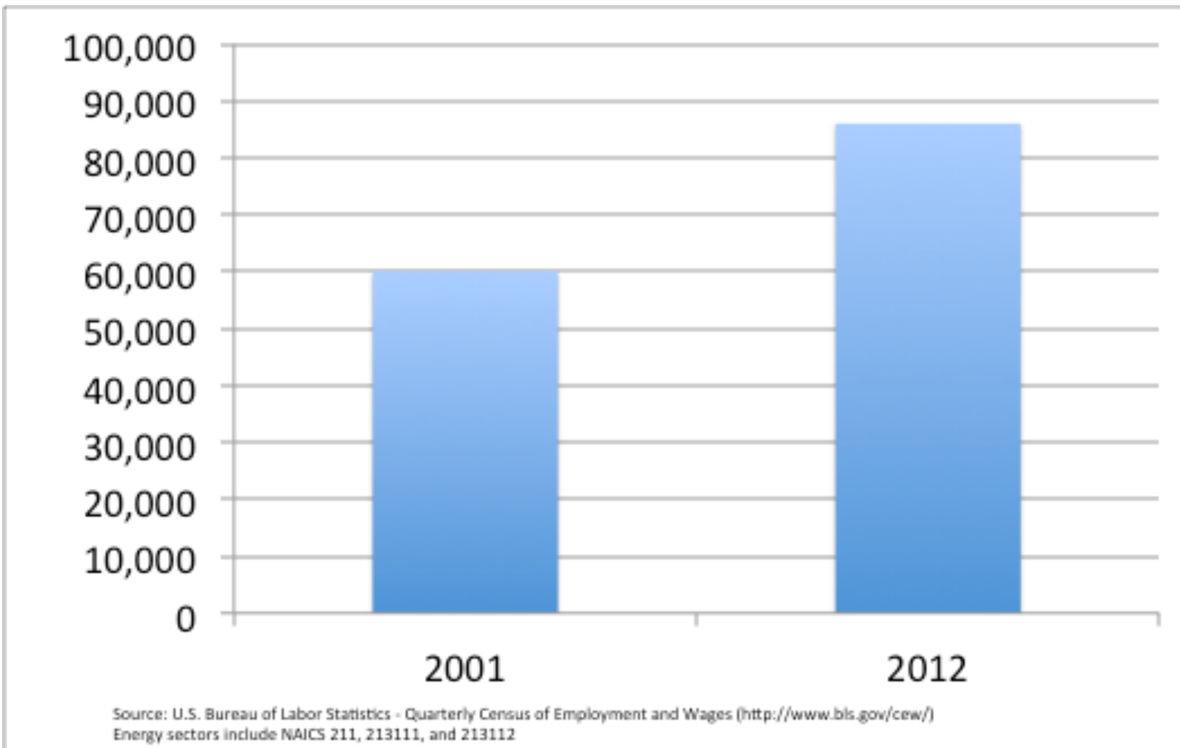


Figure 7: Converse County, Williams County, and the U.S. Share of Total Wages and Salary from Mining, 1969-2012

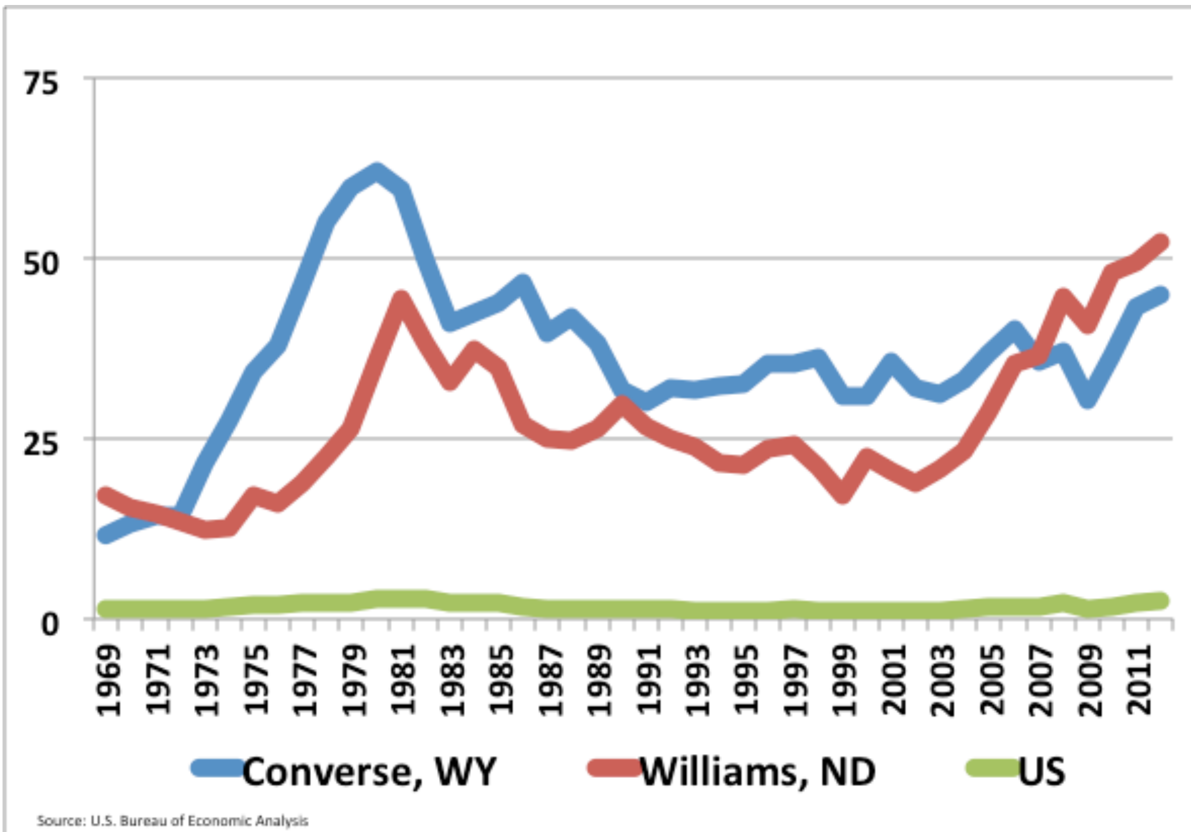


Figure 8: Population Growth for Converse County, Williams County, and the United States, 1969-2012 (1969 = 100)