Resource Regions and the Transition to Sustainable Knowledge-based Development: Escaping the Resource Curse?

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Abstract. According to the economic concept of the “resource curse”, the specialization of countries and regions in the extraction of minerals can have a negative impact on their long-term economic development. The authors of the article propose, that this influence can significantly slow down the transition to development based on knowledge. The article tested this hypothesis using the dynamics of indicators of the knowledge-based economy the group of resource regions of Russia. Of the 12 resource regions of Russia, only two successfully form the knowledge-based economy – Tomsk Region and The Republic of Tatarstan. These regions had a developed education system and research infrastructure even before the discovery of oil here in the 1940s-1960s. For the rest of the resource regions, there is a large lag behind the leading regions of the knowledge economy in Russia, which does not significantly decrease during 2005-2019. At the same time, these regions did not have a developed scientific and educational base by the beginning of the active industrial development of natural resources on their territory. Thus, the formation of the knowledge-based economy in resource regions is strongly influenced by both the resource curse and path dependence effects. The absence of structural economic policies in the regions that are rich in natural resources will hinder their transition to knowledge-based development.

1. Introduction

It is known that the specialization of countries and regions in the extraction of minerals can have a negative impact on their long-term economic development. This pattern was reflected in the concepts of "resource curse" [1], "paradox of plenty" [2], "Dutch disease" [3]. From an economic point of view, the extraction of minerals is a production with diminishing returns and a small multiplier. Therefore, a successful development strategy for areas rich in natural resources is considered to be reinvestment of income from the sale of raw materials into the processing industry, i.e. diversification of the economy. There are examples of successful implementation of this strategy in Norway, the UAE, Malaysia and a
number of other countries. However, there are much more cases of inertial development of resource-producing regions.

In our opinion, resource specialization can also have a negative impact on the prospects for the transition of territories to knowledge-intensive development, a modern type of sustainable development model. The wide-sense knowledge-based economy can be described as an economy, in which humans create, distribute and use scientific knowledge for a self-development in harmony with Nature, Society and State [4-7].

We assume that resource specialization hampering the development of the knowledge-based economy in the absence of an active economic policy. The action of market mechanisms in this case prevents the formation of a demand for innovation and highly skilled labor. This creates unfavourable conditions for the development of high-tech sectors of the economy, which contributes to the conservation of the existing sectoral structure in a country or region.

To test this hypothesis, we propose to analyse the development of the knowledge-based economy in a group of Russian regions with economic specialization in resource extraction.

2. Methodology and methods
To classify the constituent entities of the Russian Federation as a group of resource regions, we use data on the sectoral structure of the gross regional product (GRP). In the work of S. A. Ayvazyan et al. [8] it is proved that the reduction in the dimension of the sectoral structure of GRP using principal component analysis makes it possible to establish the integral characteristics of the economic specialization of regions. In the coordinates of the principal components of GRP, 12 regions can be attributed to the group of regions specializing in the extractive industry: Kemerovo, Sakhalin, Tomsk, Tyumen, Orenburg regions; The Republics of Komi, Sakha, Tatarstan, Udmurtia; Khanty-Mansi, Chukotka and Yamalo-Nenets Autonomous Areas.

As a methodological basis for the measurement of “knowledge-based economy”, it is proposed to use the factorial approach, which is most consistent with the cumulative nature of this concept. Accordingly, the accuracy of measurement within the framework of the factorial approach is directly related to how representative the selected set of factors is, how fully it characterizes the meta-phenomenon under study. Following the interpretation of the knowledge-based economy as an economy “that creates, disseminates and uses knowledge to ensure its growth and competitiveness” [9] and the established traditions of measuring it in Western science, we consider it appropriate to single out four key factors of the knowledge-based economy: education and regional innovation system, ICT infrastructure and living conditions of the population.

There is no doubt that the main processes of the knowledge-based economy are localized in the indicated factors. So, the regional innovation system (RIS) covers the processes of knowledge production (considering the potential of research activities and its results) and their use (in various sectors of the economy from the standpoint of data on its structure). Education provides both the creation (universities) and the dissemination of knowledge. These two aspects form the core of the knowledge-based economy. ICT infrastructure provides interaction of various actors of the core of the knowledge-based economy. The living conditions of the population characterize the environmental parameters of the environment that affect the attractiveness of the territory for specialists employed in the knowledge-intensive activity.

Quantitative evaluation of knowledge-based regional development can be done with the help of knowledge-based economy index (KBEI) method [10]. Each of these factors includes few indicators, which was chosen according to existing methodological approaches to evaluation of an innovation process in the economy. Choosing of these indicators also reflects the capabilities of the Russian system of state statistics. The value of KBEI and subindexes $\in [0; 10]$, where “0” refers to a hypothetic region with the lowest value of every single indicator, and “10” refers to a hypothetic region with the highest value of every single indicator.

For the aims of analysis, we used values of KBEI and its subindexes for Russian regions in between 2005 and 2019.
The analysis of regional unevennesses of the knowledge-based economy includes calculation of indices $Q_i(X_j)$, which characterizes the ratio between average value of subindexes of education, environmental conditions of life etc. of the first 20 percent of regions rated by the value of corresponding subindex and an average value of analyzed region or regions

$$Q_i(X_j) = \frac{\bar{X}_{20j}}{\bar{X}_{ij}}$$  \hspace{1cm} (1)

where $X$ is a value of $j$-subindex of the knowledge-based economy, $\bar{X}_{20j}$ – an average value of subindexes of the first 20 percent of regions; $\bar{X}_{ij}$ is a value (or an average value) of $j$-subindexes of analyzed / region / regions.

The value of quintile coefficient $\in [0; +\infty)$. If $Q_i(X_j) \leq 1$, the differentiation between the first group of regions and analyzed region / regions is insufficient and vice versa.

The quintile coefficients for years between 2005 and 2019 were calculated based on the rating of regions in the year 2005. This method allows estimating not only structural but dynamical aspect of differentiation.

3. Results and discussion
Russia is a shining example of regional unevennesses. The most part of a population and productive capacity is located in the centre and in the south of European part of Russia’s territory, but the most part of natural resources – in the north-east of European part and in Asian part of the territory. These regions may be defined as regions with rigorous climate, huge economic costs and poor infrastructure’s development [11]. It is possible to say that regional differentiation of economic development in Russia has global scales [12].

Real referents of a knowledge-based development model in Russia are two cities of federal importance: Moscow and Saint-Petersburg. Average value of KBEI for Moscow in the last 14 years equals to 7.8, for Saint-Petersburg – 7.0. Relative development of the knowledge-based economy in these cities twice surpasses an average development of other Russian regions. Two megapolises have well-developed educational and scientific infrastructures, households and firms are secured to modern ICTs, a knowledge is used in the production of goods and services. These aspects represent well the concept of knowledge-based development be used [10].

Chukotka Autonomous Area and Tuva Republic can be contingently named as outsiders of knowledge-based regional development. The first region has low-developed educational and scientific infrastructure, but a relatively high standard of living (GRP per capita equals to 21 000 USD). Per contra GRP per capita value in Tuva Republic equals to 2100 USD, but education and science are more developed in the region [10].

The purpose of the article is to assess how the resource specialization of the region and the development of the knowledge economy are related. To do this, we calculate the average values of the knowledge economy index for a group of 12 resource regions for 2005-2019 (we use the arithmetic mean and the median). For the obtained average values, we find the quintile coefficients by formula (1). The results are shown in Figure 1.
Figure 1. The dynamic of average values of the knowledge-based economy index for Russian resource regions from 2005 to 2019.

It can be noted that the resource regions of Russia, despite significant wealth and (often) a high level of GRP per capita, are not leaders in the formation of a knowledge-based economy. The minimum KBEI gap from the leaders (Q coefficient) for the entire period was 1.3 and was achieved in 2014.

At the same time, the values of these coefficients have decreased over 14 years: from 1.46 to 1.42 (arithmetic mean) and from 1.40 to 1.35 (median). Formally, this indicates a reduction in the gap between resource regions and the leaders of knowledge-intensive development by 3%. However, such dynamics is typical for most of the lagging regions of Russia in this period (regions of the third to fifth quintiles according to KBEI). Taking into account the significant size of the gap, it should be concluded that its reduction by such an insignificant amount over 14 years indicates that there is no priority for the development of the knowledge-based economy in the resource regions of Russia.

Attention should be paid to significant differences between two mean values: the arithmetic mean and the median for resource regions. The KBEI distribution of these regions differs from the normal one, it is shifted towards the minimum values. Only two resource regions have KBEI values that exceed the average by more than half the standard deviation – Tomsk Region and The Republic of Tatarstan. Three regions have values within half the standard deviation of the mean: The Republic of Sakha (Yakutia), the Udmurt Republic, and the Orenburg Region. The remaining seven resource regions have KBEI below the average by more than half the standard deviation. For further analysis, we will designate these groups of regions as resource regions with high, medium, and low KBEI, respectively.

To confirm or refute the hypothesis about the negative impact of a region's resource specialization on its sustainable knowledge-intensive development, let us consider the dynamics of quintile coefficients in the context of three groups of regions (Fig. 2).

A stable positive trend is characteristic only for a group of resource regions with a high KBEI - the Tomsk region and the Republic of Tatarstan. In 2005, their KBEI value was almost identical to the average value for the leading regions of the knowledge economy in Russia (Q = 0.99), in 2019 it exceeded the average (Q = 0.89). These regions combine the resource profile of the economy and the priority development of the knowledge-based economy.
Figure 2. The dynamic of average values of the knowledge based economy index for three groups of Russian resource regions from 2005 to 2019.

The group of resource regions with an average KBEI is characterized by fluctuations in the coefficient around the initial value (1.36). For regions with low KBEI, that is, for most resource regions, there is a positive trend in 2006–2014, when their lag from 20% of the leading regions decreased (Q coefficient decreased from 1.60 to 1.45). Then, in 2014–2019, the gap increases again (Q coefficient increased from 1.45 to 1.60). Thus, over the 14-year period, most of the resource regions of Russia developed inertially, and did not switch to knowledge-intensive development.

Let us analyze the dynamics of quintile coefficients in the context of three groups of regions for four subindices (Fig. 3).

Dynamics of the educational systems. According to Figure 3, three groups of resource-producing regions are significantly differentiated by the scale of educational systems. Regions with high KBEI (Tomsk Region and The Republic of Tatarstan) in 2005 had values of education indicators similar to the average values for the group of 20% of the leading regions in education. However, over time, the indicators of these two regions surpassed the average values of the leaders, and Q in 2015–2019 was about 0.77. For the group of resource regions with an average KBEI, there is a stable dynamic: Q in the initial period (2005) was 1.26, in the final (2019) - 1.25, while in 2011–2015 there was a significant increase in this coefficient. For the group of resource regions with low KBEI, the Q coefficient in the analyzed period, on the contrary, increased from 1.95 (2005) to 2.05 (2019). It should be borne in mind that EI includes only comparative indexes not quantitative or qualitative. In the case of accounting of quantitative and qualitative indexes, the scale of the differentiation would be much larger.

Thus, only two resource regions carry out an expanded reproduction of qualified personnel necessary for knowledge-intensive development. It seems that these successes are largely due to the rich academic traditions of these regions, and not to their resource specialization: Kazan University was founded in 1804 (it is the third oldest university in Russia), Tomsk University in 1878. For the rest of the resource regions, an inertial scenario of personnel training is characteristic, which not only does not contribute to the transition to the knowledge economy, but has a negative impact even on the industrial economy [13].
Dynamics of environmental conditions of life. In terms of the ecological living conditions of the population, the differentiation between the groups of resource regions is lower than in the field of education. Regions with high KBEI differ in living conditions comparable to the leading regions in this aspect. For a group of resource regions with an average KBEI, the Q coefficient fluctuated around 1.35 throughout the analyzed period without significant changes. For the third group of regions, the gap from the first 20% of regions remained significant, but the dynamics were positive. The Q coefficient decreased from 1.56 (2005) to 1.45 (2019).

The data show that most resource regions do not use revenues from mining to create favorable conditions for human life. The average life expectancy here is lower than the average for Russia. The population is steadily declining due to the negative migration flow. Kuzbass is a striking example here. The unfavorable ecological situation over the past decades remains one of the central problems of the region: it regularly takes the worst positions in various environmental ratings.

Dynamics of ICTs infrastructure. In the analyzed period, the dynamics of the ICT index was unstable for all three groups of resource regions. Regions with high KBEIs have indicators comparable to the leaders in this aspect: the Q coefficient was 1.08-1.13 in different years. For the group of resource regions with an average KBEI, the lag behind the leaders for 14 years has slightly increased: from 1.36 to 1.40. However, in the most favorable years (2014-2015), the Q values here reached 1.09-1.03. For the third group of resource regions, Q also increased in the analyzed period: from 1.36 to 1.49.

The instability of the dynamics of ICT indicators in resource regions is largely due to the instability of the value of the indicator “share of expenditures on ICT in GRP”, primarily in terms of GRP. The economic crisis of 2014 had a different impact on the regions depending on the resources extracted in them, which affected the GRP.

However, in general, with the exception of the Tomsk Region and the Republic of Tatarstan, resource regions lag behind the leading regions in terms of infrastructure development. This gap not only did not decrease, but increased over the analyzed period. Consequently, ICT development and digitalization are not a priority for resource regions.

Dynamics of regional innovation systems. Systems of reproduction and economical utilization of knowledge in Russian regions are characterized by the huge level of the differentiation, the most similar to differentiation in educational systems’ development. This is also true for the differentiation of resource regions in this aspect. Tomsk Oblast and The Republic of Tatarstan in 2005 had regional innovation systems, similar to the regions leaders in this aspect, as indicated by the value of the Q coefficient equal to 1.1. For 14 years, these two resource regions have managed to make significant progress in the development of innovative activities, becoming one of the leaders in Russia (Q = 0.87). The differences between the second and third groups of resource regions from the leaders of innovative development, on the contrary, are enormous (in 2005, Q was equal to 2.88 and 2.43, respectively). By 2019, the gap narrowed by 23-26%, but still remained significant. For the group of regions with an average KBEI, the Q coefficient was 1.85, for the group with a low KBEI - 2.13.

As in the case of successes in the field of education, the high results and positive dynamics of innovation activity Tomsk Region and the Republic of Tatarstan owe to the scientific base that has been formed here for several centuries. These regions today support the development of science and innovation through the renewal of resource wealth.

For the rest of the resource regions, the periods of growth of "innovativeness" fall on the crisis periods: 2008 and 2014. This is due to the overall decline in GRP, and especially with its part formed by the raw materials sector. As a result, the relative indicators of innovation (for example, the share of innovative goods, works and services) are relatively growing, but their absolute values practically do not change. These data show that in the post-crisis period, the “innovativeness” of the regional economy continues to decline.

In 2019, domestic current expenditures on research and development in Kuzbass were 0.13 % in gross regional product, in Orenburg Region – 0.1 %. This is one of the lowest indicators for Russia. The share of innovative products in the total volume of goods, works and services did not exceed few
percent (on average in the regions of the Russian Federation - 6.4%). Thus, vast majority of these regions preserves the resource profile of the economy, does not use the possibility of transition to knowledge-intensive growth.

**Figure 3.** The dynamic of quintile coefficients of knowledge-based economy for three groups of Russian resource regions from 2005 to 2019.

### 4. Conclusions

The analysis showed that out of 12 resource regions of Russia, only two successfully form the knowledge-based economy - the Tomsk region and the Republic of Tatarstan. These are regions that had a developed education system and research infrastructure even before the discovery of oil here in the 1940s-1960s. The development of oil production added resource industry specialization to these regions, but their scientific and educational potential continued to develop. The rest of the regions did not have a developed scientific and educational base by the beginning of the active industrial
development of natural resources on their territory.

Since the regions rich in natural resources are deprived of incentives for the development of high-tech sectors of the economy, this contribute to the conservation of the existing sectoral structure in the region. This is confirmed by the analysis of the dynamics of development in these regions of the knowledge economy in four aspects: education, environmental living conditions, ICT infrastructure and regional innovation systems.

The dynamics in terms of living conditions of the population is positive, but the attractiveness of the regions for the population is still low, there is a negative migration flow. The gap from the leaders in terms of innovation activity is also somewhat narrowing, but the main growth falls on the crisis years of 2008 and 2014. This is due to an increase in relative indicators due to a general decline in GRP, and its part, formed by the raw materials sector. Data shows that in the post-crisis period, the “innovativeness” of the regional economy continues to decline. In terms of education and ICT infrastructure, the dynamics are negative. Thus, the lag of resource regions from the leading regions of the knowledge economy in Russia remains significant throughout 2005-2019.

The analysis shows that the presence of raw material economic specialization has a negative impact on the development of the knowledge economy. This confirms the validity of the "resource curse" concept in relation to knowledge-intensive development.

We also noted a strong influence of the path-dependence effect [14]: resource regions with a high initial scientific and educational potential support the development of science and innovation through the reinvestment of resource wealth.

Thus, in conditions of a liberal-oriented regional economic policy, mining and other resource regions are not able to convert resource wealth into innovation [15], but they also incur the socio-economic costs of building the knowledge-based economy in other regions of the country and the world. Inertial development preserves inequality [16]. This necessitates a transition to an active structural policy in order to ensure their sustainable development

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