The assessment of resilience of Russian resource-based regions

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Abstract. The article examines contemporary approaches to and the evaluation of “resource dependence” and “resource-based regions”. Resource dependence analysis is based on the data of the Russian Federal State Statistic Service (Rosstat) and customs service statistics from 2005 to 2016. The starting point (2005) was chosen to marking the end of economic restoration after the 1990s steep decline. Moreover, it was in 2005 when the calculation of mining industry share in gross regional product began. 2016 is the last year available. The authors suggest resilience as a new criterion for choosing an optimal development trajectory. For the assessment of the resilience of Russian resource-based regions the authors use the approach of R. Martin, P. Sunley, et al and methods of coefficients calculation for adaptive resilience and resilience adaptability. The concept is regarded as the ability of a region to mitigate external and internal shocks in a short-term perspective, and to choose an optimal development trajectory in a long-term one. Results of this study show that 19 out of 85 constituent entities of Russia may be defined as resource-based (resource-dependent). Their resource dependence is different, varying from monoregions to region’s specialization in mining (resource-dependent regions). Analysis of their resource dependence dynamics shows that in most regions resource dependence grows, and their resilience assessment shows that most regions are resilient and tend to retain the selected development trajectory in a long-term perspective.

1. Introduction

Issues of the innovation development of Russian resource-based regions in the context of worldwide trends and their future role in the national economy have become subject to close attention. Its relevance is caused by the fact that Russia is lagging behind in pace and quality of economic growth, and the development of social, political and economic institutions while having considerable reserves of mineral resources. This issue has become especially topical as the world economy began to shift its development paradigm, which includes development of the Industry 4.0, depletion of easily mined resource deposits, deterioration of energy market conjuncture and hydrocarbon revenues volatility.

Currently, inertial development trajectory of the fuel and energy complex and economy has completely exhausted itself, posing a constraint on the national economy development. These circumstances put the need to solve a number of theoretical and practical questions regarding the assessment of prospects for the resource-based regions to change their development trajectory high on the agenda.

Conceptualization of development perspectives of the Russian resource-based regions has just begun. Description of the regional transformation expected outcome and criteria for the evaluation of plausibility of achieving it is the hardest task. Foreign literature mainly offers approaches towards the
description of ways to change the development trajectory of resource-based regions: diversification, new industrialization, holistic development, etc. It seems that weakness in the evaluation of development perspectives for resource-based regions comes from the aspiration of authors to find the place-neutral approach towards the issue. In the meantime, resource-based regions differ from each other in terms of their development level, resource dependence reproduction mechanisms, the extent to which the resource-based development model is exhausted, and, finally, they are different in their readiness and ability to change their development model. The last point reflects the necessity to assess the region’s ability to maintain balance between the goal of development sustainability and the goal of transformation aimed at changing development model and new spatial specialization during the development trajectory change. The authors suppose that the latter may be described with the “resilience” concept that is widely used in foreign literature.

The goal of this article is to assess the degree of short-term and long-term resilience of Russian resource-based regions and to define prospects for changing their development trajectory.

2. Data and methods

Resource dependence analysis is based on the Rosstat data from 2005 to 2016. 2005 was chosen as the starting point because it was the end of economic restoration after 90s steep decline. Besides, calculation of mining industry share in gross regional product began in 2005, and 2016 is the last year where the data is available. In order to analyze and summarize the data on different regions, coefficients of mining spatial localization for each region were calculated.

For the assessment of the resilience of Russian resource-based regions the authors use the approach of R. Martin, P. Sunley, et al. [1] and methods of coefficients calculation for adaptive resilience [2-4] and resilience adaptability [5,3].

3. Features of the resilience of Russian resource-based regions

3.1. Russian resource-based regions

Academic literature does not have a common approach for identifying resource-based regions, this owing mainly to the fact that consequences of regions’ specialization in mining industry have been researched only on macro-level for a long period of time (R. Auty [6], J. Sachs & A. Warner [7,8], H. Mehlum, K. Moene and R. Torvik [9], P. Kaznacheev [10], I. Grinets [11] et al.). Lately it has become obvious that understanding of resource specialization problems is not possible without complex examination of regional issues (V. Kryukov, V. Shmat, V. Nefyodkin [12], S. Levin, M. Kurbatova [13], O. Vasilyeva [14], I. Ilyina [15], E. Kagan and E. Goosen [16] et al.)

In this article, “resource-based regions” are defined as “regions that, due to their location and considerable natural reserves, specialize in extracting and processing mineral resources, that host large vertically integrated mining companies, which are export-oriented and define the trajectory and features of regional economic development” [16]. The Authors used mining industry spatial localization coefficient to identify resource-based regions. The coefficient was calculated based on the following formula (1):

\[ K = \frac{K_{\text{reg}}}{K_{\text{Rus}}} \]  

(1)

where \( K_{\text{reg}} \) is the share of mining industry in gross regional product, \( K_{\text{Rus}} \) is the share of mining industry in Russian gross domestic product.

Those regions whose localization coefficient is above 1 (\( K > 1 \)) are considered resource-based. As \( K \) had different dynamics from 2005 to 2016, we also consider regions that had their \( K \) above 1 at least once during this period as “resource-based”. Totally we identified 26 regions. As resource-based replication model is the most apparent in the regions that specialize in coal mining and oil and gas
extraction, we excluded those regions that do not specialize in extracting fuel resources. As a final result, we 19 regions were selected for studying.

At the next stage, the selected regions were divided into three groups depending on the spatial localization coefficient (K) value in 2016. Thus, as of 2016 we identified 10 monoregion with $K \geq 3$, 6 regions with high degree of resource dependence with $3 > K \geq 2$ and a group of resource-dependent regions with $K < 2$. For all these regions we tracked resource dependence dynamics and identified mineral resources prevailing in their economy.

The table shows that the number of resource-dependent regions increased from 14 to 19 over the period of 2005–2016. The number of monoregions also increased: in 2005 there was 5 monoregions, while in 2016 this number doubled. Absolute value of the spatial localization coefficient also increased: in 2005 its maximum value was 5.85 and in 2016 it reached 8.08. Most regions (17 out of 19) showed growing resource dependence, with 5 regions showing significant growth. Only two regions, namely, the Republic of Tatarstan and Tomsk Region, decreased their resource dependence. It demonstrates that for the most of resource-based regions the development model based on mineral resource extraction and processing has not exhausted itself yet.

Table 1. Resource-based regions of Russia: types and dynamics.

| No. | Region                  | Prevailing type of extracted mineral resources | 2005  | 2010  | 2016  | Resource dependence dynamics |
|-----|-------------------------|-----------------------------------------------|-------|-------|-------|-----------------------------|
|     |                         |                                               |       |       |       | Monoregions                 |
| 1   | Nenets Autonomous Okrug | Oil and gas                                   | 5.8   | 7.56  | 8.08  | Increase                    |
|     | Khanty–Mansi Autonomous Okrug (KhMAO) | Oil and gas                                   | 5.85  | 6.06  | 6.01  | Marginal increase           |
| 2   | Sakhalin Region Republic of Sakha (Yakutia) | Oil and gas                                   | 1.73  | 5.70  | 5.90  | Significant increase        |
| 3   | Tyumen Region Yamalo-Nenets Autonomous Okrug (YaNAO) | Oil and gas                                   | 3.09  | 3.86  | 5.10  | Increase                    |
| 4   | Chukotka Autonomous Okrug | Oil and gas                                   | 4.68  | 4.80  | 5.07  | Increase                    |
| 5   | Komi Republic           | Oil and gas                                   | 2.12  | 3.02  | 3.01  | Increase                    |
| 6   | Orenburg Region         | Oil and gas                                   | 2.23  | 2.3   | 2.70  | Decrease                    |
| 7   | Perm Territory          | Oil and gas                                   | 0.57  | 1.48  | 1.00  | Marginal increase           |

|                           | Regions with high degree of resource dependence |
|                           |                                               |
| 8   | Tomsk Region            | Oil and gas                                   | 2.77  | 2.3   | 2.70  | Decrease                    |
| 9   | Irkutsk Region Krasnoyarsk | Coal                                          | 0.30  | 0.72  | 2.10  | Significant increase        |
| 10  | Astrakhan Region Republic of Tatarstan | Oil and gas                                   | 0.30  | 1.74  | 2.10  | Significant increase        |
| 11  | Udmurt Republic         | Oil and gas                                   | 0.84  | 1.14  | 1.32  | Increase                    |
| 12  | Kemerovo Region         | Coal                                           | 0.57  | 1.48  | 1.00  | Increase                    |

Resource-based regions
Source: Rosstat data [17] and the authors’ own calculations

This phenomenon may be explained by referring to the concept of regions’ resilience.

3.2. The resilience of Russian resource-based regions

The concept of “resilience” originates in ecology and psychology [18,19]. At present, it has become one of the most popular inter-disciplinary concepts in the evolutionary economy explaining regions’ development specifics [20,1]. Economics define resilience as “the capacity of a system to absorb disturbance, so as to still retain essentially the same function, structure, identity” – the adaptive resilience (Walker et al. 2004 и 2009 [21,22]). Foster (2007) [23] defines resilience of a region as “the ability to anticipate the change, develop plans, respond to and recover after disruptions”. Experts also distinguish “the resilience adaptability” of “adaptive resilience” that is understood as the ability of a system to create alternative development trajectories (Folke) [24]. M. Hill & N.L. Engle [25] view adaptability as the capacity of a region to successfully recover after economic disruptions that derail or may delay it from its development trajectory. It is supposed that the more development alternatives system has at the moment of crisis resolution, the more resilience it has (Boschma and Martin, 2007 [26], 2010 [27]; Simmie and Martin [28], 2010, Martin and Sunley, 2014 [20]). The crucial point of resilience adaptability research, as researchers highlight it, is that there is an opportunity to change region’s development trajectory during a crisis or severe disturbance (Boschma and Martin, 2007 [26]).

There are several different approaches to selecting indicators for region’s economic resilience evaluation in academic literature. In order to calculate indicators, researchers rely on dynamics of GDP, GRP, investments, and employment rates [29]. In this article, calculations are based on the GRP dynamics because changes in gross regional product in Russia are more dynamic during crises, thus being more representative.

In order to assess resilience, we chose the period of the 2008–2010 financial crisis, using the time frame from 2007 to 2011 where 2007 is the pre-crisis year and 2011 is the year when Russian economy overcame the crisis. The greatest decline occurred in 2009.

![Figure 1. GDP dynamics of the Russian Federation in 2005–2016.](source)

Source: Rosstat data [17], the authors’ own calculations

Using the method for calculation of adaptive resilience used in Lagravinese (2015), Giannakis and Bruggeman (2017), and Faggian et al. (2018) [2-4], the authors assessed the overall resilience of Russian resource-based regions that reflects their short-term resilience (adaptive resilience). To do so, the following equation (2) is used:

$$
\beta^{\text{reg}}_{\text{res}} = \frac{Y^{\text{reg}}_t - Y^{\text{reg}}_{t-1}}{Y^{\text{reg}}_t - Y^{\text{reg}}_{t-1} - \left| \frac{Y^{\text{Rus}}_t - Y^{\text{Rus}}_{t-1}}{Y^{\text{Rus}}_t - Y^{\text{Rus}}_{t-1}} \right|}
$$

where $Y^{\text{reg}}$ is GRP on a regional level (million roubles);

$Y^{\text{Rus}}$ is GRP on the national level (million roubles);
$t - 1$ – the starting point (last pre-crisis year, 2007) and $t$ is the final year of the economic crisis (2011).

Positive value of the $\beta_{res}^{reg}$ overall resilience index implies that the region had a smaller GRP decrease than other Russian regions, therefore, it was more crisis-resilient in a short-term perspective. Negative $\beta_{res}^{reg}$ means that region’s resilience is less than the average value in Russia. Results are summarized in Table 2, column (1). Data shows that 12 out of 19 resource-based regions are resilient in a short-term perspective.

**Table 2.** The resilience of resource-based regions in 2007–2011.

|                    | Overall resilience | Resistance | Ability to recover | Group |
|--------------------|--------------------|------------|-------------------|-------|
|                    | $\beta_{reg}$      | $\beta_{rest}$ | $\beta_{rec}$    |       |
| Nenets Autonomous Okrug | 0.1085             | 1.286065   | $-0.35242$        | III   |
| Khanty–Mansi Autonomous Okrug | -0.33893         | -0.79873   | $-0.11026$        | I     |
| Sakhalin Region Republic of Sakha (Yakutia) | 0.759777         | 1.563478   | 0.266801          | IV    |
| Tyumen Region Yamalo-Nenets Autonomous Okrug (YaNAO) | -0.21265        | -0.72055   | 0.034985          | II    |
| Chukotka Autonomous Okrug | 0.002166          | -0.36079   | 0.164899          | III   |
| Komi Republic | 0.817799           | 6.937703   | $-1.01645$        | III   |
| Orenburg Region | 0.296174           | 0.763202   | 0.053527          | IV    |
| Kemerovo Region | -0.21072           | -0.20719   | $-0.19061$        | I     |
| Tomsk Region | 0.148649           | 0.178805   | 0.114369          | IV    |
| Udmurt Republic | 0.016919           | -0.14944   | 0.087703          | II    |
| Irkutsk Region | -0.07589           | -0.03606   | $-0.08375$        | I     |
| Krasnoyarsk Territory | 0.216687          | 0.165744   | 0.137142          | IV    |
| Arhangelsk Region | 0.210681           | 0.009961   | $-0.14317$        | III   |
| Arkhangelsk Republic of Tatarstan | 0.017897 | 0.414131   | $-0.14645$        | III   |
| Perm Territory | 0.162063           | 0.165744   | 0.137142          | IV    |
| Samara Region Republic of Khakassia | -0.31652        | -1.01145   | 0.024271          | II    |
| Khakassia | 0.243032           | 0.877455   | $-0.05352$        | III   |

Source: the authors’ own calculations

To assess the regions’ long-term resilience (ability to maintain resilient growth), the authors used the methodology proposed by Cainelli et al., 2018; Giannakis & Bruggeman, 2017 [5,3]. In accordance with chosen method, the period of 2007–2011 was split in two sub-periods: the resistance phase (2007–2009), when the economy showed decline, and the recovery phase (2009–2011) (Fig. 1). Consequently, resistance index ($\beta_{rest}^{reg}$) and recovery index ($\beta_{rec}^{reg}$) were calculated for each of the
previously selected resource-based regions regarding average index values for Russia using the following equations (3 and 4):

\[
\beta_{rest}^{reg} = \left( \frac{Y_{t}^{reg} - Y_{t-1}^{reg}}{Y_{t}^{Rus} - Y_{t-1}^{Rus}} \right) \left( \frac{Y_{t}^{Rus} - Y_{t-1}^{Rus}}{Y_{t-1}^{Rus}} \right)
\]

(3)

where \( Y^{reg} \) is GRP on a regional level (million roubles);
\( Y^{Rus} \) is GRP on the national level (million roubles);
\( t - 1 \) – the starting point (last pre-crisis year, 2007) and \( t \) is the economic crisis peak (2009).

\[
\beta_{rec}^{reg} = \left( \frac{Y_{t}^{reg} - Y_{t-1}^{reg}}{Y_{t}^{Rus} - Y_{t-1}^{Rus}} \right) \left( \frac{Y_{t}^{Rus} - Y_{t-1}^{Rus}}{Y_{t-1}^{Rus}} \right)
\]

(4)

where \( Y^{reg} \) is GRP on regional level (million roubles);
\( Y^{Rus} \) is GRP on the national level (million roubles);
\( t - 1 \) is the economic crisis peak (2009) and \( t \) is the final year of the economic crisis (2011).

Results obtained are summarized in Table 2, columns (2) and (3). To assess the data, all regions were divided into four groups. The designation of a group, which the region is assigned to, is given in column (4).

Group I: low resistance and slow recovery \( \beta_{rest}^{reg} < 0 \) and \( \beta_{rec}^{reg} < 0 \) – regions with extremely volatile and risky development trajectory in a long-term perspective. This group includes Khanty-Mansi Autonomous Okrug (Yugra) – a monoregion with slow pace of resource dependence growth, Orenburg and Irkutsk Regions – resource-based regions with a high degree of resource dependence showing fast pace of resource dependence growth. These regions need the specialization change critically. They cannot resist external shocks and recover their economy slowly after the end of crisis. These regions have no internal sources to change their development trajectory.

Group II: low resistance and fast recovery \( \beta_{rest}^{reg} < 0 \) and \( \beta_{rec}^{reg} > 0 \) – this correlation demonstrates that chosen trajectory in a long-term perspective may facilitate the sustainable development of a region that relies on internal sources. However, during periods of decline these regions need extra investments, as their decline may prove to be deep. In general, their development trajectory is stable and these regions are unlikely to change their development model in the near future. This group includes Yamalo-Nenets Autonomous Okrug, Tyumen Region, Udmurt Republic, Krasnoyarsk Territory, Samara Region, and Perm Territory. They differ in their resource dependence and all of them have resource dependence on the rise. It is to be expected that in a short-term perspective these regions will keep their specialization.

Group III: high resistance and slow recovery \( \beta_{rest}^{reg} > 0 \) and \( \beta_{rec}^{reg} < 0 \) – the most inert group in terms of resilience and the most uncertain in terms of development prospects. The group includes five regions: Nenets Autonomous Okrug, Chukotka Autonomous Okrug, Tomsk Region, Arkhangelsk Region and Republic of Khakassia. This group is highly heterogeneous: Nenets Autonomous Okrug, Arkhangelsk Region and Tomsk Region are on the verge of depleting their highly-profitable oil and gas reserves, while in Krasnoyarsk Territory and the Republic of Khakassia the process of oil, gas and coal reserves development has only begun. The development trajectory of these regions can be described as changing or just emerging at the moment. These regions especially need federal support to facilitate resilient development.

However, they do not have enough internal sources for fast recovery and further development. Regarding long-term development prospects, regions of this group are not expected to change their development trajectory.
Group IV: high resistance and fast recovery $\beta_{\text{res}}^{\text{reg}}>0$ and $\beta_{\text{rec}}^{\text{reg}}>0$. This correlation demonstrates that regions are resilient both in short-term and long-term perspectives. They have enough sources to facilitate their development and they are unlikely to change their development trajectory. This group includes five regions: Sakhalin Region, the Republic of Sakha (Yakutia), Komi Republic, Kemerovo Region, and the Republic the Tatarstan. The trajectory chosen by these regions is optimal. Moreover, all these regions, except for Tatarstan, are aimed at increasing their resource dependence.

4. Conclusions
The article presents a study of the short-term and long-term economic resilience of Russian resource-based regions, aiming at identifying opportunities for them to change their development trajectory. Results of this study show that 19 out of 85 constituent entities of Russia may be defined as resource-based (resource-dependent). Their resource dependence is different, varying from monoregions to region’s specialization in mining (resource-dependent regions). Analysis of their resource dependence dynamics shows that in most regions resource dependence grows, and their resilience assessment shows that most regions are resilient and tend to retain the selected development trajectory in a long-term perspective. All of the above, allows us to draw the following conclusion: in order to change the current situation, decisive political actions of a federal government are needed.

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