Advances in Research on Russian Business and Management
ISSN: 2578-725X, e-ISSN: 2578-7268

Stimulating the Development of Responsible Management and Green Business in Smart Regions of Russia to Support the Reduction of the Environmental Footprint of the Economy

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Abstract: The research aims to determine the consequences of the development of smart regions in Russia for the environmental footprint of the economy and develop recommendations for stimulating responsible management and green business in these regions to support the reduction of their environmental footprint. To achieve this, the authors employed regression analysis to assess the impact of the emergence of smart regions on environmental conservation efforts, the greening of industrial production, and the implementation of socio-environmental initiatives in Russian regions. The study is based on the experiences of the top 15 smart regions in Russia in 2022. The findings demonstrate that the development of smart regions does not lead to an increase but rather contributes to a reduction in the environmental footprint of the economy. On this basis, the authors conclude that the development of smart regions is expedient for reducing the environmental footprint of the economy in Russia and emphasize the importance of stimulating responsible management and green business development in these regions. The scientific novelty of the author's conclusions lies in their elucidation of the causal links between the development of smart regions and Russia's

economic environmental footprint. The theoretical significance of this research is expressed in the reevaluation of the consequences of digitalization for the environment from a regional perspective, thereby establishing a scientific and methodological basis for applying a meso-level approach to studying the environmental footprint of the economy. The regional focus on studying the environmental footprint presented in the research will enable a more precise determination of the environmental consequences of digitization and their minimization, thereby supporting green economic growth. The practical significance of this research is justified by the perspective it presents on the development of responsible management and green business in smart regions of Russia, as well as the proposed recommendations for stimulating their development. These insights can be utilized in the formulation of strategies for green economic growth in smart regions of Russia.

Keywords*:* responsible management, green business, smart region, Russian regions, environmental footprint of the economy

JEL codes: O18, Q55, Q45, Q57, R11, R52

The economic environmental footprint is most clearly manifested at the meso-level of economic systems; it is also most susceptible to management at this level. This is explained by the fact that the region represents the primary unit of the green economy. At the meso-level, direct environmental statistics related to natural resource use in the region are considered, rather than generalized data. The consequences of implementing environmental initiatives in the region are clearly visible to all stakeholders.

The initiation of economic digitization processes has changed contemporary practices of natural resource use. The problem lies in the fact that the existing approach, which involves studying the economic environmental footprint at the macro level, inadequately explains the impact of digitization on the environment. The current approach considers aggregated data from the digital economy, while its environmental consequences can vary significantly among regions.

The process of economic digitization is actively studied at the meso-level of economic systems, with the smart region being the research object. This forms the basis for applying a meso-level approach to studying the economic environmental footprint. However, the complexity arises from the uniqueness of the regional economy in each economic system. This prevents the transfer of the experiences of regions in one country to regions in other countries, requiring the separate study of regional economies in different countries.

The experience of the Russian regions, as one of the most advanced and dynamically developing digital economies in the world, certainly deserves attention and in-depth study. This served as the basis for selecting the research objective: to determine the consequences of the development of smart regions in Russia for the environmental footprint of the economy and develop recommendations for stimulating responsible management and green business in these regions to support the reduction of their environmental footprint.

Literature Review

This research is based on the scientific concept of a green economy, which emphasizes that the functioning and development of economic systems are accompanied by environmental costs that need to be minimized (Kusakina et al., 2016; Tolmachev et al., 2023). From the perspective of a macro-level approach to studying the economic environmental footprint, existing literature provides scientific arguments for the negative consequences of digitization on the environment.

This argumentation is rooted in the fact that digital economic growth is accelerated and, therefore, requires a greater volume of natural resources, leading to their expedited depletion, as well as an increase in production and consumption waste (Popkova et al., 2022; Sergi et al., 2019; Vechkinzova et al., 2022). The existing meso-level studies highlight the following key manifestations of environmentally responsible corporate management and green business:

- Environmental conservation efforts (Karbekova et al., 2019);
- Greening of industrial production (Ragulina et al., 2018);
- Implementation of socio-environmental initiatives: creating green jobs and conditions for more active engagement of external stakeholders (investors, consumers, and the general public) in environmental care based on business environmental initiatives (Turginbayeva & Shaikh, 2022).

The literature review has revealed numerous publications on the topic of smart regions. However, the economic environmental footprint of smart regions remains understudied and largely undefined. This gap in the literature leads to the following research question (RQ): "What are the consequences of the development of smart regions in Russia for the economic environmental footprint?"

Drawing on a series of studies (Arkin et al., 2020; Turginbayeva & Abildaev, 2013) indicating that smart regions provide a favorable socio-economic environment for developing responsible management and green business, this research puts forward the hypothesis that the development of smart regions in Russia contributes to a reduction in the economic environmental footprint. To test this hypothesis, the authors examined the consequences of the emergence of smart regions for environmental conservation activities, the greening of industrial production, and the implementation of socio-environmental initiatives in the regions of Russia.

Materials and Methods

The research methodology is based on the application of regression analysis. Using this chosen method, the authors determined the influence of the "IQ Index of Cities" (iqi), which are regional centers, in 2021 (according to the assessment of the Ministry of Construction, Housing and Utilities of the Russian Federation (2022)) on environmental conservation activities ("Environmental protection index": EFP_1), the greening of industrial production ("Industrial-environmental index": EFP_2), and the implementation of socio-environmental initiatives ("Socio-environmental index": EFP_3) in the regions of Russia in 2023 (according to the assessment of the Green Patrol (2023)). The sample includes the top 15 largest smart regions of Russia. The statistical data for the study are provided in Table 1.

Table 1

IQ index of regional centers and indicators of the environmental footprint of the economy in the top 15 smart regions of Russia in 2022

Region (city) of Russia	IQ index, scores 1–200	Environmental protection index, scores 1–100	Industrial-environmental index, scores 1–100	Socio-environmental index, scores 1–100
Moscow	117.16	40	90	76
St. Petersburg	98.13	57	85	65
Novgorod Region	88.26	48	81	56
Republic of Bashkortostan	86.70	47	82	60
Republic of Tatarstan	85.00	50	84	50
Krasnoyarsk Region	75.97	37	72	50
Volgograd Region	72.95	60	79	45
Chelyabinsk Region	70.97	28	72	55
Voronezh Region	70.57	53	80	45
Perm Region	67.71	56	81	69
Tyumen Region	100.75	58	83	67
Ryazan Region	87.76	58	81	57
Khanty-Mansi Autonomous Area	86.25	48	77	50
Kostroma Region	78.68	73	82	65
Vologda Region	76.98	63	83	72

Source: Compiled by the authors based on the Green Patrol (2023), Ministry of Construction, Housing and Utilities of the Russian Federation (2022)

Based on the regression analysis results, the authors determined the prospects for the development of responsible management and green business in smart regions of Russia to support reducing the environmental footprint of the economy.

Results

Using the data from Table 1, the authors carried out a regression analysis of the impact of the IQ index of regional centers on the indicators of the environmental footprint of the economy in the top 15 smart regions of Russia in 2022. Regression statistics is shown in Table 2.

Table 2

Regression statistics

Resulting variables	Regression coefficients		t-statistics		Observed F	Significance F	Multiple R
	Y-intercept	iqi	Y-intercept	iqi			
Environmental protection index (EFP_1)	57.3687	-0.0669	2.9163	-0.2898	0.0840	0.7765	0.0801
Industrial-environmental index (EFP_2)	60.8933	0.2363	10.2340	3.3847	0.0049	11.4564	0.6844
Socio-environmental index (EFP_3)	27.9309	0.3664	1.8491	2.0675	4.2745	0.0592	0.4974

Source: Calculated and compiled by the authors

The results from Table 2 indicate that the environmental protection index did not demonstrate a statistically significant dependence (close to zero correlation, F-test and t-test not passed) on the IQ index of regional centers in the top 15 smart regions of Russia in 2022.

The change in the industrial-environmental index in the top 15 smart regions of Russia in 2022 is by 68.44% determined by the IQ index of regional centers. This indicates a close relationship between the studied indicators and makes it possible to formulate the following paired linear regression equation:

$$EFP_2=60.8933+0.2363*iqi \quad (1)$$

Equation (1) indicates that an increase in the IQ index of regional centers by one point leads to a growth of the industrial-environmental index in the top 15 smart regions of Russia in 2022 by 0.2363 points. The significance F is 0.0049. Therefore, equation (1) corresponds to a significance level of 0.01. At the given significance level, the tabular F is 9.0738. The observed F is 11.4564, exceeding the tabular value. Thus, the Fisher's F-test is passed.

At 14 degrees of freedom and at the given significance level, the tabular t is 2.9768. The observed t is 3.3847 for the factor variable, exceeding the tabular value. Therefore, the Student's t-test is passed. The change in the socio-environmental index in the top 15 smart regions of Russia in 2022 is by 49.74% determined by the IQ index of regional centers. This indicates a close relationship between the studied indicators and makes it possible to formulate the following paired linear regression equation:

$$EFP_3=27.9309+0.3664*iqi \quad (2)$$

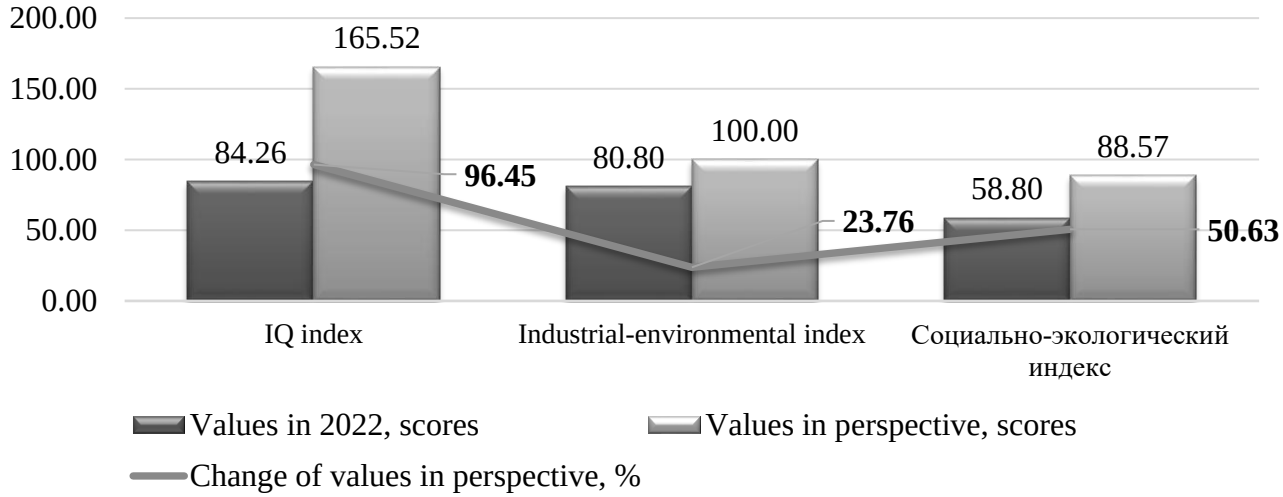
Equation (2) shows that an increase in the IQ index of regional centers by one point leads to an increase in the socio-environmental index in the top 15 smart regions of Russia in 2022 by 0.3664 points. Significance F is 0.0592. Therefore, equation (2) corresponds to the

significance level of 0.10. At the given significance level, the tabular F is 3.1362. The observed F is 4.2745, exceeding the tabular one. Thus, Fisher's F-test is passed.

At 14 degrees of freedom and at the given significance level, the tabular t is 1.7613. The observed t=2.0675 for the factor variable, exceeding the tabular one. Therefore, the Student's t-test is passed. Based on the regression equations (1) and (2), the perspective of responsible management and green business development in smart regions of Russia in support of reducing the environmental footprint of the economy is determined (Figure 1).

Figure 1

Prospects for responsible management and green business in Russia's smart regions



Source: Calculated and compiled by the authors

As shown in Figure 1, increasing the IQ index of regional centers by 96.45% (from 84.26 points in 2022 to 165.52 points) will maximize the industrial-environmental index, resulting in an increase of 23.76% (from 80.80 points in 2022 to 100 points). Additionally, this will lead to an increase in the socio-environmental index by 50.63% (from 58.80 points in 2022 to 88.57 points). To practically implement the perspective presented in Figure 1, the following recommendations are proposed to stimulate the development of responsible management and green business in smart regions of Russia:

- Wide application of machine vision for environmental monitoring to popularize and enhance the effectiveness of conservation activities;
- Installation of smart sensors to monitor resource consumption and waste in industrial productions for their greening;
- Creation of green jobs for digital professionals and the use of smart technologies in issuing green bonds to scale up socio-environmental initiatives.

The comprehensive implementation of these measures will unlock the potential of smart regions in Russia for reducing the environmental footprint of their economies.

Discussion

The research contributes to the advancement of scientific propositions within the concept of the green economy by refining the implications of the development of smart regions in Russia on the environmental footprint of the economy. In contrast to Popkova et al. (2022), Sergi et al. (2019), and Vechkinzova et al. (2022), this research provides evidence that the development of smart regions in Russia does not increase but rather reduces the environmental footprint of the economy.

The regression analysis results demonstrated that an increase in the IQ index of regional centers determines a 68.44% growth in the industrial-environmental index and a 49.74% growth in the socio-environmental index in the top 15 smart regions of Russia in 2022. This substantiates the proposed hypothesis and corroborates the assumptions put forth by Arkin et al. (2020) and Turginbayeva and Abildaev (2013).

Conclusion

The main conclusion of this research is that to reduce the environmental footprint of the economy in Russia, it is advisable to develop smart regions and stimulate the development of responsible management and green business in these regions. The scientific novelty of the author's conclusions lies in the fact that they revealed and explained the cause-and-effect relationship between the development of smart regions and the environmental footprint of the Russian economy. The theoretical significance of the research is expressed in the fact that it rethinks the consequences of digitalization for the environment from a regional perspective, thus laying the scientific and methodological foundation for the application of a meso-level approach to studying the environmental footprint of the economy. The new regional perspective of studying the environmental footprint presented in the research will make it possible to accurately determine the environmental consequences of digitalization and minimize them, supporting green economic growth.

The practical significance of this research is due to the fact that the perspective of responsible governance and green business development in smart regions of Russia presented in it, as well as the proposed recommendations to stimulate the development of responsible governance and green business in smart regions of Russia, can be used in developing green economic growth strategies in smart regions of Russia.

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