The influence of the pipeline system on the socio-economic development of oil and gas regions

I V Provornaya¹,², I V Filimonova¹,², M V Mishenin¹,², Yu A Dzyuba¹,² and A V Chebotareva¹,²

¹Trofimuk Institute of Petroleum Geology and Geophysics SB RAS, 3 Koptyug ave., Novosibirsk, 630090, Russia
²Novosibirsk National Research State University, 2 Pirogova str., Novosibirsk, 630090, Russia
E-mail: FilimonovaIV@list.ru

Abstract. In the article on the basis of the cluster, 20 oil and gas regions of Russia are allocated for which the level of pipeline provision is calculated. The group with a low level of transport security included mainly the regions of Eastern Siberia and the Far East. On the example of the ESPO and the “Power of Siberia” it is shown that the construction of pipelines favorably affects the socio-economic development of regions along the routes.

1. Introduction
According to the “Concept of Long-Term Socio-Economic Development of the Russian Federation for the Period until 2020”, the goals of state policy in the oil and gas sector are to develop the raw material base, transport infrastructure, processing facilities and increase the share of high value-added products in the production and export of the oil and gas sector. The priority areas for the development of resource oil and gas regions of Russia in order to increase the level of socio-economic development of the Russian Federation are the implementation of promising projects for the construction of pipelines, the development of transport infrastructure, including the construction of LNG (liquefied natural gas) plants [1].

The purpose of this article is to study the level of supply of pipeline infrastructure in the oil and gas regions of Russia and assess the impact of the pipeline system on the socio-economic development of the regions.

To achieve this goal, the following tasks were formulated:
(1) identify oil and gas resource regions of Russia based on cluster analysis,
(2) determine the level of provision of pipeline infrastructure for the oil and gas regions of Russia,
(3) evaluate the impact of trunk pipelines on the socio-economic development of regions,
(4) to determine the direction of state policy in the field of stimulating the integrated development of transport infrastructure and improving the level of socio-economic development.

2. Materials
The information base for compiling statistical information was sources: the Federal State Statistics Service, the Federal Tax Service, the Ministry of Economic Development of Russia, the State Balances of Russia, reference and statistical materials and publications on the results of the...
development of the fuel and energy complex of Russia - “Fuel and Energy Complex of Russia”, “InfoTEC”.

Identification of resource regions. To determine the resource regions, groups of factors were identified: macroeconomic, fiscal, and sectoral. As a result, differentiation of regions was carried out at various levels of consideration, which increases the degree of reliability and reliability of the results.

The macroeconomic factor in the study is represented by an indicator of the share of extractive industries in the structure of gross regional product [2]. The proposed indicator reflects the degree of development of the extractive sector of mineral resources, which in fact determines the degree of resource of the corresponding region.

The second central factor reflecting the degree of resource of the region, along with the macroeconomic one, was determined to be fiscal [3]. The proposed factor was presented as an indicator of the share of the tax on mining in the total amount of taxes received from the region. Mineral extraction tax is the main specialized tax that is levied on mined minerals.

An industry factor represented by the level of oil and gas production was proposed as the third indicator.

In order to exclude a certain duplication and multicollinear factors in all cases, a check was carried out between them for the presence of a connection.

Clustering was carried out on the example of 85 regions of Russia according to indicators for 2018.

Determination of pipeline security of oil and gas regions. To identify the level of supply of pipeline infrastructure in the oil and gas regions on the basis of strategic documents and analytical reports, data were collected on the length of main pipelines in each region [4]. Further, taking into account the area and population of the region, the Engel coefficient was calculated.

3. Methods

At the first stage, among the totality of Russian regions, resource oil and gas and non-resource regions are determined. To identify the resource regions of Russia, the method of cluster analysis is used in the work [5].

The task of cluster analysis is to identify homogeneous groups of regions and establish a quantitative measure of similarity (difference) between them [6]. To determine the measure of similarity between objects, the concepts of similarity and heterogeneity were quantified. The criterion for determining the similarity and difference of clusters is the distance between the points on the scattering diagram. There are several ways to determine the measure of distance between clusters. Since there is no information in the work that some feature is more important for classification, the usual Euclidean distance was chosen by the metric:

$$d(X_i, X_j) = \left( \sum_{k=1}^{n} (x_{ik} - x_{jk})^2 \right)^{1/2}$$

where $x_{ik}$, $x_{jk}$ – attribute values k for the i-th object and j-th object.

The article used the Ward method for clustering, as it gives compact and well-separated clusters. Cluster analysis was carried out using a specialized statistical data processing package Stata 13.

At the second stage of the study, the oil and gas regions of Russia are divided into clusters according to the level of pipeline supply.

The pipeline security indicator is calculated on the basis of the Engel coefficient, which shows the ratio of the absolute length of the transport network to the area of the territory and population [7]:

$$K = \frac{L}{\sqrt{S \times N}}$$

where L – length of the pipeline network, S – the area of the land,
4. Results and discussion

Clustering allowed at $d = 30$ to divide the regions of the Russian Federation into two clusters. The first cluster included 20 resource regions. In these regions there are high values of the share of MET in the structure of taxation and the share of value added from mining in the structure of GRP. The remaining regions fell into the second cluster.

At the second stage, 20 resource regions are distributed according to the level of pipeline supply based on the Engel coefficient (table 1). The Engel coefficient is calculated as the ratio of the length of the sum of main oil and gas pipelines to the area of the territory and population. At this stage, it is important to note that information on the regional length of the pipeline system was manually collected for each region, taking into account all existing projects.

The cluster with a high level of pipeline security included the regions of Russia (regions of Western Siberia and the Ural-Volga region) through the territory, which are the largest trunk pipelines from fields to consumption centers within the country and European markets. Also, these regions are characterized by a long history of the development of the oil and gas complex. And in these regions a higher level of socio-economic indicators can be observed than in other oil and gas regions.

The second cluster includes oil and gas regions that have a short history of development, mainly the regions of Eastern Siberia and the Far East. As hydrocarbon production increases due to drilling new production wells, increasing the efficiency of geological and technical measures, and developing hard-to-recover reserves, the need for the formation of infrastructure for oil and gas supplies will grow [7, 8]. The development of the pipeline system will contribute to the growth of socio-economic indicators of the regions through which the routes run.

| No. | Region                                      | Engel coefficient |
|-----|---------------------------------------------|-------------------|
| 1   | Nenets Autonomous District                  | 0.00196           |
| 2   | Krasnoyarsk region                          | 0.00051           |
| 3   | Irkutsk region                              | 0.00117           |
| 4   | Tomsk region                                | 0.00299           |
| 5   | The Republic of Sakha (Yakutia)             | 0.00258           |
| 6   | Yamal-Nenets Autonomous District            | 0.01472           |
| 7   | Khanty-Mansi Autonomous District            | 0.01751           |
| 8   | Krasnodar region                            | 0.00999           |
| 9   | Volgograd region                            | 0.01445           |
| 10  | Saratov region                              | 0.01215           |
| 11  | Komi Republic                               | 0.01106           |
| 12  | Astrakhan region                            | 0.00848           |
| 13  | Republic of Bashkortostan                   | 0.00843           |
| 14  | Republic of Tatarstan                       | 0.01603           |
| 15  | Udmurtia Republic                           | 0.00701           |
| 16  | Perm region                                 | 0.01723           |
| 17  | Orenburg region                             | 0.01033           |
| 18  | Samara Region                               | 0.02094           |
| 19  | Tyumen region                               | 0.03376           |
| 20  | Sakhalin Oblast                             | 0.00985           |

Table 1. Cluster partitioning by the level of pipeline provision.
Currently, two large pipeline projects have been launched in the east of the country – the East Siberia-Pacific Ocean (ESPO) oil pipeline and the Power of Siberia gas pipeline.

Using the example of the ESPO and the “Power of Siberia”, we will show the socio-economic benefits for the regions through which the routes pass [8]. The main advantages for the regions from the construction of pipelines are the creation of new infrastructure, the emergence of new jobs, an increase in tax revenues, the attraction of additional investments, and the emergence of opportunities to develop the oil and gas industry. Also, as a benefit for the regions through which the pipelines pass, one can highlight the social effect. Within the framework of corporate social responsibility, transport companies, developing their projects in the regions, are surely involved in the construction of roads, healthcare facilities, sports complexes and other infrastructure.

The ESPO oil pipeline connects East Siberian fields with consumers on the Russian market, as well as with countries in the Asia-Pacific region. ESPO-1 goes from Taishet in the Irkutsk Region to Skovorodin in the Amur Region, where a branch to Daqing (China) was built. ESPO-2 connects Skvorodino and the Kozmino oil port in Nakhodka, from where oil is delivered to Japan and Malaysia [3]. The ESPO oil pipeline provided an incentive for the development of oil fields in Western and Eastern Siberia and ensured the diversification of Russian oil supplies to world markets (from the European direction to the Asia-Pacific region), as well as to the oil refineries of the Far East. In addition, the pipeline made a significant contribution to the development of transit regions: new jobs were created, and an increase in taxes was received in regional and local budgets. The project also gave an impetus to the development of various industries throughout Russia: metallurgical enterprises, construction and transport companies. During the construction of the pipeline, more than 15 thousand new jobs were created.

At the end of 2019, the first section of the Power of Siberia gas pipeline was launched, which runs from the Chayandinskoye field (Republic of Sakha (Yakutia)) to Blagoveshchensk (Amur Region). In the future, it is planned to launch another section from the Kovykta field (Irkutsk region) to the Chayandinskoye field. The route route laid along the existing trunk pipeline “Eastern Siberia - Pacific Ocean”, which can significantly save on infrastructure and energy costs. The construction of the gas pipeline created the basis for the systematic gasification of regions and industrial facilities in the east of the country, as well as a network of regional and intra-settlement gas infrastructure [9, 10].

The construction of the Power of Siberia gas pipeline accelerates the pace of gasification in the eastern regions of the country. The route of the gas pipeline route is chosen in such a way as to gasify the maximum number of settlements. The construction of the Power of Siberia gas pipeline opens up opportunities for gas supplies to Russian consumers, industrial enterprises, and municipalities.

In the future, the Sakhalin – Khabarovsk – Vladivostok and Power of Siberia gas pipelines could be connected in the Khabarovsk region. It is planned that the gas transportation system being created in the East in the future will be connected with the Unified Gas Supply System of Russia. This will solve the issues of gas supply to the Far Eastern regions.

The construction of trunk pipelines had a direct impact on the socio-economic development of the regions of the Far East and Eastern Siberia:

Amur region.

The main benefit for the Amur Region from the construction of the ESPO pipeline is the creation of new jobs. Almost 1,800 people work at ESPO facilities in the region.

The main benefits for the Amur Region from the construction of the Power of Siberia gas pipeline are the prospects for increasing the region’s gasification level and the creation of a petrochemical cluster. According to the plan for the development of gas and petrochemicals in Russia, the cluster in the Far East will become one of the six in the country designed to restore Russia's leadership in the world market and cover domestic needs. Thus, the Amur gas chemical complex (the project is being implemented by SIBUR) with a capacity of up to 1.5 million tons of ethylene and polyethylene should become the leading company in the world in the production of base polymers. The development of the Amur gas-chemical complex requires not only gas, but also oil. PJSC Gazprom Neft began development of the oil "part" of the Chayandinskoye field. Upon reaching its design capacity, it is
planned to produce 3 million tons per year. Oil will be delivered to the ESPO pipeline. In parallel with the construction of a gas-chemical complex, construction of a residential microdistrict in the city of Svobody is underway for future plant employees. The microdistrict will be provided with a kindergarten, a school, a polyclinic, a universal sports and training complex.

Until 2026, it is planned to begin supplying gas to 38 thousand houses and 33 boiler houses in the Amur Region. This will allow the region to abandon expensive and non-environmentally friendly fuel oil, and accordingly significantly save budget money and improve the region’s ecology.

The total number of jobs associated with the construction of the Power of Siberia gas pipeline will be more than 10 thousand people.

The Republic of Sakha (Yakutia).

In the Republic of Sakha (Yakutia), with the construction of ESPO, oil production increased by more than 10 times. Tax payments of transport companies make up 4% of the consolidated budget of the republic.

A new gas production center based on the Chayandinskoye field was created in the Republic of Sakha (Yakutia), where a significant number of residents of the region work. With the construction of the Power of Siberia gas pipeline, prospects for gasification of the region appeared.

Irkutsk region.

The budget of the Irkutsk region from the construction of the pipeline "Eastern Siberia - Pacific Ocean" received more than 11 billion rubles. The construction of the ESPO brought additional benefits to the Irkutsk region, as it stimulated the development of a number of northern oil and gas fields and allowed the development of not only large, but also small oil fields.

Khabarovsk region.

Annually, Transneft group of companies transfers about 2 billion rubles to the budget of the Khabarovsk Territory. The company also assists in the implementation of projects in the field of social protection, health protection, cultural and sports development in the region. The construction of the ESPO allowed pipeline deliveries to two oil refineries in the region: Khabarovsky and Komsomolsky.

Primorsky Krai.

One of the leaders in the economy of Primorsky Krai is Transneft Port Kozmino, LLC, which provides for the export of Russian oil to the countries of the Asia-Pacific Region (APR). Annual tax deductions to the budgets of various levels of the enterprise amount to about 2 billion rubles.

So, using the example of two large transport projects in the east of the country, it is shown that the development of the hydrocarbon supply system actively affects the growth of socio-economic indicators, both of the regions and the country as a whole.

In the next 5 years, Transneft will not implement new projects. The main emphasis will be placed on the modernization, reconstruction, overhaul of existing infrastructure. However, this aspect will also favorably influence the growth of socio-economic indicators of the regions in which oil pipelines are located.

Some promising new gas transportation projects in Russia include: Nord Stream-2 (export gas pipeline to Europe), the second phase of the Power of Siberia gas pipeline (from the Kovykta field in the Irkutsk region to the Chayandinsky field in the Republic of Sakha (Yakutia)), the third stage the Power of Siberia gas pipeline (expansion of gas transmission capacities in the section from the Chayandinskoye field to Blagoveshchensk), expansion of the Sakhalin-Khabarovsk-Vladivostok gas pipeline. So, there are significant prerequisites for the growth of socio-economic indicators in the regions across the territory that the proposed gas pipelines will pass.

5. Conclusion

At the first stage, using cluster analysis, all regions of Russia were divided into resource oil and gas and non-resource by three indicators: the volume of oil and gas production, the share of mineral extraction tax in the tax structure and the share of gross value added in the GRP structure. So, 20 resource oil and gas regions were allocated on the data for 2018.

Further, all resource regions using the Engel coefficient were distributed according to the level of
transport security. And it was shown that the level of transport security is higher in those regions where there is a long history of the development of the oil and gas complex and through the territory through which the largest trunk pipelines run from fields to consumption centers. Also, these regions are characterized by a higher level of socio-economic indicators.

The second group in terms of pipeline provision included oil and gas regions, which have a short history of development, mainly the regions of Eastern Siberia and the Far East. New pipelines, ESPO and Power of Siberia, pass through the territory of most regions of this group. As part of the ESPO project, bends are currently being formed from the oil pipeline, as part of the Power of Siberia project, new gas fields are being connected to the pipe, which in turn affects the growth of transport availability. The article identifies the socio-economic benefits for the regions along the ESPO and the Power of Siberia routes from their construction. It is shown that the main advantages are the creation of a new infrastructure, the creation of new jobs, an increase in budget tax revenues, the attraction of additional investments, and the emergence of the opportunity to develop the oil and gas industry. Also, as a benefit, we can highlight the social effect. Within the framework of corporate social responsibility, transport companies, developing their projects in the regions, are surely involved in the construction of roads, healthcare facilities, sports complexes and other infrastructure.

Thus, the development of the hydrocarbon supply system in non-gas regions actively influences the growth of socio-economic indicators, both of the regions and the country as a whole.

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References
[1] Mirkin B G 2011 National Research University Higher School of Economics 88
[2] Engel E 1882 Railway business 1–2
[3] Bogomolova L L, Takmasheva I V et al 2017 Academy of Strategic Management Journal
[4] Filimonova I V, Eder L V et al IOP Conference Series: EES 84 012011
[5] Kontorovich A E, Eder L V and I V Filimonova IOP Conference Series: EES 84 012010
[6] Kontorovich A E, Eder L V et al 2016 Geology and Geophysics 57(12) 2097–114
[7] Mukhametshin V S, Kotenev Y A and Sultanov S K 2018 IOP Conference Series: EES 194 082027
[8] Nefedov Y 2018 European Association of Geoscientists & Engineers vol 2018 No 1 1–6
[9] Sidortsov R, Ivanova A and Stammler F 2016 Energy Research & Social Science 16 54–68
[10] Brusco M J, Singh R et al 2017 International Journal of Operations & Production Management