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Article

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International Journal of Energy Economics and Policy

Provided in Cooperation with:
International Journal of Energy Economics and Policy (IJEEP)

Reference: Bekareva, Svetlana V./Meltenisova, Ekaterina et. al. (2018). Arctic energy resources as an economic growth factor : evidence from Alaska, USA. In: International Journal of Energy Economics and Policy 8 (4), S. 1 - 12.

This Version is available at:
http://hdl.handle.net/11159/2131

International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2018, 8(4), 1-12.

Arctic Energy Resources as an Economic Growth Factor: Evidence from Alaska, USA

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ABSTRACT

Nowadays, the Arctic is referred to as a specific region rich in natural resources, including energy resources, with a severe climate and challenging conditions of doing business, connected not only with the climate itself but also with the existing legislative limitations. According to the researchers of the Arctic, together with the challenges, the Arctic offers huge development opportunities, including those in the oil and gas sector. Alaska is one of the territories of the region which has the richest energy resources. The objective of this study has been to estimate how the factor of the region's energy resources, which we have related to the oil production growth rates on the Alaska North Slope, affects the economic growth of Alaska. The study methodology is based on both the classical models of economic growth and their modification considering the factor of the energy resources. The vector error correction model was used for evaluating the proposed economic growth model modification. The influence of classical factors, the labor and the capital, on the economic growth of the region in the long-term perspective has been empirically proven. The factor of the energy resources has proved to be significant in the equation describing the economic growth only for the short-term perspective. We believe the influence of this variable on the long-term economic growth to be indirect, exercised through the parameter of capital investment.

Keywords: Arctic Region, Alaska, The Alaska North Slope, Energy Resources, Economic Growth, Vector Error Correction Model
JEL Classifications: Q32, Q43

1. INTRODUCTION

Scientists are not unanimous regarding the exploration of the Arctic. The region is rich in natural resources and is very difficult for exploration and development; it may be a driver in development of the economies of northern countries. The climate warming may cause environmental problems, and at the same time, it may indicate the emergence of new opportunities for business development. In the starting period of exploration and development of the northern territories, the Arctic region was influenced by a number of countries which were involved in whaling; besides, this region was rich in fish and mineral resources (Avango et al., 2014). Currently, due to re-appraisal of the oil and natural gas resources in the onshore and offshore Arctic, the significance of this region for the economies of the countries constituting the Arctic zone has undoubtedly grown. The potential of developing the oil and gas deposits makes the countries which have access to the Arctic coast to a large extent economically sustained.

Notwithstanding the increasing share of renewable energy in the total consumption of the energy resources, the trend in the oil and gas production and consumption is positive. For example, in the production of oil, the region of the middle East is demonstrating the highest growth rates of oil production, and the Pacific region has the highest oil consumption rates (BP Statistical Review, 2017, p. 18). In the production of electricity, in 2015, the share of coal (38%) was the largest among the used primary energy resources, followed by the nuclear energy and renewables (35%); the share of natural gas amounted to 23%, while that of oil constituted 4% (Lindholt and Glomsrod, 2018. p. 4). In the nearest two or three decades, the share of natural gas is assumed to grow slightly, and that of oil is expected to decrease in the global consumption structure of the primary sources of electric energy.

Oil and gas production and the explored deposits of these energy resources in the Arctic make up an essential fraction of the global figures. For example, in 2012, oil production by the five leading oil producers, accounting for 85% of the global oil production (Shell, Chevron, Exxon, Total and BP), was 15% of the total production in the Arctic and Subarctic regions (the production regions are Alaska and the Russian Federation) (Emida, 2014). The share of gas production in the Arctic by these companies amounted to 6% of these companies' total production (the production regions are Norway and the Russian Federation) (Emida, 2014. p. 269).

The energy resources constitute a large portion of the natural riches of the Arctic, with its unique ecosystem. Due to the large volume of the explored oil and gas deposits in the onshore and offshore Arctic, the development potential of the oil and gas industries in this region is high. However, there are factors which may negatively affect the operation of the oil and gas companies, which is related, among other things, to climate warming. On the other hand, climate warming may make offshore oil exploration easier for companies (O'Garra, 2017).

The undiscovered petroleum resources in the Arctic region are appraised to constitute approximately 22% of the total global reserves (Budzuk, 2009). The provinces of West Siberian Basin (the Russian Federation) and Arctic Alaska (the USA) have the largest undiscovered resources (Table 1).

It is assumed that availability of energy resources is an important factor of economic stability and sustainability of a region and of an economy as a whole. Without prejudice to the significance of different energy resources, we consider the geographical aspect of the issue in this study, regarding this region so rich in resources and so difficult in exploration and development.

The goal of this study is to analyze the significance of the factor of the Arctic energy resources production for the economic growth of the region, which includes the Arctic coast. Due to the limited statistical data relating to this issue, the state of Alaska (USA) was chosen to be the subject of investigation, as an area accounting for the significant fraction of the energy resources of the entire region located in the offshore Arctic. According to the data of Table 1, Alaska has over 33% of all the oil resources available in the Arctic and over 13% of the natural gas resources. In addition, in accordance with the recent review published on December 22, 2017 by the U.S. Department of the Interior, "the estimated undiscovered oil resources in the Nanushuk and Torok Formations are significantly higher than previous estimates" (Houseknecht et al., 2017. p. 1). The level of oil production on the northern coast of Alaska in the district of North Slope has been considered as a parameter for estimating the degree of exploration of the energy resources.

2. LITERATURE REVIEW

2.1. The Economic Aspects of the Exploration of the Arctic

According to the National Snow and Ice Data Center (NSIDC), as shown in Figure 1, the Arctic may be considered using three approaches: "the tree line; the 10°C isotherm, and the Arctic Circle at 66° 34' North"[1]. Researchers of the Arctic most often choose the latter approach, considering the Arctic region as a territory surrounding the North Pole, including the Arctic Ocean and the onshore regions of a number of countries.

Based on the Declaration on the Establishment of the Arctic Council (Declaration, 1996), the following countries are referred to as the Arctic countries: Canada, Denmark, Finland, Iceland, Norway, the Russian Federation, Sweden, and the United States of America. However, not all the above listed countries have access to the Arctic coast, not all of them have energy resources. The countries having access to seas in the Arctic region are Canada, Denmark (Greenland), Norway, the Russian Federation, and the United States of America (Alaska). Accordingly, all the above countries except Finland and Sweden control the 200 nautical mile Exclusive Economic Zone (Eliasson et al., 2017). Countries having significant energy resources, in the descending order of their reserves in discovered deposits, are the Russian Federation, Canada, the United States, and Norway (Sidortsov, 2016. p. 2). These countries lawfully refer to the resources of their Arctic region as an economic competitive advantage of the entire country, allowing them to make use of the available resources for the purpose of boosting the economic growth and achieving stability of their national economies. In addition, the unexplored and estimated energy resources referred to above (Table 1) allow these countries to feel confident of their energy sustainability for a long-term perspective.

Among the scientific publications relating to the problems, objectives, and perspectives of development of the Arctic territories, investigations may be indicated relating to both individual countries and their opportunities and to the relevant issues and challenges of the region's development, including rational nature use, reasonable rules of doing business, effective functioning of petroleum production companies, and social support of the population of the Arctic territories, as well as protection of the environment and study of the climate change. It is noted that abundance of natural resources, the geographic and climatic conditions, and the available infrastructure are the main factors of further development of the Arctic territories In accordance with the above criteria, the territories of the Barents Sea, the Beaufort Sea, and the Kara Sea have the greatest perspectives. The latter of the above territories is characterized by less developed infrastructure, compared to the former two, and by more scarce population (Eliasson et al., 2017).

Nowadays, the Russian Arctic coast is a territory of investment projects connected with production of minerals and development of energy and infrastructure (Novoselov et al., 2017). Due to vastness of the Arctic territories and their strategic importance for the country, the concept of sustainability in Arctic energy development (Andreassen, 2016) is one of the essential issues of the economic growth of Russia. Development of certain Arctic territories is wholly related to the business of oil and gas companies (Tysiachniouk and Petrov, 2017).

1 What is the Arctic? National Snow and Ice Data Center (NSIDC). Available from: https://nsidc.org/cryosphere/arctic-meteorology/arctic.html, accessed 05.02.2018.

Table 1: Undiscovered petroleum arctic resources (2008)

Province	Oil, MBO*	Oil, %	Total gas, BCFG*	Total gas, %
West Siberian Basin	3,695.88	4,14	651,498.56	39,04
Arctic Alaska	29,960.94	33,60	221,397.60	13,27
East Barents Basin	7,406.49	8,31	317,557.97	19,03
East Greenland Rift Basin	8,902.13	9,98	86,180.06	5,16
Yenisey-Khatanga Basin	5,583.74	6,26	99,964.26	5,99
Amerasia Basin	9,723.58	10,90	56,891.21	3,41
West Greenland-East Canada	7,274.40	8,16	51,818.16	3,11
Laptev Sea Shelf	3,115.57	3,49	32,562.84	1,95
Norwegian Margin	1,437.29	1,61	32,281.01	1,93
Barents Platform	2,055.51	2,31	26,218.67	1,57
Eurasia Basin	1,342.15	1,51	19,475.43	1,17
North Kara Basin and Platforms	1,807.26	2,03	14,973.58	0,90
Timan-Pechora Basin	1,667.21	1,87	9,062.59	0,54
North Greenland Sheared Margin	1,349.80	1,51	10,207.24	0,61
Lomonosov-Makarov	1,106.78	1,24	7,156.25	0,43
Svedrup Basin	851.11	0,00	8,596.36	0,52
Lena-Anabar Basin	1,912.89	2,15	2,106.75	0,13
North Chukchi-Wrangler Foreland Basin	85.99	0,10	6,065.76	0,36
Vilkitskii Basin	98.03	0,11	5,741.87	0,34
Northwest Laptev Sea Shelf	172.24	0,19	4,488.12	0,27
Lena-Vilyui Basin	376.86	0,42	1,335.20	0,08
Zyryanka Basin	47.82	0,05	1,505.99	0,09
East Siberian Sea Basin	19.73	0,02	618.83	0,04
Hope Basin	2.47	0,00	648.17	0,04
Northwest Canada Interior Basins	23.34	0,03	305.34	0,02
Mezen' Basin	NQA*	0,00	NQA	0,00
Novaya Zemlya Basins and Admiralty Arch	NQA	0,00	NQA	0,00
Tunguska Basin	NQA	0,00	NQA	0,00
Chukchi Borderland	NQA	0,00	NQA	0,00
Yukon Flats Basin	NQA	0,00	NQA	0,00
Long Strait	NQA	0,00	NQA	0,00
Jan Mayen Microcontinent	NQA	0,00	NQA	0,00
Franklinian Shelf	NQA	0,00	NQA	0,00
Total	89,168.10**	100**	1,668,657.82**	100**

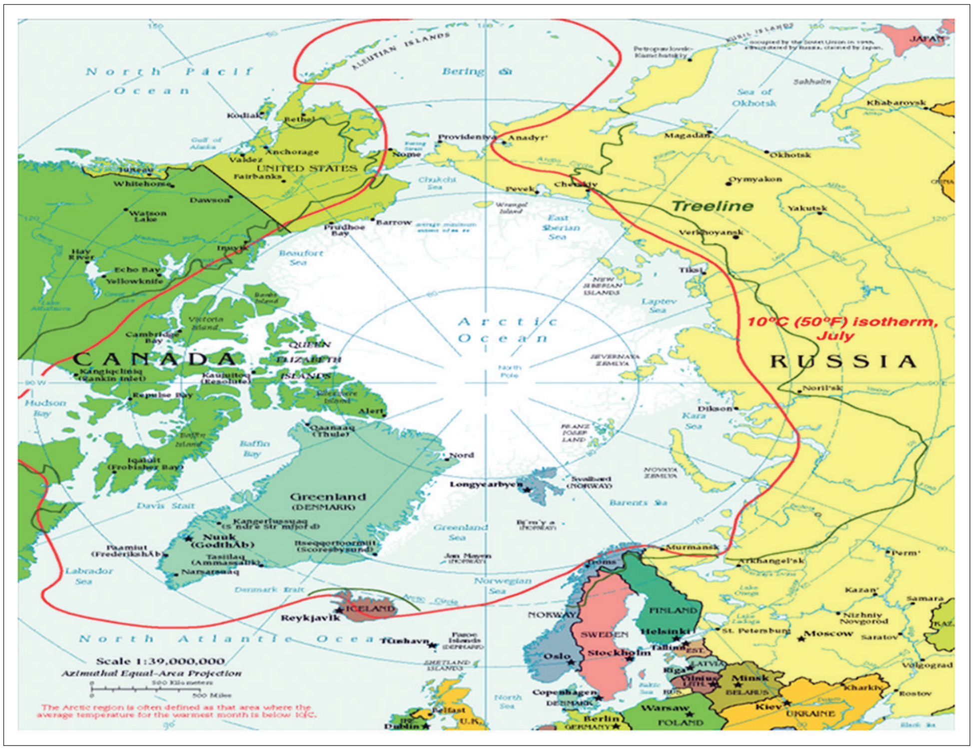
Source: Gautier, D.L., Moore, T.E. (2017), Introduction to the 2008 circum - arctic resource appraisal professional paper, Chap. A of Moore, T.E., Gautier, D.L., editors. The 2008 Circum - Arctic Resource Appraisal: U.S. Geological Survey Professional Paper 1824. p. 8. Available from: https://doi.org/10.3133/pp1824A. [Last accessed on 2018 Feb 01].
*MMBO: Million barrels of oil, BCFG: Billion cubic feet of natural gas, NQA: Not qualitatively assessed. **In the table, the total resources of the entire Arctic region were appraised on the basis of the original sources' data on the resources in the provinces; the shares of the reserves in the provinces were appraised by the authors of this paper

Analyzing the development of the Arctic territories in the Faroe Islands, Iceland and Greenland, researchers note that the issues of the active growth of the oil and gas sectors are now attracting special attention (Smits et al., 2016). Development of the energy sector for these territories consists in economic independence and diversification of the economy, development of large companies' businesses, and the use of the human capital, which, as noted by the authors, is extremely important for development of scarcely populated territories. At the same time, Canadian petroleum producing companies working in the offshore zone of Canada's Beaufort Sea are facing different challenges, including those caused by the opposition of the risks and opportunities of sectoral development, uncertainty of doing business by companies, bureaucracy, and ineffectiveness and rigidity of the decision-making process (Noble et al., 2013).

Evaluating two infrastructure projects being currently implemented in the Oulu region, Finland, researchers note, in addition to availability of credible and attractive options, many challenges of their implementation, as well as the necessity of taking additional efforts required for their successful implementation, related to the regions' geography, the severe climate, poor development of the local economy, and other negative aspects (Hintsala et al., 2016). The issues of infrastructural development are significant also for the researchers studying the Arctic region of the USA, who proposed a dynamic model reflecting the resource allocation challenges and an Arctic oil spill response network, which may ensure "support of the energy exploration initiatives in the U.S. Arctic" (Garrett et al., 2017, p. 285).

It is to be pointed out that the interest for the Arctic territories is displayed not only by the countries of the Arctic zone. For example, since 2008, the European Union has been developing its own policy, positioning itself as a global partner and an active participant of the economic transformation and environmental control in the Arctic (Perez and Yaneva, 2016). In addition, China, for example, is currently defining itself as a "near Arctic" nation and "seeks to further its influence in the arctic" (Bertelsen and Gallucci, 2016). The interests of China are currently mostly related to the transportation routes in the Arctic Ocean, the use of which wins the time and reduces the costs of cargo transportation. However, as many researchers point out, the Asian shipping companies encounter serious economic, organizational, and navigational challenges, trying to develop this sector of the economy (Beveridge et al., 2016).

Figure 1: The arctic, the region's borderlines. Source: What is the arctic? NSIDC, Available from: https://nsidc.org/cryosphere/arctic-meteorology/arctic.html. [Last accessed on 2018 Feb 05]



Drawing conclusions regarding the current situation and the growth prospects of the Arctic region, researchers point, along with the considerable scope of discovered petroleum deposits and explored reserves, to the following challenges of their exploration and development, compared to the other regions of the world: Much larger expenditures relating to transportation of the produced oil and gas, greater risks and costs and longer time of oil and gas field development, possible denials by the local authorities conducting their own policy of territorial development, and the costs of environmental protection (Budzuk, 2009). In addition, they refer to the ubiquitous shortage of infrastructure, workforce, and the difficulties relating to the general working conditions, taxation conditions and business administration (Avango et al., 2014). In general, the Arctic region has to be developed stepwise and consistently, considering the experience of Arctic exploration gained and using the elements of international regulation. The latter statement is all the more important in terms of the risk of pollution from oil spills (Gulas et al., 2017).

Speaking about the current achievements and perspectives of the oil and gas companies in the Arctic, researchers express opinions that the optimal time of the region's development has been missed (Wood-Donnelly, 2016). This conclusion is based on the following: Along with the above listed challenges of the region's development, the oil prices are much lower now, compared to those of the early 2010s, and the scope of the use of renewables is growing.

The already realized opportunities of certain territories relating to the rise in the living standards of the local population resulting from long-time production of energy resources in the region should be mentioned. The energy natural resource funds in Alaska (Alaska Permanent Fund) and Alberta (Alberta Heritage Savings Trust Fund) are a good example of timely accumulation of super revenues from production of energy resources and of improvement in the local population's quality of life (Baena et al., 2012).

Despite the problems described above, we share the opinion regarding positive long-term prospects of the Arctic region's development. The proofs of the positive character of this trend are the vital interest shared by the countries of the world for the Arctic and its opportunities and the recognized significance of energy resources for economic development, which is related to the growth of the global consumption of energy resources. In order to evaluate the role of the energy resources in the economic growth of the region in question and of the country as a whole, we will consider economic growth models in this study.

2.2. Economic Growth Models the Main Principles of their Structure

The Solow economic-growth model (1956) explains economic growth using such main macroeconomic factors as labor, capital, and technological progress. It is also based on the following basic prerequisites: The diminishing marginal productivity of capital, constant returns to scale, a constant capital motion rate, and no investment lags. It is also assumed that the technological progress is an exogenous value. Based on these key prerequisites, the Solow model proves the existence of long-term economic equilibrium, i.e., that the total supply in the system is equal to the total demand. Total supply is described as a production function with constant returns to scale. Total demand, according to the Solow model, is determined through investments and consumption, disregarding public purchases. Under steady-state conditions, investments are equal to savings, which are proportional with the income. That means, supply on the commodity market will be determined by a production function, while demand for the product made will depend on capital accumulation. Hence, in the framework of the Solow model, the value of the steady-state level of income per capita is determined by the growth rate of the technological progress, the marginal aptitude of economic actors to saving, and the capital motion rate. When the situation on the commodity market is stable, the total income in an economy corresponds to the produced gross domestic product (GDP).

Consideration of the technological progress factor in the Solow model changes the original production function. Technological progress is assumed to be directed at the growth of labor efficiency at a constant rate, implying that it is in fact labor-saving. Technological progress results in the economic growth, accompanied by the constant capital/labor ratio and per capital output, reflecting the condition of the continuous growth in the living standard.

One of the basic prerequisites, the diminishing marginal productivity of capital, causes a large number of discussions among the researchers. Theoretically, the diminishing marginal productivity of capital cannot proceed endlessly, and at zero values of the factor, serious apprehensions appear regarding the existence of a balanced growth trajectory. One of the options of solving the issue consisted in expanding the value of the capital factor, namely, including not only physical but also labor capital into this concept. Considering the labor capital, the model considering the factor of the diminishing marginal productivity of capital seems already more viable.

Romer (1986) modified the Solow economic growth model, having questioned the exogenous character of the technological progress factor. In his opinion, technological progress depends on the total amount of accumulated capital in an economy, the labor capital factor playing quite a significant role, supporting the steady returns to the capital.

Based on such prerequisites and supported by the Uzawa model, Lucas (1988) proposed a Uzawa-Lucas model, in which, along the standard factors of economic growth, the role of the labor capital was considered in detail. This model implied that the physical and labor capitals were developed in accordance with different technologies, the labor capital formed in the sector of education.

Barro and Sala-i-Martin (1991; 1992), Mankiw et al. (1992), and Temple (1999) modified the Solow model, having shown that, considering the labor capital, the steady-state level of GDP per capita exists in economics; only the concepts of the economic growth rate in the long-term perspective change.

Natural resources, the condition of the environment, and energy consumption seem to be important factors of the economic growth. Malthus (1978) was one of the first to note that restraints in oil and in other energy resources must necessarily be taken into account in modeling long-term equilibrium. It is the new factor of restrained natural and land resources considered by the author that that was used as a basis for the modified model of economic growth, which demonstrated that the income per capita may have both positive and negative values. However, technological progress may have a triggering effect on the economy. If the technological progress growth compensates the negative effect of reduction of natural and land resources, that means, the trajectory of sustained development does exist.

2.3. The Role of the Energy Resources as a Factor of Economic Growth

Analysis of the determinants of economic growth is attracting more and more attention. This study focuses on analysis of the significance of availability, production, and consumption of energy resource as a factor of economic growth. The growth of an economy is always accompanied by increased consumption of different types of resources; at the same time, reverse dependence, exists, too, when the growth of energy consumption and investments in advanced technologies in the energy sector create conditions for sustained growth of the economy in the future.

Many studies published in literature may serve as empiric confirmations of the significance of energy resources for the economic growth of a country (Tiba and Omri, 2017). Different methods of econometric analysis are used in the modern studies, including: Causality tests, vector autoregressive models, VAR models, vector error correction models, VECM, the autoregressive distributed lag (ARDL) cointegration technique, panel data analysis, and other. Table 2 shows the publications of several authors dedicated to empirical evaluations of the role for different types of consumed energy resources for the economic growth of the countries.

As it follows from the materials of Table 2, to prove the impact of the factor of energy resource consumption on economic growth and the feedback between these parameters, the researchers investigated different countries and regions in different periods of time and applied various econometric tools. It can also be noted that the conclusions obtained vary. This may be related both to the original tasks of research and the specific details of the methodology applied. Most authors note the interrelation between consumption of energy resources and economic growth.

Among the list of studies referred to above, only the study by Kraft and Kraft (1978) may be noted, in which the authors demonstrated the reverse relation of the variables in the classical economic growth model, namely, exclusively the impact of the economic growth rates on the energy consumption level. The other authors note the impact of the energy consumption factor on the economic growth rate or their mutual interrelation; certain authors indicate the absence of interrelation between these parameters (Smiech and Papiez, 2014).

It is shown in Shahbaz et al. (2013) that for China in the period of 1971–2011, a direct relation is true, i.e., the energy consumption growth contributes to the economic growth of the country. Similar conclusions were made in the papers of other authors, who studied consumption of electricity produced from renewable resources

Table 2: Empirical studies of the factor of consumption of energy resources in economic growth models

Authors	Year	Countries	Period	Methodologies	Conclusions
Kraft and Kraft	1978	USA	1947–1974	Granger causality test	Causality runs from economic growth to energy consumption
Shahbaz et al.	2013	China	1971–2011	ARDL, bounds testing VECM methodology	Causality runs from energy consumption to economic growth
Fallahi	2011	USA	1960–2005	Markov-switching vector autoregressive models (MS-VAR), Granger causality test	Bi-directional causality exists between energy consumption and economic growth
Chang et al.	2014	G6 countries	1971–2011	Granger causality test	Bi-directional causality exists between nuclear energy consumption and economic growth; others
AQ1 Smiech and Papiez	2014	25 European Union member states	1993–2011	Bootstrap Granger panel causality approach	No causality exists between energy consumption and economic growth
Sadorsky	2009	G7 countries	1980–2005	Panel cointegration	Causality runs from renewables consumption to economic growth
Wang et al.	2011	28 provinces in China	1995–2007	Cointegration and VECM methodology	Bi-directional causality exists between energy consumption and economic growth
Bekareva et al.	2017	USA	2000–2014	Panel data analysis	Causality runs from renewables consumption to economic growth

ARDL: Autoregressive distributed lag

(Sadorsky, 2009; Bekareva et al., 2017). Sadorsky (2009) showed for a sample of G7 countries that consumption of renewable energy has positive influence on the economic growth of these countries. Bekareva et al. (2017) empirically confirmed this relation for one country considering its regional development: The economies of all the US states were analyzed.

Interrelation of the considered parameters was revealed in the studies conducted by many authors, including those shown in Table 2 (Fallahi, 2011; Chang et al., 2014; Wang et al., 2011). Fallahi (2011) empirically proved mutual interrelation between the energy consumption level and the GDP produced by the USA in the period of 1960–2015. Such conclusions testify to importance of investing in the projects in the energy sector, in order to ensure the economic growth of the region.

Speaking about the influence of the energy resources on the economic growth rates, the researchers also consider the positions of individual types of the primary energy sources, analyzing their significance for the economy. The talk is primarily about renewables and the nuclear power. In Chang et al. (2014), the authors applied the Granger causality procedure on meta-analysis in heterogeneous mixed panels to the G7 countries and showed the relation between consumption of nuclear power and the economic growth rate to be mutual. A conclusion is drawn that, as the economic growth increases, the growing need for the energy resources determines growth in nuclear power production, the cost of which is comparatively low. On the other hand, it has been proven that the growth in the nuclear power consumption triggers the growth of the G7 economies, creating conditions for development of the national economies.

2.4. The Role of the Oil and Gas Sector in the Alaskan Economy

Our study has concentrated on the economy of the state of Alaska, USA. The northern province of the state is situated in the Arctic zone. This territory has significant energy resources both in terms of the national scale and in terms of the global economy. The economy of Alaska is based on development of the oil and gas sector. It can also be stated that the role of the state's oil and gas production sector has positive influence on the condition of the economy of the entire country.

Alaska is the largest state of the United States of America for its territory and at the same time, it has the lowest population density. It is the third smallest state in the USA in terms of population (Walker et al., 2017). The state economy is represented by such main sectors as maritime cargo, air cargo, railroad, fishing, extracting of natural gas, crude oil, coal, and mining of copper, zinc, silver, and gold. In addition, there are enterprises working in such economic sectors as manufacturing, agriculture, and tourism (Walker et al., 2013). A number of publications dedicated to the issues of transport, fishing, geologic exploration, mining, and ecology testify to the importance of development of all the aspects of economic life, not only of the oil and gas production of sector in the Arctic (Stabeno et al., 2016; Chang, 2017; Pirtle et al., Kohshour et al., 2014; Leighty and Lin, 2012; Leewis et al., 2013). The state's exports include the products of the fishing (49%) and mining (32%) sectors (Walker et al., 2013).

The nominal gross regional product (GRP) for 2016 was 50,713 million dollars (Walker et al., 2017). In the rating list of the states, Alaska is rated 46th for the GRP. In terms of the employment rate, Alaska remains a rather stable region, where the employment rate has fluctuated around 7% over the recent ten years, despite the periods of economic crisis and recession, which the national and global economies have faced. The cost of living in Alaska is high: It is exceeded only in four American states: Hawaii, District of Columbia, California, and New York (Walker et al., 2017).

Alaska has significant energy resources, including oil, natural gas, and coal, as well as the wind energy and geothermal potential.

Alaska has proved petroleum reserves of 2.1 billion barrels and natural gas reserves 4.6 trillion cubic feet at the beginning of 2016[2]. In December 2017, new data were published containing assessment of undiscovered oil and gas resources in Northern Alaska Province. According to the U.S. geological survey, the undiscovered resources of oil and gas are now assessed as being larger, reaching 8.7 billion barrels of oil and 25 trillion cubic feet of natural gas, for the cretaceous nanushuk and torok formations (Houseknecht et al., 2017. p. 1). Currently the Alaska North Slope is currently the main territory where oi and gas is produced in the USA.

Over the recent decades, the oil and natural gas industry has been the leading sectors of the Alaskan economy. The state's prosperity is directly connected with the sector's development. Even in the period of the unfavorable market situation for oil, with the descending price of the natural resources, the oil and gas production industry always remained a link which sustained the Alaskan economy. In 2009, 90% (Parnel et al., 2011), and in 2013, 92% of all the taxes collected by the state of Alaska came from the oil and gas production industry (Walker et al., 2013). In 2016, about one-third of all the people employed in the Alaskan economy worked in the oil and gas sector[3]. In addition, beginning with 1982, the Alaska Permanent Fund has been regularly paying dividends to the Alaska residents. Although this fund, meant to reduce the gap in the incomes of the local population, has not fully reached this objective, its work has undoubtedly positively influenced the growth of the general well-being of the residents of Alaska (Kozminski and Baek, 2017).

The state's development programs encompass different sectors of the Alaskan economy, including the oil and gas sector. To help develop the workforce of the state of Alaska, the Alaska oil and gas occupation fund, the alaska construction academies, the State Training and Education Program and other opportunities were established, provided for in the Alaska Oil and Gas Workforce Development Plan. Business development in the oil and gas sector in Alaska is stimulated by providing financial opportunities and tax perks and privileges (The More Alaska Production Act, May 21, 2013). Support of business by providing advice and training is also conducted by the Alaska Small Business Development Center and AK SourceLink (Alaska, 2017).

The role of the oil and gas industry of Alaska for the entire country should not be underestimated. The potential advantage from the operation of the oil and gas companies of Alaska for the USA may be generally assessed considering the fact that there are restrictions for the export of oil from the Alaska North Slope. To take an example, in 2016, only 1,8 million barrels out of 474,08 million barrels of oil produced in Alaska were exported to Canada, which accounted for 0.3% of the total oil production in Alaska[4]. That means, practically all the oil and natural gas produced in this region are consumed inside the USA.

3. METHODOLOGY

The modified version of the Solow model (1956) served as a basic model for our study, in which capital, labor, and technological progress are the main factors determining the economic growth, and, according to the ideas of Malthus (1978), the factor of the energy resources is also considered.

The distinctive feature of this study is the use of the energy production as a factor of the energy resources, with the resources consumed practically entirely in the national economy. In our opinion, this parameter may be used for analyzing the economic growth both at the level of the economy as a whole and of an individual region rich in the given resources. The hypothesis which we test empirically using the proposed model consists in the positive influence of the produced amount of such an energy resource as oil on the growth rate of the GRP in the long-term perspective. In addition, the character of the influence of the economic growth factors on GRP in the short-term perspective is investigated in the study.

The model proposed for the purpose of this analysis looks as follows:

$$Y(t)=K(t)^{\alpha}R(t)^{\beta}A(t)L(t)^{1-\alpha-\beta} \quad (1)$$

$\alpha > 0$, $\beta > 0$, $\alpha+\beta > 1$

Where:
Y (t) is the production level in the country or in the region,
K (t) is the amount of capital,
R (t) is the amount of produced and consumed energy resources,
L (t) is the number of people employed,
A (t) is the technological component.
At that:

At that: $\frac{\partial K}{\partial t} = sY(t)\text{-}\delta K(t), \frac{\partial L}{\partial t} = g_L L(t), \frac{\partial A}{\partial t} = g_A A(t)$

Where:
s is the accumulation rate,
δ is the capital motion rate,
g_L is the population growth rate,
g_A is the technological progress rate.

Considering the limitations of the energy resources, we assume a negative growth rate for variable R(t). That means that the growth rate of the energy consumption, Where, gR > 0.

The balanced growth trajectory in this modified version of the Solow model exists, despite the fact that, as opposed to the Solow model (1956) disregarding the energy resource factor, the capital/labor ratio here (considering the technological progress, $\frac{K}{A \times L}$) does not work for a certain value.

2 Alaska. State Profile and Energy Estimates. October 19, 2017. Available from: https://www.eia.gov/state/analysis.php?sid=AK. [Last accessed on 2018 Feb 07].

3 Essig, B. Oil and gas drives Alaska economy despite decline. Jun 02, 2017. Available from: www.ktuu.com/content/news/Oil-and-Gas-drives-Alaska-economy-despite-decline-426042144.html. [Last accessed on 2018 Jan 12].

4 U.S. Crude Oil Exports to International Destinations. Available from: https://fas.org/sgp/crs/misc/IN10604.pdf. accessed 17.02.2018.

The capital growth rate is expressed as follows:

$$\frac{\partial K/\partial t}{K(T)} = s\frac{Y(t)}{K(t)} - \delta$$

In order for an economy to be on the balanced growth trajectory and $\frac{\partial K/\partial t}{K(T)} = 0$, it is required that Y(t) and K(t) should grow at equal rates, i.e., g_Y and g_K should be equal, Where:
g_Y is the growth rate of the GRP,
g_K is the growth rate of the capital.

In order to analyze the growth rates of the considered parameters, we transform equation (1) into a logarithmic form to obtain:

$$\ln Y(t)=\alpha \ln K(t)+\beta \ln R(t)+(1-\alpha-\beta)[A(t)+L(t)] \quad (2)$$

If we differentiate equation (2) and consider that the derivative of the natural logarithm is growth rate of the variable itself, we obtain:

$$g_y(t)=\alpha g_k(t)+\beta g_R(t)+(1-\alpha-\beta)[A(t)+L(t)] \quad (3)$$

Where:

K is total investments of the federal government in the state of Alaska, billion dollars. We assume, given the steady-state conditions, the investments to be issued for capital increment in the state, with g_k calculated as an annual investment growth rate in the state.

L is the labor force, the number of people employed; in the model g_L is the annual growth rate of the labor force in the state of Alaska.

A is the number of patents obtained in the USA. Statistical sources do not present any special data on the number of patents issued in the state of Alaska; however, we supposed that the technological progress rate in an individual state may be approximated to the technological progress rate in the USA as a whole. This supposition is similar to the hypothesis used by Mankiw et al. (1992), where the authors showed that the technological progress rates are practically equal for a large sample including different countries of the world. In our study, we assume the steadiness of the technological progress rate not for the entire world but for the United States only. In the model g_A is the annual growth rate of the number of patents issued in the state of Alaska, which is equal to this parameter for the USA.

R is the factor of energy resources, which is calculated as a daily ratio between oil produced in the region of the Alaska North Slope and its total amount produced in the state of Alaska, as average for the year. Thus, considering that the region of the Alaska North Slope is practically entirely situated in the offshore Arctic, calculation of the oil production share in this region will allow correct assessment of oil production in the Arctic zone of the country in the economic growth of the region, the state of Alaska. In the assessed model, g_R is the annual growth rate in the share of oil produced in the Arctic zone from the total amount of oil produced in Alaska.

Y is the GRP of Alaska, g_Y is the annual GRP of Alaska.

In our study, we evaluate equation (3), which shows changes in the growth rates of the parameters investigated. We analyze the long-term relation between the economic growth rate in the state of Alaska and the energy resources the US Arctic zone is rich in. In the empirical part of our study, the following sequence of actions is observed:

1. Doing the ADF test to analyze the parameters investigated: Investments in fixed assets (capital), labor, and energy resources in order to reveal unit roots for checking statistical sequences of data for stationarity. In case they are revealed, this will testify to non-stationarity of the time series; hence, statistical tests for cointegration should be carried out.
2. Doing the Johansen test. In case a cointegration vector is revealed by the Johansen test for determining the cointegration order for the time series, we can state that there is a long-term relation among the parameters considered.
3. Determining the optimal lag depth on the basis of AIC tests for all the parameters under study, the economic growth factors (Akaike, 1974) and HQIC (Hannan and Quinn, 1979), and
4. Finally, evaluating the parameters of the cointegration vector. The evaluations obtained will serve as a basis for drawing conclusions regarding the presence or absence of long-term impact of energy resource production in the offshore and onshore Arctic (USA) on the economic growth of the state of Alaska.

4. RESULTS AND DISCUSSION

To carry out empirical assessment of the proposed model, statistical data on the parameters described in detail in the Methodology part of this paper were collected, the descriptive statistics for which is presented in Table 3. All the parameters cover the period of 41 years, 1976–2016, with the annual data used in the calculation. The statistical data were derived from the State Energy Data System (SEDS), the source of the U.S. Energy Information Administration's (EIA) comprehensive state energy statistics[5].

Table 3 contains preliminary statistical analysis of the variables from the proposed model, broken down by periods. The length of the periods is similar. The first of the four periods (1976–1989) from Table 3 is a period of the beginning of active development of oil and gas fields in the Arctic region. The third period (2001–2010) may be described as a period of intense growth of investments and development of the oil and gas fields. Despite the economic and financial crisis, which was observed in this period, it was one of the most effective periods in terms of the growth rates of the product, investments, and labor involved in the oil and gas production sector. An interesting fact is the fact that the share of oil produced in the territory in question almost does not change depending on the period of time. Certain increment in the share of oil produced in the Arctic from the total amount of produced oil in the region has been observed over the two recent decades.

5 The State Energy Data System (SEDS), the U.S. Energy Information Administration's (EIA), Available from: https://www.eia.gov/state/seds/. [Last accessed on 2017 Dec 15].

Table 3: Descriptive statistics. The average values of parameters considered, the state of Alaska, %

Parameter	1976–1989	1990–2000	2001–2010	2011–2016
GRP growth rate	1,12	1,98	7,45	−0,93
Investment growth rate	n/a	15,71	28,48	4,59
Employment growth rate	0,47	0,67	1,26	−0,07
Growth rate in patent applications	−5,18	−9,09	−4,63	−3,71
The share of oil produced from the Alaska North Slope	93,18	94,47	97,66	97,28

At the first stage of the empirical part of the study, the time series were analyzed for stationarity. For this purpose, the ADF test was used to check the presence of unit roots (Table 4). It can be seen from the table that the considered time series are not stationary, and it is likely that here first-order integration takes place.

To determine the presence of cointegration, a Johansen test was carried out (Johansen, 1998). The test results are shown in Table 5. In accordance with Table 5, one cointegration vector is characteristic of the array of data considered.

In accordance with the results shown in Table 5, the value of trace statistics becomes less than the statistical value from the table at the 5% critical level for the parameter testifying to the presence of another cointegration equation[6]. In relation to this parameter, we cannot reject the null hypothesis of no cointegration.

To continue analysis, it is necessary to determine the lag depth, which is used in analysis of short-term and long-term interrelations among the parameters. It can be seen from Table 6 that a two years' lag is suitable for the sample in question – the AIC test (Akaike, 1974) and the HQIC test (Hannan and Quinn, 1979) support this fact.

Table 7 presents the results of evaluating the parameters with the vector error correction model, which allowed us to make a conclusion regarding short-term interrelations. This econometric method allows us to determine the fact of the influence of each equation parameter on all the other variables in the short-term period, as well as to evaluate the intensity of this influence.

The most essential results of assessment of the proposed model in the short-term perspective, considering the error correction vector for all the variables, may be characterized as follows. All the factors considered in the model have positive influence on the variable reflecting the growth rate of the economy of the state of Alaska. The values of the workforce, capital, and technological progress factors fully agree with the Solow neoclassical economic growth model. The factor of the energy resources, the growth rate of the oil production share on the Alaska North Slope in the total oil production in the state, is also significant for the economic growth, with corresponds to the theoretical statements of Malthus.

Significance of the cointegration vector (the ECT1 variable for the GRP of the state), as well as the negative sign in front of the obtained value of the given variable, testifies to the fact that in the short-term period GRP is below the balanced growth trajectory, which may indicate the presence of prerequisites for the fast economic growth in the state of Alaska.

6 for details see Johansen (1998b)

Table 4: ADF unit root test, with intercept and trend*

41 years			
Variable	Constant	Trend	Conclusion
g_K (t)	-0.07	3.14	Non-stationary
G_R (t)	-0.08	4.19	Non-stationary
G_A (t)	-0.71	3.12	Non-stationary
G_L (t)	-0.07	1.11	Non-stationary

Table 5: Cointegration test results: Johansen's methodology

Null hypothesis	Trace statistics	Eigenvalue	5% critical value
H_0: r=0	72.37	-	68.52
H0: r≤1	33.08*	0.52	47.21
H0: r≤2	11.71	0.46	29.68
H0: r≤3	4.07	0.31	15.41
H0: r≤4	2.11	0.29	8.51

*Corresponds to the cointegration vector I(1), r: The number of the cointegration equations

Table 6: VAR lag order selection

Lag	AIC	HQIC	SBIC
0	−29.65	−30.13	−29.61
1	−179.9	−150.41	−180.12
2	−354.802*	−182.11*	−210.11*
3	−312.31	−110.11	−110,12
4	−212.11	−58.19	−51.29

*Indicates lag order selected to be the criterion. AIC: Akaike information criterion, HQIC: Hannan-Quinn information criterion. SBIC: Schwarz's Bayesian information criterion

The factor of the technological progress, i.e., the growth rate in the patent application in the USA, the workforce factor, or the employment growth rate in the region, and the energy resource factor, related to the growth rate of oil production on the Alaska North Slope in the total amount of oil production in the state of Alaska were found to influence the variable of the capital growth rate, characterizing the investment growth rate, in the short-term period. The obtained estimate of the cointegration vector for the capital variable indicates oversaturation of the economy of this region with investments.

Oil production on the Alaska North Slope is an important factor of the state's economic development, indicated by the empiric model estimates: 5% significance of the variable in all the regression equations set up for analyzed variables. The estimates demonstrate that the oil production growth rate has positive influence both on the employment growth rate in the state economy, reducing unemployment, and the investment growth rate, contributing to development of companies in the oil production sector and of the accompanying infrastructure. The oil production growth rate also has positive impact on the technological progress rate, determining development and

Table 7: The results of assessment of the VECM parameters

Regressors	g_Y (t)	g_K (t)	g_R (t)	g_A (t)	g_L (t)
g_Y (t) (−1)	0.912** (6.86)	0.35 (0.38)	−0.11 (−0.78)	0.02 (0.55)	0.07** (2.41)
g_K (t) (−1)	0.112** (1.98)	0.09 (0.23)	−0.06 (−0.88)	0.07** (3.23)	−0.05** (4.58)
g_R (t) (−1)	0.34** (4.21)	0.15** (2.15)	−0.49 (−0.54)	−2.34** (−7.53)	0.59** (2.74)
g_A (t) (−1)	1.49** (6.83)	2.897* (1.89)	−0.02 (−0.1)	0.711** (8.53)	0.19** (4.25)
g_L (t) (−1)	4.38** (4.1)	3.33** (4.14)	0.78 (0.65)	1.91** (4.87)	−0.45** (−2.7)
ECT1	−1.93** (−13.8)	2.27** (2.29)	0.14 (0.91)	0.11** (2.18)	0.06* (1.99)
Constant	−0.02** (−4.26)	−0.02 (-0.52)	−0.02 (−0.25)	0.004* (1.78)	−0.05** (3.17)
R-squared	87.68	86.40	87.766	88.64	41.21
Chi^2	614.17	53.60	83.11	146.41	1.56

**,*5% and 10% levels of significance, respectively; the factors' values are shown in brackets (t-statistics)

introduction of new technologies in developing the oil fields in the Arctic region.

To assess the long-term interrelation, the cointegration vector was evaluated, which included not all of the economic growth factors considered above:

$$g_Y(t)-1.47gK(t)-0.63gL(t)=9.04 \quad (4)$$

(−2.15) (−2.69).

Based on the vector obtained (4), it can be stated that for the case in question, the classical Solow economic growth model, considering two interchangeable factors, labor and capital, is confirmed in the long-term perspective. Hence, in the long-term perspective, the growth rate of physical capital and the employment rate in the region have positive influence on the regional economy. The cointegration vector obtained does not account for the presence of long-term relations between production of energy resources in the region and the growth rate of the GRP; nor does it consider long-term impact of the technological growth rate on the value of GRP under study. We suppose that the influence of oil production in the region of the Arctic coast on the Alaskan economy is displayed indirectly, through the impact on the growth rate of investments in the fixed assets (capital) in the short-term period.

5. CONCLUSIONS

The Arctic countries having rich natural resources, including energy resources such as oil and natural gas, have competitive advantages and are economically and energetically sustained. Availability of reserved energy resources presupposes a potential for development of a national economy, which, on condition of developing the petroleum deposits and consuming energy resources, provides an opportunity for development of all its sectors. In our opinion, support of the oil production sector is most essential for development of the Arctic zone regions, which is currently based on availability of explored and estimated energy resources. The amount of oil and gas produced is a factor determining the economic growth of a region.

The object of our study was the state of Alaska as a region including the Arctic coast having large reserves of oil. The topicality of our study is confirmed both by the official reports of the government of Alaska and by evaluation of significance of businesses of the petroleum producing companies in its economic and social aspects and by the geological exploration carried out in Alaska at the national level, by the results of which more energy resources were reported to be there in the region at the end of 2017 than previously reported. It is to be pointed out that more than 99% of all the oil produced in the offshore Arctic in the region of the Alaska North Slope is consumed in the national economy.

To evaluate significance of the energy resources factor for the economic growth of the region, the respective theoretical models were used in the study. It can be concluded that the economic growth models are relevant in our time, too. The empirical estimates have demonstrated sustainability of the classical Solow model, as well as of the Malthus model considering the factor of energy resources.

The empirical results have confirmed the reasonability of using the oil production parameter as one of the factors of development of the regional economy and a parameter determining its economic growth in the short-term perspective. In our opinion, the indirect influence of this parameter on the long-term economic growth is exercised through the investments index. Development of the oil and gas production sector in the region consists in the growth of investments in the business of the oil and gas production and infrastructure companies and the growing employment of the local population in the long-term perspective. The study has not confirmed significance of the technological progress variable in the long-term perspective; it is significant only in the short-term perspective. We believe that this fact requires further study, as the rate of the number of issued patents can currently correlate with globalization of the economy and may not reflect the actual state in the technological development in the region under study.

In our further studies, we plan to evaluate the influence of the share of the energy resources produced in the Arctic region in the total oil and gas production of the USA on the entire national economy, not only on the economy of the region of production. We are also planning to make comparative analysis of the results of our calculations for all the countries of the Arctic zone.

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