"Economic Impacts of Energy Development: Opportunities, Challenges and Policy Implications"

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Abstract

The technology for energy extraction changed significantly during the late 1990s and early 2000s, which affected the production and price of energy. This energy boom has revered long downward trend in U.S oil and natural gas production. This increased has opened new possibilities for the U.S economy. A key question is whether this new abundant and accessible natural resources has positive effect on U.S economic conditions through higher demand for labor in the energy sector and spillover spending in the local economy. The purpose of this paper is to review the impacts of changes in energy price on the economy; evaluating gains and challenges with a particular emphasis on changes in energy prices on employment in the U.S. Using Rendon Effect Regression we examined how changes in U.S. oil and natural gas production may affect employment. Our result shows that there is a positive impacts of lowering energy price on employment. Some of the states providing new energy resources are becoming less economically diversified and more economically vulnerable to energy price declines and benefiting more from price increase. As a result of innovations such as hydraulic fracturing, some government, industry, and academic observers have predicted that the United States will soon become energy self-sufficient and possibly become a net exporter of natural gas and petroleum. Fracking, renewable energy are just a few of the things that have reshaped the energy picture over the past 20 years, how much it will change in the next 20 years and policy implications are discussed.

Keyword: Energy price, employment, hydraulic fracturing

Introduction

U.S. policymakers' concerns on high price of energy were highlighted in the 1970s when episodes of sharply rising oil prices led to recessions, economic stagnation, and high inflation. However, recent gains in U.S. oil and natural gas production are changing the dialogue about U.S. energy strengths and vulnerabilities. Leaders from both specific markets and regions are looking at the opportunities and challenges associated with the so-called energy production revolution ushered in by the new means to access natural gas and other fuels. Using projected annual growth in U.S natural gas consumption, current U.S reserves of natural gas represent an estimated 70 years' worth of supply (Brown, 2014). Production and proven reserves of natural gas have increased significantly since the mid-2000s. Prior to the advent of shale gas (is a field in which natural gas accumulated is locked in tiny bubble like pockets within layered sedimentary rock such as shale) in the mid-2000s, total natural gas production in the United States was flat at about 19 trillion cubic feet to 20 trillion cubic feet, however, by 2011 total annual production had grown nearly 30 percent to 24.6 trillion cubic feet (Energy Information Agency, 2011). A continued increase in domestic production could lead to improvement of net exports. The trend in net exports likely depends on the pace of conversion of gas-fired plants, traditional coal-fired power plants and possible conversion of vehicles to natural gas as transportation fuel. According to energy Information Agency (EIA) net exports of natural gas are expected to grow to 3.6 percent trillion cubic feet in 2040, representing only 12 percent of consumption. The federal government has approved three permits for liquefied natural gas export facilities within the last two years (Brown, 2014).

Another study found different impacts on exports and imports. Imports respond to a change in energy production before exports, as changes in exports require new distributors in foreign countries. If the growth rate of domestic energy production increases by 1 percentage point, the energy import growth rate declines by 1.7 percentage points over the fourth quarter of 2014 and first quarter of 2015, statistically significant effect.

Similarly, a 1 percentage point increase in domestic energy production growth leads to a 1 percentage point increase in exports growth over the fourth quarter of 2014 and first quarters of 2015, statistically insignificant effect (Hakkio and Nie, 2014). It is estimated that energy imports are will decline 2.9 percent in 2014 and 4.6 percent in 2015 (Ibid).

Oil at a half price should boost the consumption and spending power of companies and households. This in turn has a positive impacts on global economy as Capital Economics Ltd (Miller, 2015) measured the impacts of crude oil price of $60 and $70 a barrel that could add 0.5 percent to global GDP in 2014 and 2015. Lower oil price along with lower euro value and low yield should add 1.75 percent to European GDP in 2015.

Indeed, many from potential energy-producing regions are assessing the trade-offs between economic growth associated with expanded gas and oil production and the risks to the environment that this production may pose. The key question is whether this new abundance and accessible natural resources has positive effects on local economic conditions. Greater availability of domestic energy resources benefits the United States by reducing dependence on imported energy and diversifying the economy (Brown and Kennelly, 2013). It is expected that energy exports to increase 12.3 percent in 2014 and 19.4 percent in 2015. The strong growth is supported by both a continued increase in domestic energy production and continued rising foreign demand. Combining the forecasts for imports and exports, net energy imports are expected to narrow by 40 percent, which helps reduce the current trade deficit by about 14 percent (Hakkio and Nie, 2014).

But the boom also brings new vulnerabilities. According to the U.S. Bureau of Labor Statistics, at the height of the early 1980s oil boom, the five industries most sensitive to oil prices—coal mining, oil and gas extraction, oil field machinery, petroleum refining, and petrochemicals—accounted for 1.6 million jobs, 1.8 percent of total U.S. nonagricultural employment. By 2000, the share of these five industries had dwindled to 0.4 percent of total U.S. nonagricultural employment, only 457,000 jobs. With oil and natural gas prices rising beginning in the early 2000s, employment in the oil and natural gas sectors began growing too (Brown and Kennelly, 2013). The boom in production of oil and natural gas from shale formations became a significant factor after 2008. Rising energy prices and the shale boom led to strong growth of U.S. oil and gas employment from 2005 to 2011. Fossil fuel industry has a smaller share of U.S. employment today than it did in the early 1980s, and the industry's share of national economic activity is relatively small. After the end of the recession, between 2010 and the end of 2012, the industry added 169,000 jobs nationwide, growing at a rate about ten times that of overall U.S. employment. The share of oil and gas extraction was 4.3 percent of U.S. GDP in 1981, declined to 0.6 percent by 1999 and rose to 1.6 percent of GDP in 2011 as a result of the shale boom (Ibid).

An energy boom based on shale gas and oil extraction may present opportunities in many different arenas. For instance, some regions will especially benefit from lower consumer prices for home heating and cooling. Similarly, switching to natural gas from diesel in the long-haul trucking industry to take advantage of low natural gas prices may help bring about lower delivery costs for a wide spectrum of household and business goods. Additionally, several parties in regions historically reliant on manufacturing, such as the Midwest, are hoping that low energy prices will bring about new development and jobs in energy-consuming manufacturing sectors, such as chemicals and plastics. Furthermore, greater energy production and chemical manufacturing may lead to more supply chain linkages, which can be developed by regional and local economies (Hanson, Lavelle, Testa, 2013). The long-term local effects from energy development are unknown and complex. According to CBO, shale development will raise GDP in the longer term in two ways: increasing the productivity of existing labor and capital, and increasing the amount of labor and capital in use. CBO estimates that, as a result, real GDP will be 0.7 percent higher in 2020 and 0.9 percent higher in 2040 than it would have been without shale development. Shale oil and gas is no panacea for the long-run issues facing the U.S. economy, and America is in no way on a path to becoming a resource-dependent economy because the U.S. economy is so enormous that no single industry is capable of making a huge difference, not all by itself. Instead, the future of the U.S. economy will need a number of key industries to step up--and it looks as if oil and gas drilling can be one of them.

There are various potential factors and local actors involved with energy development. Market forces, government polices (federal, state, and local), and stocks of local wealth influence energy development, the multiplier effect can become very complex; the owners of land and mineral rights receive energy payments, which in turn affect property values. Thus, payments have a direct effect on income and wealth, both of which influence consumption, savings, and investment.

Other factors to consider is if commodity prices drop for any reason–even if it is because a debt bubble is popping–it is going to affect how much companies are willing to produce. There is going to be a tendency to cut back in new production. If prices drop too far, it is even possible that some companies will leave the market altogether. Even if it doesn't look like a country "needs" the current high oil price, there may still be a problem. Oil exporters depend on the high taxes that they are able to obtain when oil prices are high. If they cannot collect these taxes, they may need to cut back on government programs such as food subsidies and new desalination plants. Without these programs, civil disorder may lead to cutbacks in oil production.

Preeg findings come as Boston Consulting Group (BCG) - a leading proponent of the idea that U.S. manufacturing will come roaring back -- predicts a surge in U.S. exports, partly helped by lower energy costs and stagnating wages. In addition, BCG says rising exports and "reshoring" of production to the U.S. from China "could create 2.5 million to five million American factory and service jobs associated with increased manufacturing" by 2020 (Hagerty, 2013). Big companies, such as Caterpillar Inc. and General Electric Co., have moved some production back to the U.S. in recent years (Ibid). Some foreign companies, such as tire maker Bridgestone Corp. of Japan, have expanded U.S. capacity, partly to serve customers in the Americas.

With the boom in shale "fracking" and lowers natural-gas and electricity prices in the U.S. along with wages stagnate, "the U.S. is steadily becoming one of the lowest-cost countries for manufacturing in the developed world," the BCG report said (2013). The U.S. will have an edge over rival manufacturing nations in energy costs, along with lower productivity-adjusted labor costs than Germany, Japan, France, Italy and Britain (Ibid). That will allow the U.S. to grab a larger share of global manufacturing sales and the trends are going faster than we thought. A big part of the return of manufacturing jobs to the US has been credited to recent surge in energy production and the historically low price for natural gas. This not only makes energy intensive manufacturing operations in the US more competitive, it also results in lower energy prices for heating homes and fueling transportation.

Tables 1 and 2 representing differences in two decades of oil and natural gas production: As indicated in Table 1, from 1993 to 2012, world oil product has increased by 33 percent. Also, Table 2 presents an increase of 34 percent of world natural gas production since 1993.

Table 1: Top Oil ProducersTotal Supply, in Million Barrels a Day

1993		**2012**	
World 67.1		**World 89.3**	
U.S	9.6	Saudi Arabia	11.7
Saudi Arabia	8.9	U.S.	11.1
Russia	7.0	Russia	10.4
Iran	3.6	China	4.4
Mexico	3.1	Canada	3.9
China	2.9	Iran	3.6
Venezuela	2.6	United Arab emirates	3.2
Norway	2.4	Iraq	3.0
United Arab emirates	2.3	Mexico	2.9
Canada	2.3	Kuwait	2.8
Price of oil $18.43		**Price of oil (spot price) $94.05**	

Source: The Wall Street Journal, November 12, 2013, P. R6.

Table 2: Top Natural Gas ProducersDry Natural Gas Output, in Trillion Cubic Feet

1993		**2011**	
World	**76.51**	**World**	**115.99**
Russia	21.81	U.S.	22.90
U.S.	18.10	Russia	22.21
Canada	4.91	Iran	5.36
Netherland	3.11	Canada	5.22
U.K.	2.31	Qatar	4.71
Turkmenistan	2.29	China	3.63
Indonesia	1.97	Norway	3.58
Algeria	1.90	Saudi Arabia	3.26
Uzbekistan	1.59	Algeria	2.92
Saudi Arabia	1.27	Netherlands	2.85

Source: Source: The Wall Street Journal, November 12, 2013, P. R6.

The past two decades have seen some dramatic changes in growth of oil and natural gas product methods, mostly due to advancement of technology that affected all oil derivatives, see Table 3. It first became economical to extract gas from shale formations in 1998, now new fields opened by hydraulic fracturing that has pushed the U.S past Russia as the leading producer of natural gas. The boom has caused gas prices to plunge, making the fuel more attractive to utilities and pushing it past nuclear power as a secure of energy in electric power plants.

Table 3: Average Prices of Selected Fuels and Electricity: 1990 to 2010

Item	**Unit**	**1990**	**2000**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Crude Oil, Composite	Barrel	$22.22	28.26	28.53	36.98	50.24	60.24	67.94	94.78	59.29	76.69
Motor gasoline: Unleaded Regular	Gallon	1.16	1.51	1.59	1.88	2.30	2.59	2.80	3.27	2.35	2.7
No.2 Heating Oil	Gallon	0.73	0.93	0.93	1.17	1.71	1.98	2.24	2.99	1.96	2.46
No.2-Disel Fuels	Gallon	0.73	0.94	0.94	1.24	1.79	2.10	2.27	3.15	1.83	2.31
Residential Fuel Oil	Gallon	0.44	0.60	0.70	0.74	1.05	1.22	1.37	1.96	1.34	1.71
Natural Gas, Residential	1000 cu/ft	5.80	7.76	9.63	10.75	12.70	13.73	13.08	13.89	12.14	11.20
Electricity, Residential	KWh	7.83	8.24	8.72	8.95	9.45	10.40	10.65	11.26	11.51	11.58

Source: U.S. Energy Information Administration, “Monthly Energy Review,” April 2011.
See also http://www.eia.gov/totalenergy/data/monthly/
Note: Crude oil is refiner acquisition cost and unleaded gas is average, all service.

Some experts believe oil glut is coming and U.S. is moving toward a significant amount of domestic oversupply of light crude (Gold, 2013). The surge in oil production has been swift, from virtually no output five years ago to one million barrels a day (Ibid). The ramification could be far reaching, including lower gas online prices for American drivers, rising profits for refineries and growing political pressure on Congress to allow oil exports. But the glut could hurt the very companies that helped create it: independent drillers, who have reversed years of declining U.S energy production but face lower prices of their products.

Globally, the surge in supply and tumbling prices are attracting notice as OPEC countries could start selling oil to the U.S for less than it would fetch in Asia, the case of price discrimination is very likely due to difference in price elasticity among importing countries. On the other hand, as domestic energy demand grows along with global demand, numbers of oil experts insist that Saudi oil production (as the main oil producer among the OPEC member countries) has peaked and, indeed, is already in decline. Saudi leverage on the world market has become more limited (Simmons, 2005). Saudi Arabia can try to meet domestic energy demand by investing in solar and nuclear energy. The kingdom has announced plans to build sixteen nuclear reactors at a cost of $ 7 billion each by 2030 (House, 2013). Iran, already staggering under the weight of economic sanctions and years of economic mismanagement, could face even more severe challenges. The country ranks fourth in the world in oil and gas production, and it depends on its energy supplies to project regional influence.

But of all OPEC'S members, it has the highest fiscal breakeven price: over $150 per barrel. Although it is possible that lower prices might further diminish the legitimacy of the regime and thereby pave the way for more moderate leaders (Blackwill, 2014).

That oil is a finite resource; in 1970, the year U.S oil production peaked at 9.63 million barrels of oil a day, hardly anyone was worried that the world's largest oil producer was about to see rapid decline in its production. But since 1970, U.S oil output has fallen, to 5.5 million barrels a day in 2010, even as U.S oil consumption has risen to roughly 20 million barrels a day, or some 25 percent of worldwide consumption. The Unites States, which in the 1950s accounted for 50 percent of global energy production, now provides only 7 percent (House, 2013).

Experts expect growing production eventually pushes prices of intermediate crude below $ 50 a barrel, down from $97.38, which will cause more pressure on Congress to loosen crude-oil export restrictions, which dated back to the 1973 OPEC oil embargo. The Energy Policy and Conservation Act of 1975 (EPCA) banned the export of most crude oil in an attempt to insulate the United States from worldwide price shocks. If this ban is lifted as some expect, the recent changes in energy technology may have ever larger effects on energy exports and hence on the GDP growth.

However, U.S relies on alternative source of energy, as indicated in Table 4, it is expected in the future reliance on crude oil will be even less. With technology of horizontal drilling energy producers first drill down and then drill at an angle or even sideways. In this way, more of the reservoir is available and more gas can be recovered. The combination of fracking and horizontal drilling significant structural change has been seen in energy production. Production of natural gas and natural gas liquids reached historical highs in 2013, while petroleum production was about 25 percent below its 1970 historical high and closer to its 1990 level (Hakkio and Nie, 2014). Petroleum production has increased until 1970, then decreased until 2006 and increased through 2013. Natural gas production also had wide swings, where production increased until 1971, decreased until 1986, then increased through 2013. Increase in domestic natural gas production must be absorbed by the market or kept in storage facilities. Thus, flooding the market with natural gas has helped to depress prices. Oil is fungible and traded on a global market, thus domestic oil production is relatively a small share of global oil and can have little effect on price of oil and its prices are determined on a global market (Fitzgerald, 2013).

Table 4: U.S. Energy Consumption, 2015 and World Energy Production, 2015, BillionBTU's

	World Energy Production	U.S Energy Consumption
Crude Oil	30,804,324	6,134,315
Natural Gas	22,093,028	4,804,273
Coal	29,360,173	3,244,231
Nuclear	7,558,478	1,483,266
Biomass	1,471,695	827,567
Hydroelectric	5,741,979	459,440
Biofuels	678,163	367,229
Wind	1,061,745	286,144
Solar	577,881	39,649
Geothermal	238,432	55,070

Source: www.usdebtclock.org/energy.html
Retrieved on March 6, 2015

The debate comes as California lawmakers consider legislation to regulate fracking, which involves pumping water, sand and other materials down wells to break apart rock formations and release oil and natural gas. All these expanded production has often come with environmental costs, which in various places include air pollution, clear cut forests and water tainted by chemicals. The state Conservation Department's Division of Oil, Gas & Geothermal Resources also is trying to create new regulations that would require more disclosure of hydraulic fracturing work in California. Concerns about fracking has risen recently in the state, as oil companies seek to tap the Monterey Shale formation, which the federal government says contains huge oil reserves. But drillers have struggled to get that oil out of the ground, even using horizontal wells and conventional fracking. Offshore, the focus is on activity at the existing 23 oil platforms in federal waters, mostly in the Santa Barbara Channel, where a well explosion in 1969 resulted in one of the largest offshore oil spills in U.S. history.

Environmental groups say the state doesn't know enough about fracking onshore or offshore. "There are no specific laws or regulations addressing fracking in either context," (Segee, 2013).

Review of Literature

An understanding of the role of energy in economic growth cannot be achieved without first understanding the role of energy in production. The concept of the production function examines the factors that could reduce or strengthen the linkage between energy use and economic activity over time. These key factors are; substitution between energy and other inputs within an existing technology, technological change, shifts in the composition of the energy input, and – shifts in the composition of economic output.

In a paper in the *Energy Journal*, Toman and Jemelkova (2003) argue that most of the literature on energy and economic development discusses how development affects energy use rather than vice versa. Thier paper surveys the literature on the effect of changes in energy supply on economic growth in general in both developing and developed countries. As Toman and Jemelkova (2003) state, the mainstream economics literature on this issue is somewhat limited. Business and financial economists do pay significant attention to the impact of oil and other energy prices on economic activity in the short-run, but the mainstream theory of economic growth pays little or no attention to the role of energy or other natural resources in promoting or enabling economic growth. An exception was the extensive discussions concerning the "productivity slowdown" following the 1970s oil crises.

Extensive empirical work has examined the role of energy in the growth process. The principal findings are that energy used per unit of economic output has declined since 1980s, but that this is to a large extent due to a shift in energy use from direct use of fossil fuels such as coal to the use of higher quality fuels, and especially electricity. When this shift in the composition of final energy use is accounted for, energy use and the level of economic activity are found to remain fairly tightly coupled. Furthermore, time series analysis shows that energy and GDP cointegrate and energy use Granger causes GDP growth when additional variables such as energy prices or other production inputs are included. When theory and empirical results are taken into account, the prospects for further large reductions in the energy intensity of economic activity seem limited. This has important implications for environmental quality and both economic and environmental policy (Stern and Cleveland, 2004).

Natural scientists and some ecological economists have placed a very heavy emphasis on the role of energy and its availability in the economic production and growth processes (e.g. Hall et al., 2001, 2003). In the extreme, energy use rather than output of goods is used as an indicator of the state of economic development (e.g. Kardashev, 1964). Some theories suggest resource abundance may increase local economic development through higher demand for labor in the energy sector and spillover spending in the local economy. Other theories suggest industries not closely related to the resource extraction industry may be harmed as energy product expands. The reason for this could be higher labor demand by the extraction industry may be high enough to push local wages high and pull employees from other lower-paying jobs and make it difficult for other industries to be as profitable-See Table 5 on changes in U.S. average hourly earnings in states with dominant energy sectors. At a national and international level, this phenomenon has been referred to as the "natural resource curse".

Brown (2014) finds that within the time frame and region he studied, an increase in natural gas production has not been a natural resource curse for local economies. Brown studied labor market conditions at the county level in a nine-state region using econometric models to determine if employment and wage have responded to the rapid expansion of natural gas production from 2001 to 2011. He found a modest positive impact on local labor market outcomes in counties where natural gas production has increased, and little evidence of a natural resource curse. Prior research on resource booms in coal-producing regions reported positive employment and earning effects during extraction and little reversal when extraction declined (Black and others, 2005). Using 2007 data, Price Water House Coopers estimated that the more than nine million employees, $558 billion in labor income and $ 1 trillion in total value added by the domestic oil and gas industry, constituted more than 5 percent of US total employment, more than 6 percent of US total labor income and more than 7 percent of US total value added, respectively (Foss, 2014). However, this study did not account for the GDP effects of utilizing oil and gas in energy systems as inputs to other goods and services, nor did include the economic effects of goods manufactured from oil and gas feedstock or economic effects of exporting these goods. In addition contribution to government taxes, royalties, and other fees paid by the oil and gas industry to all government jurisdictions are not considered. All of these benefits would push the total economic value of the US industry into the trillions of dollar and a potential contribution to U.S GDP.

The McKinsey Global Institute estimates that by 2020, unconventional oil and gas production could boost the United States annual GDP by between two and four percent, or roughly $380-$690 billion, and create up to 1.7 million new permanent jobs. Furthermore, since energy imports account for roughly half of the more than $720 billion U.S. trade deficit, declining energy imports are already leading to a more favorable U.S. trade balance (Blackwill, 2014).

One study found that in 2011 an estimated 3.4 percent of all farms, roughly 74,000 farms, received lease or royalty payments from energy activities (Weber, et all, 2013). Using nationally-representative data on U.S. farms from 2011, Weber (2013) assessed the consumption, investment, and wealth implications of the $2.3 billion in lease and royalty payments that energy companies paid to farm businesses. They estimated that the savings of current energy payments combined with the effect of payments on land values added $104,000 in wealth for the average recipient farm.

Another study found that counties experiencing a boom in gas production in Colorado, Texas, and Wyoming saw wage and salary income increase by $69 million over the growth period (Weber, 2012). Extraction also generates billions of dollars in payments to landowners and in tax revenues for state and local governments. The long-term implications of gas development on local wealth depend on the industry’s direct effect on local capital (e.g. roads or air quality) and on how workers, landowners, and government use income for development.

Energy Prices, Economy and Employment and Opportunities

There has been extensive debate concerning the trend in energy intensity in the developed economies, especially since the two oil price shocks of the 1970s. It is commonly asserted that there has been a decoupling of economic output and resources, which implies that the limits to growth are no longer as restricting as in the past (Stern and Cleveland, 2004).

The Khazzoom-Brookes postulate (Brookes, 1990; Khazzoom, 1980) “rebound effect” and arguing that energy saving innovations can end up causing even more energy to be used as the money saved is spent on other goods and services which themselves require energy in their production. Energy services are demanded by the producer or consumer and are produced using energy itself. An innovation that reduces the amount of energy required to produce a unit of energy services lowers the effective price of energy services. This results is an increase in demand for energy services and therefore for energy (Binswanger, 2001). The lower price of energy also results in an income effect (Lovins, 1988) that increases demand for all goods in the economy and therefore for the energy required to produce them. There may also be adjustments in capital stocks that result in an even further increased long-run demand response for energy (Howarth, 1997). This adjustment in capital stocks is termed a "macro-economic feedback". Howarth (1997) argues persuasively that the rebound effect is less than the initial innovation induced reduction in energy use, so improvements in energy efficiency do, in fact, reduce total energy demand.
Regional perspectives are different; Partridge (2013) argued that new horizontal drilling technologies appears to be having positive net effects initially, and large economic benefits on jobs. However, the energy sector is one of the most capital-intensive, causing higher productivity in the economy; therefore, it does not typically employ large numbers of people on as sustainable basis (Ibid). Regarding another regional consideration, Pennsylvania and Ohio recently gained thousands of jobs associated with shale formation development. But as a percentage of total employment, the net effect has been small. Typically, local job effects drop off after the period of well development in the locality, and the employment effects tend to be longest lived where the corporate offices of development companies are located. Brown (2014) finds that within the time frame (2001-2011) and region (nine-state region in the central United States) under consideration, an increase in natural gas production has not been a natural resource curse for local economies. So far, local employment and wage effects have been positive, but modest.

In our study it shows that in some states wage effects have been much stronger than others- Louisiana, North Dakota, West Virginal and Wyoming had the highest percentage of increase in hourly wage from 2007-2012, see Table 5. North Dakota's fossil fuel industry has grown rapidly since the onset of the shale boom and extraction is now 4 percent of state employment. West Virginia, with a strong coal industry, benefited from higher oil prices and higher demand for labor that affected the hourly wage rate. We can observe different changes in average hourly from 2012-2013 despite the fact that economy was recovering and national jobless rate was declining. For example in Louisiana there was a decrease in average hourly earnings by 11.09 percent from 2012-2013 and in North Dakota a decline of 24.7 percent.

Table 5: Average Hourly Earnings of All Employees on Total Private Payrolls, by State

State	2007	2008	2009	2010	2011	2012	2013	% change-2007-2012
Alaska	24.7	25.01	24.8	23.9	24.51	25.58	25.53	3.65
Louisiana	18.73	19.22	19.46	19.55	20.63	21.36	18.99	14.12
New Mexico	18.57	18.73	18.92	19.57	19.7	19.82	19.94	6.73
N. Dakota	18.34	18.76	19.21	20.19	21.45	22.77	17.14	24.15
Oklahoma	20.61	20.93	21.33	21.56	21.75	22.23	19.20	7.86
Texas	21.06	21.3	21.39	21.36	21.97	22.21	21.35	5.46
W. Virginia	17.04	17.71	18.09	18.65	18.94	19.58	18.05	14.91
Wyoming	20.04	20.83	21.06	21.45	22.18	22.38	21.05	11.68

Source: Handbook of U.S Labor Statistics, 2007-2013, http://www.bls.gov/oes/tables.htm and author calculation.

Three general approaches have been used to estimate the employment impacts of energy price changes: large scale macroeconomic models of the economy (Wharton and D.R.I. model), estimation of the elasticities of factor substitution and factor demand in a production function framework (Brendl and Wood, 1975) and regional growth models (Huntington and Kahn, 1977). A macro-model that estimates sectoral and occupational employment effects has been developed by Early and Mahtadi (1976) where they used the B.L.S. input-output model to obtain employment forecasts for 129 sectors and 470 occupations in 1985. They produced employment estimates for ten major sectors and nine occupational categories. The most relevant finding was that manufacturing employment declined by about 1 percent with increase in imported oil price to $16 per barrel compared to a reference price of $13 per barrel. Berndt and Wood (1975) used four factor translog cost function for U.S manufacturing for the 1947-1971 period. They found labor and energy to be substitutes, implying that a rise in the energy price relative to wages will increase employment. Their estimated cross price elasticities of labor with respect to the price of energy are -0.3. Hudson and Jorgenson (1974) used the same methodology finding cross price elasticities of -.04. The Griffin-Gregory (1976) study employs the same four factor translog cost function approach (holding output constant) and applied it to the manufacturing sector on the nine industrial nations. They too found that labor and energy are substitutes and they estimated cross price elasticities to be 0.08 to 0.15. Deschenes (2010) notes that higher industrial energy costs may affect labor demand; he uses 30 years of data to estimate a cross-price elasticity of -0.15 to -0.08, implying that the proposed bill's 3 percent increase in electricity prices might result in 0.3 percent less employment in the short run. These models capture the effects of changes in the composition of final demand, and do not reflect the substitution among factor inputs that may result from changing relative factor price. Solnick (1980) developed a model captured the limitations of the other models discussed by taking into consideration the substitution of other inputs for energy as its relative price rises, or the impact of higher energy prices on the level of output and employment. Furthermore, he evaluated the potential impacts of price changes of oil on employment in 1980s. He found the negative relationship between employment change and energy price change, holding output constant.

Brown and Yücel (1995) estimated the pattern of impacts of oil price on employment in different periods; 1992 and then 2000. In 1992, 10 percent higher oil prices reduced employment by 1.86 percent in Delaware and increased employment by 0.95 percent in Oklahoma and 1.40 percent in Wyoming. By 2000, the same increase is projected to yield extremes of –1.54 percent in Delaware, 0.58 percent in Oklahoma, and 0.94 percent in Wyoming. They found the employment-weighted variance of the response across states to be 0.0749 in 1992 and 0.0360 in 2000. Brown and Hill (1988) estimated the long-run oil price elasticities of employment in each key industry. They found elasticities of +1.01 for oil and gas extraction, +1.23 for oil field machinery, +0.45 for coal extraction, –0.56 for petroleum refining, and –0.32 for petrochemicals.

Methodology

Because the United States is an oil importer, its economy has been hurt by previous episodes of sharply rising oil prices that resulted from oil supply shocks (Kilan, 2009). Not all economies are affected to oil price shocks, studies shows that the economies of forty-two states and the District of Columbia would suffer if oil prices rise. In contrast, the economies of eight states—Alaska, Louisiana, New Mexico, North Dakota, Oklahoma, Texas, West Virginia, and Wyoming—would benefit from such increases (Brown, 2013).

In this study, we measured the pattern of impacts of changes in oil price on the above eight states on unemployment rate for 15 years (120 data observations), 1999-2014. The major sources of employment data came from the Bureau of Labor Statistics, U.S. Department of Labor and United States Census Bureau and data for price of oil came from U.S Energy Information Administration (EIA). Random Effect Regression is applicable in the context of panel data that is data comprising observation of two or more "units" or "groups" in two or more time periods. The choice between fixed effects and random effect expressed as tradeoff between robustness and efficiency. Random effect estimation ignoring the intergroup variation that is why it has been chosen.

We used Random-Effects GLS and found out the oil price elasticity of employment for these states is +0.268, which means for every 10 percent decrease in price of oil, on average employment increases by 2.68 percent-see Table 6.

Table 6: Dependent variable: Unemployment [Random Effect GLS Regression]

Variable	Coefficient	t-ratio
intercept	0.706	4.34
ln_oil	0.268	6.44
Wald_Chi_square	41.50	

Other studies estimated the impacts of changes in price of energy on employment in different states. Several states with larger fossil fuel industries see positive effects or a smaller negative effect than the country as a whole. Combined, these eight states would add around a hundred thousand jobs in response to a 25 percent rise in oil prices (Brown, 2013). Wyoming would benefit most from an oil price spike because it has a small population and a large share of oil and gas extraction employment. Alaska's economy has traditionally depended on the oil extraction industry, has the second highest share of extraction employment among all states, and remains a beneficiary of higher oil prices. North Dakota's fossil fuel industry has grown rapidly since the onset of the shale boom and extraction is now 4 percent of state employment. West Virginia, with a strong coal industry, benefits from higher oil prices, but by less than what we previously estimated in 1995 for 1982 and 1992 (Brown, 2013).

The employment effects of various energy price have been previously studied in 1970s when price of oil was increasing and U.S was more dependent on imported oil compared to today. In 1982, the states with the greatest concentration of energy-related industries were West Virginia, Wyoming, Delaware, Oklahoma, Louisiana, and Texas (Brown and Yücel, 1995). Rising oil and gas prices since the early 2000s prompted a resurgence of energy employment. Oil and natural gas accounted for much of the activity except in Delaware, which had a high concentration of the petrochemical industry, and in West Virginia, the heart of coal country.

Shares of energy-related employment ranged from 7.3 percent in Texas to 13.7 percent in West Virginia. By 2000, these shares had declined to a range from 2.5 percent to 7.4 percent (Brown, 2013). Increased use of horizontal drilling and hydraulic fracturing led to further gains in oil and gas hiring. As of 2011, the states with the highest shares of energy employment were Alaska, Louisiana, New Mexico, North Dakota, Oklahoma, Texas, West Virginia, and Wyoming. Energy employment shares increased in all eight of these states from 2000 to 2011. Between 2006 and 2012, while U.S. employment declined 0.05 percent per year on average, employment in North Dakota and Texas grew by 3.4 and 1.5 percent, respectively, the fastest growth in the country (Brown, 2013).

Challenges and Policy Implications

While many are concerned about the long-term damage to our environment, we need to continue the use of carbon-based fuels until greener energy sources are competitive economically. U.S economy is based on cheap and easy energy and U.S. cannot meet its current needs without carbon-based energy-See Table 4 on U.S. Energy Consumptions. Any programs that would increase taxes on current energy sources (carbon tax) will raise energy costs. In addition to inflicting damage on the economy, rising fuel and energy prices would be an additional burden on a middle class that has seen their incomes fall in the last decade. Technological advances are required not only to make green energy more cost competitive, but also to build capacity for green energy. A consistent, gradual shift to greener fuels is among the best option to greener energy sources without inflicting severe economic damage on a still struggling economy.

The Environmental Protection Agency (EPA) in March 2014 issued long-awaited rules to cut the sulfur content of gasoline by 67 percent in 2017, and to reduce tailpipe emissions in cars and pickups starting in the 2017 model year.

The EPA said the rules were developed with input from oil producers and refineries, as well as vehicle makers and environmental groups, and would bring about significant reductions in pollution at a low cost. The auto industry and environmental and health-advocacy groups hailed the new rules, called Tier 3 standards, saying they would help reduce smog and save lives by reducing lung disease. In addition, the rules would tighten emissions standards for cars made for model year 2017 and beyond, reducing pollutants such as nitrogen oxides and volatile organic compounds. Cars made before that will emit less pollution once they start using the new gasoline in 2017. The reduction in ground-level smog could save America $19 billion a year in health-related costs by 2030 (Mundy, 2014).

The energy industry countered that the environmental benefits would be negligible and come at a high price for industry and consumers. The American Petroleum Institute, which represents oil producers, and the American Fuel & Petrochemical Manufacturers, the refineries' trade association, say the rules would raise gas prices 10 cents a gallon and cost the industry billions of dollars in capital costs.

We need to embrace several different green technologies if we hope to replace the current amount of coal, oil, and natural gas used in just the US. Solar energy is a proven technology for many parts of the country, but is less competitive at higher latitudes and in areas that receive little sunshine. Solar farms require large amounts of land with full sun exposure, which is plentiful in the southwest but not so much in the northeast (where the people are). Wind power is attractive for many areas of the country, but again is less useful in areas that are not windy. There are also some environmental concerns with large windmill farms on the flight paths of migratory birds. Tidal power is an option for coastal areas, but the technology is still in its infancy. Geothermal holds promise, but installation is expensive and is not feasible everywhere. Then, nuclear power could be an option, but after Fukushima there is a doubt any new nuclear plants will be built in the US. Water-power is well established, but the environmental concerns regarding dams has seen them actually being removed from rivers.

If we are to move to greener energy sources, we also need to redesign the infrastructure for distributing power in the US. The current model is to generate electricity at central power plants and to distribute that power to remote customers. With the introduction of roof-mounted solar panels and wind turbines, technology was also developed to sell excess energy back to grid. We need to build on this model and start planning now to change from centrally generated and distributed electricity to electricity generated at millions of points and fed into a grid.

With new technologies for extracting gas and oil from wells, it appears that we are still decades away from peak oil and gas production. This extra energy comes at an extremely high cost.

As we have learned from the Deepwater Horizon oil spill, just because we have the technology to extract oil and gas from new sources does not mean that we can do it safely.

As the price of oil has risen and technology has advanced, we are now able to extract oil and gas from areas that were previously inaccessible. New sources of oil and gas from shale formations in the US and tar sands in Canada require more energy resources to extract and result in both direct and indirect pollution. Extraction of oil from tar sands requires the generation of large amounts of steam and uses solvents to process and help transport the oil. Hydraulic fracturing to extract oil and gas from shale formations requires the injection of large amounts of fresh water along with chemicals into wells to break up the shale and release the gas and oil. Accessing this energy requires tens of thousands of new wells, each fracked with enough water to fill several Olympic swimming pools and hundreds of gallons of chemicals. It also requires turning whole countries into industrial zone, compete with fleets of trucks, air quality concerns, a disruption of nature, and fear that water aquifers will be poisoned (Gold, 2014). The waste water from this process is contaminated and is considered hazardous waste; much of it is injected into dry wells. Fracking has also been associated with well water contamination. In rural areas, fracking competes with agriculture for fresh water. The rapid pace of unconventional gas extraction has raised concerns about potential effect on the environment and their varied associated costs in different parts of the country. The environmental debate mostly has centered on water quality. Poorly cemented wells can leak and contaminate groundwater, as has been documented in Colorado, Ohio and Pennsylvania (Lustgarten, 2009a). Flowback water not recaptured by drilling companies can contaminate surface water, as occurred in Dimrock, Pennsylvania (Lustgarten, 2009b). But captured water requires treatment to remove dissolved solids. In areas with insufficient wastewater facilities, one disposal method has been to pump the water back underground. This approach, however, has been blamed for causing earthquakes (Fischtti, 2012).

As fossil fuels become more difficult and dangerous to extract, transport, and process, we will likely see more disruptions in supply of oil and gas. We already see price spikes when hurricanes shut down oil rigs in the Gulf of Mexico. Drilling for oil in remote areas above the arctic circle will be subject to winter storms and impacted by the presence (and absence) of sea ice. As global demand for energy rises, we will continue to search for more sources of energy in more remote and inhospitable areas of the globe, prices will become more volatile and interruptions to supply will become more frequent. There are other reasons as well. From Saudi Arabia, Iran to Mexico, in Europe and Africa oil and gas belong to the state. State-run energy companies, in many parts of the world, administer and exploit these national resources. The governments usually own all the oil and gas, even if they are under private property. The United States chose a different path; American colonists rejected English common law, which reserved all minerals rights for the monarch. Initially, landowners in the United States owned their minerals and this created an enormous incentive for them to allow oil and gas drilling. A permissive legal system, large financial incentives for the owners of mineral rights to allow drilling, and a tradition of small, independent energy companies struggling for survival and willing to take risks created an environment where fracking took root and flourished. From 1982 to 2008 fracking industry reached an annual production of 1.84 trillion cubic feet of natural gas from shale. It took years to double that to 3.68 trillion cubic feet. And it took less than two years to double that again to 7.36 trillion cubic feet (Gold, 2014). So, fracking is here and it will stay, what began in Texas moved to neighboring states and then across the country. It is now spreading around the world. Fed by steady capital from investors, the drilling industry created a glut of gas and reserved decades of declining oil production. The energy industry wasn't prepared, and neither were landowners and government officials. While fracking created new wealth, jobs and economic opportunities, it also had its own set of problems.

Aside from the environmental damage incurred from our current over reliance on fossil fuels, access to these fossil fuels is starting to become a global political issue as well. The US, Canada, and Russia are arguing over who has mineral rights to the arctic. Many of the countries we purchase oil from are ruled by dictators who suppress their citizens, use the oil revenue to solidify their positions, and to enrich themselves and their inner circles. Some of these countries even support terrorist groups.

The best way for the US to secure its economic future is to move from a net importer of energy to a net exporter of energy and/or energy technology. To save the environment for the next generation, U.S. need to base its economy on non-polluting, renewable sources of energy. If U.S. can develop and implement alternative means of supplying the energy needed for domestic economy, it will be in a position to be the Middle East of the renewable/green energy economy. If we choose to continue to chase fossil fuels at the expense of greener energy supply, we will continue to be at the mercy of others for our energy and economic security.

Conclusion

Over the past two decades, two new technologies-hydraulic fracturing and horizontal drilling-brought significant change to the energy sector. As a result of higher production and hence changes in energy prices have had sizable but different effects on economic activity across states. The American energy revolution does not just have commercial implications; it also has wide-reaching geopolitical consequences. Global energy trade maps are already being redrawn as U.S. imports continue to decline and exporters find new markets. Most West African oil, for example, now flows to Asia rather than to the United States. And as U.S. production continues to increase, it will put downward pressure on global oil and gas prices, thereby diminishing the geopolitical leverage that some energy suppliers have wielded for decades. Most energy-producing states that lack diversified economies, such as Russia and the Gulf monarchies, will lose out, whereas energy consumers, such as China, India, and other Asian states, stand to gain. Lower energy prices will be a particular boon for China and India, which are already major importers and which, according to the International Energy Agency, will see their demand for oil imports grow by 40 percent (for China) and 55 percent (for India) from 2012 to 2035. As the two countries import more energy from the Middle East and Africa, they will take ever-greater interest in these regions (Blackwill, 2014).

By 2020, U.S oil production will grow to an all-time high of 11.1 million barrels a day, and America could become the largest global oil producer (Gold, 2014). Lower oil price boost the consumption and spending power of companies and households and boost the economy in the long run. Net energy imports are expected to decline which helps to reduce current trade deficit.

The industrial composition of a state's economy determines the employment response to a change in energy prices. As the states diversify away from energy-intensive and energy-producing industries, the variation across states in the response of economic activity to oil price changes is lessening. Furthermore, study supporting less sensitivity to oil price changes and less variation across states in the response to changing oil prices since 1980s (Brown, 1995).

New technologies for accessing energy resources, changes in global energy markets, and government policies at all levels have influenced energy development in the 2000s. Local wealth endowments – particularly of natural resources, but also of human, physical, and other types of capital – have affected where development has occurred. Energy development in turn has affected local wealth endowments by creating income, jobs and government revenue that can be invested locally or by affecting natural amenities or social capital. Energy-producing regions have tended to favor policies that would boost domestic energy prices, while energy-consuming regions have tended to favor policies that would lower domestic energy prices.

Economic impacts of development in domestic energy production brings about excitement about the prospects for future growth and development not only for the Unites States, but also globally. At the same time, it raises important questions for further empirical research on plunging investment in energy industry and more consumption at lower price with greater contribution to the global warming.

The newly found fossil fuels in North America seems to hold the potential for profound and widespread benefits in terms of energy supplies and lowering costs of production and positively affecting the trade gap and balance of payments in the United States. However, the environmental, human, and economic impacts of the related technologies are, as yet, poorly understood and it requires further investigations in order to measure the social impacts on the economy as well. In the early years of the fracking the industry is eager to capitalize on this newfound resource. In its wake, it generated concerns and some real problems for people who lived near wells and for the environment. It would take years for these problems to be identified. Citizens, regulators, and some parts of the industry are hard at work trying to find fixes (Gold, 2014). Due to fracking, the United States is producing more natural gas than ever. The same technology used to get gas out of shale is now being used to get oil as well. In the summer of 2013, the United States pumped nearly 7.5 million barrels a day of crude oil, a level unseen since 1990 (Gold, 2014). While it seems unlikely that America will ever become "energy independence," it is certainly unwinding its dependence on foreign suppliers in the Middle East and Africa. For generation, the United States has used its military might to keep oil flowing, fighting wars and supporting undemocratic governments like Shah of Iran and Saudi Arabia and patrolling sea lanes. Maybe this era now come to an end.

At the same time, U.S. policymakers will need to make sure they protect the sources of the country's energy wealth. Even though private-sector players have driven nearly all the advances that unleashed the boom, their success has depended on a supportive legal and regulatory environment.
Leaders at both the state and the federal levels will have to strike the right balance between, on the one hand, addressing legitimate concerns over the environmental and other risks associated with fracking and, on the other hand, securing the economic benefits of production.

Likewise, leaders in the U.S. energy sector should work with public authorities to establish standards of transparency, environmental protection, and safety that can help build public confidence and address the risks of developing shale resources (Blackwill, 2014). And the country as a whole will have to update and expand its energy infrastructure to fully harness developments in unconventional oil and gas -- a transformation that will require substantial investments in building and modifying pipelines, railroads, barges, and export terminals.

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