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Potential impacts of expanded Arctic Alaska energy resource extraction on US energy sectors

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ABSTRACT

This paper examines the potential effects of the expansion of crude oil and natural gas extraction in Arctic Alaska on the U.S. economy, focusing on key energy sectors. Expanded extraction activities are expected to boost the U.S. economy at relatively small rates because the oil and natural gas extraction industries comprise a small share of GDP compared to other U.S. industries. However, this expansion may have substantial implications on energy sectors, with considerable growth expected in the oil and petroleum products manufacturing industry. The U.S. trade balance for energy resources may be improved through increased exports of crude oil (108%), natural gas (26%), and petroleum products (10%). Such increased exports of energy from the U.S. are important supplies to the international energy market given the substantial role of the U.S. in global energy trade. In the domestic market, U.S. households enjoy lower prices of fossil fuels and electricity as a result of expanded extraction.

1. Introduction

The Arctic Region is estimated to contain approximately 22% of the world's undiscovered oil and natural gas deposits[1] (Bird et al., 2008); however, the region currently contributes only one-tenth of the world's production of oil and one-fourth of the world's production of natural gas (The Arctic, 2017). Current production is primarily performed onshore or close to mainland areas where there are low levels of ice cover. Investment and extraction activities are limited to onshore or nearby areas because the associated costs for offshore activities are relatively high (Harsem et al., 2011; Johnston, 2012). Offshore operations in the Arctic require expensive ice breaking due to high levels of sea ice thickness and extent (Hassol, 2004; Hong, 2012). Extreme weather conditions and unpredictable movements of sea ice may also damage infrastructure, adding high costs for reconstruction and maintenance activities (Harsem et al., 2011).

These conditions, however, may change in the near future. Arctic sea ice has declined by 12% per decade since the 1970s (Weather Underground, 2016). Temperatures in the Polar regions have been increasing at twice the rate of the global average[2] (Council on Foreign Relations, 2013). Arctic temperatures are expected to increase by another 8° Celsius by the end of the 21st Century (Weather Underground, 2016). As a result, scientists forecast ice free zones by 2030 (Hong, 2012; Wang and Overland, 2012), allowing commercial ships to navigate through the Arctic Ocean year round. An ice-free Arctic sea may offer additional opportunities for investment in energy extraction activities in the Arctic Ocean.

The potential for expanded extraction activities in the Arctic raises a number of social and environmental concerns. Expanded production will likely increase employment rates and decrease poverty rates in the Arctic and nearby regions where economic opportunities are somewhat limited (Kiel Institute for the World Economy, 2015). Proponents of Arctic extraction also cite the potential to lessen the United States' dependence on foreign-produced oil and strengthen its trading position. The United States Energy Information Administration predicts a 28% increase in the world's demand for energy by 2030 compared to the current consumption level (Doman, 2016). This expected increase in energy demand is mainly constituted by strong economic growth in Asia. For example, China, India and other non-OECD countries in Asia may account for more than 50% of the world's total increase in energy consumption in the next decade. Increasing energy consumption may result in a production shortfall of oil and natural gas if production is not expanded (Harsem et al., 2011; Koivurova et al., 2008). Consequently, U.S. production of oil and natural gas in the Arctic may not only meet

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[1] The Arctic may contain 90 billion barrels of oil, 1669 trillion cubic feet of natural gas, and 44 billion barrels of natural gas liquids. Of these, 84% of energy resources in the Arctic are located offshore in deep water.

[2] The global temperature has been increasing by 0.8° Celsius from the pre-industrial period (National Aeronautics and Space Administration (NASA), 2016).

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domestic demand but also contribute to global energy security.

Arctic extraction also has the potential to cause environmental harm. A 2017 proposal in the U.S. Senate to allow drilling in the Arctic National Wildlife Refuge resulted in a letter from 37 Arctic wildlife scientists opposing the measure. In their letter, they cited the incompatibility of the proposal with the refuge's intended purpose and an array of adverse impacts on fish and wildlife.[3] Potential environmental impacts range from increases in water, air, and noise pollution, spread of invasive species, damage to species' habitat, and increases in the risk of oil spills- impacts that are likely to accumulate over time and have broad regional impacts (Raisbeck and Mohtadi 1974; National Research Council, 2003; Kumpula et al., 2011). Truett et al. (1997) found that oil development in Arctic Alaska would significantly affect habitats of black brant and snow geese by altering their living environment and food supplies. Thienpont et al. (2013) showed that such activities would considerably affect Arctic lake ecosystems. Alaska native residents, who often rely on marine mammals for subsistence, would be affected because mammals would move further offshore in order to avoid heavy traffic from production and transportation activities (Schmidt, 2011). Other potential social impacts include increased crime rates and population pressures in the Arctic and nearby regions (Kiel Institute for the World Economy, 2015).

Because debates about Arctic extraction are likely to become more frequent and more heated in the coming years, it is important to have analysis in place that can address some of these issues. Herein, we examine the likely economic impacts of oil and gas extraction in Arctic Alaska, focusing on key energy sectors in the U.S. economy. While important, environmental impacts are beyond the scope of this research. Our work, therefore, is meant to provide a baseline from which to evaluate tradeoffs between economic impacts and other social and environmental concerns. Analysis is completed with a modified version of the Global Trade Analysis Project Energy Model (GTAP-E), which allows us to estimate impacts on the U.S. and global economies and Carbon Dioxide equivalent (CO_2-e) emission levels associated with energy production in the United States and around the world.

According to the literature on expected sea ice melting (Hong, 2012; Wang and Overland, 2012), we assume that by 2030, sea ice in the Arctic may shrink to a level that allows U.S. energy companies to operate intensive energy extraction activities in the Arctic Ocean. Impacts are measured relative to a projected world economy in 2030, based on macroeconomic projections without the expanded supply of energy in the Arctic (OECD, 2015; World Bank, 2017). We simulate these macroeconomic projections in tandem with an increase in the supply of Arctic Alaska energy (which we refer to as the energy scenarios) in our modeling framework. We investigate two energy scenarios with different assumptions regarding production costs. The deviations between the energy scenarios and the baseline describe the impacts of increased Arctic energy extraction.

Studies that assess the economic effects of energy extraction in the Arctic are limited. Research on this topic is divided into two main strands. The first strand focuses on the conditions and extent of Arctic sea ice that may subsequently lead to an expansion of oil and natural gas production in the Arctic. Such studies provide general economic implications from Arctic energy extraction, such as Borgerson (2008), Prowse et al. (2009), Johnston (2010), Lindholt and Glomsrød (2012) and Johnston (2012). The second strand studies the factors that are likely to affect energy extraction in the Arctic Ocean (Conley, 2013). For example, Harsem et al. (2011) indicates that climate conditions, political issues, and economic and market conditions are key factors that affect petroleum production levels in the Arctic Ocean. Studies that use an economic modeling approach to estimate the potential economic effects of major additional energy extraction in the Arctic are extremely limited. The Arctic Climate Change, Economy and Society (ACCESS) project analysis conducted during 2011–15 uses a multi-country computable general equilibrium (CGE) model to investigate the economic impacts of oil extraction in the European Arctic.[4] While an important contribution, this report lacks explicit information regarding the modeling assumptions, data, sectoral disaggregation, and scenario design for the analysis (Calzadilly et al., 2015). Our work is an important contribution to the literature as we assess the potential effects of expanded oil and natural gas extraction in Arctic Alaska on the U.S. economy. To the best of our knowledge, our research is the first to employ a CGE modeling approach to assess the economy-wide impacts of future energy extraction expansion in Arctic Alaska.

2. The role of Alaska's oil and natural gas production in the U.S. economy

Oil was first discovered in Alaska in the Prudhoe Bay field in 1968, developed by Humble Oil and the Atlantic Richfield Company (now owned by BP). The field was initially estimated to contain around 9.6 billion barrels of oil; however, 12 billion barrels of oil have been produced, with an additional 4 billion barrels of oil estimated to remain. Production in Alaska played an important role in the U.S. energy industry during the 1980s and 1990s, when it supplied around 25% of the total country's production of petroleum (Henderson and Loe, 2014). Current production in Alaska, however, is only one quarter of its former production level (around 0.5 million barrels per day compared to 2 million barrels per day during the 1980s[5]), and its share in overall production in the United States continues to decline (Fig. 1). Part of the decline in Alaska's production has been attributed to the availability of shale in the lower 48 states, which is considerably cheaper than extraction in Alaska (Henderson and Loe, 2014). Alaskan natural gas production is also relatively low compared to production levels of other states, such as Colorado, Wyoming, Louisiana, Oklahoma, Pennsylvania and Texas (Fig. 2), but expected to increase in tandem with Arctic oil production.

This decline in oil production in Alaska decreased the State's revenue and employment considerably. The decline also puts the Trans-Alaska Pipeline System at risk, which is used to transport oil from Prudhoe Bay in Alaska to the contiguous U.S. If the throughput falls below 300,000 barrels per day, ice formation and increased wax settlement occurs inside the pipeline so that maintenance on the pipeline becomes extremely expensive (Henderson and Loe, 2014). Consequently, the U.S. government has called for new development in Alaska to maintain the function of the pipeline system, and many oil companies are considering expanded extraction in Alaska.

Onshore development in Alaska has focused on the National Petroleum Reserve – Alaska (NPRA) and the Arctic National Wildlife Refuge (ANWR) (shown in Fig. 3). Between 2008 and 2011, around 1.8 million acres in the NPRA (out of a total area of 22.7 million acres) were leased to several companies for oil exploration. ConocoPhillips and Anadarko were particularly active in finding new reserves in order to secure their Alpine field, which is located on the nearby North Slope (Henderson and Loe, 2014). However, the Energy Intelligence Agency recently estimated that this area only contains 1 billion barrels of oil, instead of 10.6 billion barrels as calculated in the original estimates. ConocoPhillips has also faced strong legal protests from local Inuit villagers and environmental groups regarding the CD-5 drill site on the eastern edge of the reserve. Despite protests, ConocoPhillips drilled in this area in 2014 and produced oil in 2015,[6] but peak output was only

[3] See https://www.audubon.org/sites/default/files/arctic_refuge_science_letter_2017_11_09_final_00000003.pdf.

[4] For more information about the ACCESS project and its reports, see http://www.access-eu.org/.

[5] See https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n = PET&s = MCRFPAK2&f = A.

[6] Bradner, T. (Dec 21, 2011). Conoco sees construction of CD-5 project in 2014, production in 2015. *Alaska Journal of Commerce*. Available online at http://www.