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Economic Impacts of Energy Development on Domestic Economy

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Abstract

New technologies and techniques to extract natural gas and gas liquids, as well as petroleum, from shale rock have greatly altered expectations for North America's capacity to produce energy products. 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. This paper will cover literature review and measure the potential impacts on economic growth and development. 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 the impacts on the economy will be discussed.

Keywords: Energy; Renewable Energy; Economic Growth; Government Policy.

JEL Classification: O13, Q27, Q43, Q48.

1. Introduction

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. 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. For those from other regions, 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.

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 (The Wall Street Journal, 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.

As the boom in shale "fracking" lowers natural-gas and electricity prices in the U.S., and 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, the report said. That will allow the U.S. to grab a larger share of global manufacturing sales. "This is a fundamental economic shift," Harold Sirkin, a senior partner at BCG, who helped write the report. "The trends are going faster than we thought," (2013), adding: Even so, the U.S. has lost much ground over the past 15 years, largely because of China's surging growth and focus on exports. The U.S. accounted for 11% of global exports of manufactured goods in 2011, down from 19% in 2000. During the same period, China's share rocketed to nearly 21% from 7%, and the European Union slipped to 20% from 22%. China's performance has cooled recently. U.S. exports of manufacturing goods to China surged 19% to $19.9 billion in the second quarter, but that is about one-fifth of China's manufacturing exports to the U.S.

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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. State Sen. Fran Pavley, a Democrat who sponsored the bill that is seen as likely to pass before the legislative session ends Sept. 13, said it is meant to address "serious unanswered questions about the safety and environmental risks of fracking," and would require disclosure of chemicals used in the process (WSJ, Sept 6, 2013). 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. Concern 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," said Brian Segee, a staff attorney at the Environmental Defense Center (WSJ, Sept 6, 2013).

2. Literature Review

The following section establishing that energy is an essential input and that in theory in the long run energy availability could constrain economic growth. 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. This 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, 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 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 & 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). Primary factors of production are inputs that exist at the beginning of the period under consideration and are not directly used up in production (though they can be degraded and can be added to), while intermediate inputs are those created during the production period under consideration and are used up entirely in production. Mainstream economists usually think, of capital, labor, and land as the primary factors of production, while goods such as fuels and materials are intermediate inputs. The prices paid for all the different inputs are seen as eventually being payments to the owners of the primary inputs for the services provided directly or embodied in the produced intermediate inputs (Stern, 1999). This approach has led to a focus in mainstream growth theory on the primary inputs, and in particular, capital and labor, and the attribution of a lesser and somewhat indirect role to energy (Stern & Cleveland, 2004).

The primary energy inputs are stock resources such as oil deposits. Therefore, the quantity of energy available to the economy in any period is endogenous, though restricted by biophysical constraints such as the pressure in oil reservoirs and economic constraints such as the amount of installed extraction, refining, and generating capacity, and the possible speeds and efficiencies with which these processes can proceed (Stern, 1999). But these are not given an explicit role in the standard macroeconomic growth theories that focus on labor and capital. Therefore, understanding the role of energy in the mainstream theory of growth is not so straightforward and the role of energy as a driver of economic growth and production is downplayed (Stern & Cleveland, 2004).

In Solow's (1956) original growth model, known as the neoclassical growth model. According to this basic neoclassical growth theory, the only cause of continuing economic growth is technological progress. Intuitively, increases in the state of technological knowledge raise the rate of return to capital, thereby offsetting the diminishing returns to capital that would otherwise apply a brake to growth. Technological knowledge has two special properties. First it is a non-rival good - the stock of this form of capital is not depleted with use. Second, it generates positive externalities in production. While the firm doing R&D obtains benefits from the knowledge acquired, there are beneficial spillovers to the economy from the R&D process so that the social benefits of innovation exceed the private benefits to the original innovator. As some of the benefit of knowledge generation is external to those producing it, the growth rate of the economy is below the socially optimal level (Stern & Cleveland, 2004).

There are positive externalities to consumers who benefit from innovation and to future researchers who benefit from past ideas. There are negative externalities due to new innovations making old vintages of capital obsolete. Both capital accumulation and innovation determine the long-run growth rate. Capital accumulation raises the returns to innovation activity. However, if there are diminishing returns in the innovation sector as technology becomes more complex the economy could have a constant growth rate (Aghion & Howitt, 1998). Solow (1997) argues that within category substitution and in particular the substitution of renewable for nonrenewable resources, is most important and seems to assume that new substitutes will always be found. The long run pattern of energy use in industrial economies has been dominated by the substitutions from wood and waterpower to coal, oil, natural gas and primary electricity (Hall et al., 1986). In large part the industrial revolution was enabled by the use of fossil fuels that freed economic activity from reliance on low power and variable but renewable solar energy. When fossil fuels are economically exhausted the next stage of energy development may see a return to solar energy, albeit captured in a more sophisticated way, rather than a move to anew substitute (Stern & Cleveland, 2004).

3. Energy and Economic Development

The previous section established that energy is an essential input and that in theory in the long run energy availability could constrain economic growth. However, 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 & Cleveland, 2004).

The Khazzoom-Brookes Postulate (Brookes, 1990; Khazzoom, 1980) or "rebound effect" argues 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 and jobs. However, the energy sector is one of the most capital-intensive, higher productive in the economy; therefore, it does not typically employ large numbers of people on as sustainable basis (Ibid). Regarding another region, 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.

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 natural gas production since 1993.

<Table 1> Top Oil Producers: Total 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: Wall Street Journal, November 12, 2013, P. R6.

<Table 2> Top Natural Gas Producers: Dry 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: 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. 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.

The U.S Energy Information Administration has estimated there could be 190 trillion cubic feet of gas and 11 billion barrels of oil under the South China Sea. China is set to start the pumps at its deep water (South China Sea) natural-gas project of $6.5 billion, it expects to double its natural gas use to 10 percent of its energy mix by 2020, helping to wean the country off the dirtier coal that produces two-thirds of its electricity (Hall, 2013). Liwan off shore gas field with 30,000 Chinese designed platforms, stands in 230 feet of water, contains enough steel to build four Eiffel Towers. It is build to withstand 30-foot waves and winds of more than 100 miles an hour. Much of Liwan projects expected output already has been sold at between $11 and $13 per million British thermal units (BT) to Chinese companies, about one-third less than the current spot-market price of liquefied natural gas sold in Asia (Ibid).

<Table 3> China's Imports of Liquefied Natural Gas from Its Main Supplier, in Millions of Metric Tons, 2013

Qatar	5.0
Australia	3.6
Indonesia	2.4
Malaysia	1.9
Yemen	0.6

Source: China General Administration of Customs, 2013

The Liwan-3 gas field has the potential to send more gas to China than current imports from Australia, China's second-largest supplier of liquefied natural gas (see Table 3). Regarding U.S, some experts believe oil glut is coming, According to Morse (head of commodities research at Citigroup) says "We are moving toward a significant amount of domestic oversupply of light crude" (Gold, Wall Street Journal, December, 6, 2013, P. A1). 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.

U.S drivers are finally benefiting from the surge in U.S oil production, with decline of gas prices on average by 12.2 cents in a matter of week in December 2013 (Ibid). U.S refineries have increased exports 22 percent between June and October 2013, and now control about 20 percent of the global market for traded diesel, jet fuel and other products (Bernstein Research energy analysis, December 2013). All these are attributed to combination of two technologies-horizontal drilling to position wells to run through layers of petroleum- rich rock, and hydraulic fractioning to break up dense geological formations. Experts expect growing production eventually pushes prices of intermediate crude below $ 80 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.

4. Conclusion

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. 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.

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