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Clustering of Russian Regions and Creating a Favorable Institutional Environment for Tax Incentives that Promote Technological Sovereignty

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ABSTRACT

Technological sovereignty as a strategic imperative of national development requires the development of adapted fiscal mechanisms aligned with the goals of innovation transformation. **The subject** of the study is the institutional environment for tax incentives for the technological sovereignty of Russian regions. **The main objective** of the study is the clustering of Russian regions that promotes the development of technological sovereignty of the country, applying various instruments of tax regulation. The **novelty** of this work lies in proposing and empirically testing a differentiated approach to creating a favorable institutional environment for tax incentives that promote technological sovereignty through the clusterization of Russian regions. The **methodology** of the study employs systemic analysis, Python-based cluster analysis, comparative research, and modeling to deepen understanding of the interaction between tax instruments and regional innovation development. **The results** of the study confirm that establishing an effective institutional environment for tax incentives supporting technological sovereignty requires a differentiated approach based on regional production index clustering, underpinned by four core criteria: regulatory transparency and international standard alignment, innovation ecosystem maturity, public-private collaborative frameworks, and digital tax procedures. **The conclusions** indicate that tax rate reductions and incentives for investment projects in all regions create a favorable institutional environment for technological sovereignty. Cluster 0 requires stabilization of tax incentives subsequent to the imposition of sanctions, Clusters 1 and 2 require the development of cross-border ties through federal mechanisms, and Cluster 3 requires the modernization of tax regimes, taking into account resource specifics.

Keywords: technological sovereignty; tax incentives; favorable institutional environment; tax instruments; tax benefits; government-private partnership; investment deductions; regional clustering; digitalization

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ОРИГИНАЛЬНАЯ СТАТЬЯ

Кластеризация российских регионов и создание благоприятной институциональной среды для налоговых льгот, способствующих обеспечению технологического суверенитета

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АННОТАЦИЯ

Технологический суверенитет как стратегический императив национального развития требует разработки адаптированных фискальных механизмов, соответствующих целям инновационной трансформации. **Предметом исследования** является институциональная среда для налоговых льгот в целях формирования технологического суверенитета российских регионов. Основная **цель исследования** — кластеризация российских регионов по уровню технологического развития с учетом применения различных инструментов налогового регулирования. **Новизна** работы заключается в предложении и эмпирической проверке дифференцированного подхода к формированию благоприятной институциональной среды для применения налоговых льгот, поддерживающих технологический суверенитет на основе кластеризации российских регионов. В **методологии** исследования используются системный анализ, кластерный анализ с помощью Python, сравнительное исследование для углубления понимания взаимодействия налоговых инструментов и регионального инновационного развития. **Результаты исследования** подтверждают, что создание эффективной институциональной среды для налоговых льгот, поддерживающих технологический суверенитет, требует дифференцированного подхода, основанного на кластеризации регионов с учетом развития высокотехнологичных видов деятельности, подкрепленного четырьмя основными критериями: прозрачностью регулирования и соответствием международным стандартам, зрелостью инновационной экосистемы, рамками государственно-частного сотрудничества и цифровыми налоговыми процедурами. **Выводы** показывают, что снижение налоговых ставок и льготы для инвестиционных проектов во всех регионах создают благоприятную институциональную среду для технологического суверенитета. Регионы Кластера 0 требуют стабилизации налоговых льгот после введенных санкций, регионы в Кластерах 1 и 2 успешно справляются с внешними шоками, однако нуждаются в развитии трансграничных связей, а в Кластере 3 необходима существенная модернизация налоговых режимов с учетом ресурсной специфики.

Ключевые слова: технологический суверенитет; налоговые льготы; благоприятная институциональная среда; налоговые инструменты; налоговые преференции; государственно-частное партнерство; инвестиционные вычеты; региональная кластеризация; цифровизация

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Introduction

In the context of rapid technological progress and economic globalization, the issue of technological sovereignty becomes particularly relevant for Russia. Modern challenges necessitate active state engagement in shaping the innovation ecosystem and developing effective tax incentives to support domestic technology development and reduce dependence on foreign policy solutions. In this context, studying how to create a favorable institutional environment for tax incentives that promote technological sovereignty in Russian regions is a significant scientific task. Current research reveals that, despite existing studies on tax regulation and innovation policy, their interdependence and impact on technological sovereignty and regional development remain inadequately explored.

This study was launched to address the need for systematizing and assessing the effectiveness of tax instruments aimed at supporting technological sovereignty in Russian regions. The authors identified a lack of a methodological framework for classifying regions based on tax mechanism efficiency, which obstructed the creation of tailored tax policies reflecting regional characteristics. The availability of a substantial dataset of empirical information on the index of high-tech industry production in Russian regions for 2022–2024, provided by the Federal Service for State Statistics of the Russian Federation (Rosstat), created a unique opportunity for comprehensive analysis. Researchers recognized the potential for identifying patterns and constructing regional clusters, enabling a transition from speculative conclusions to scientifically grounded findings regarding the impact of the tax environment on the technological development of territories.

The realization that technological sovereignty represents a strategic priority for national development necessitated scientific reflection on the role of tax instruments in achieving this goal. Researchers understood that without an in-depth analysis of regional specificity in the application of tax incentives, it would be impossible to develop effective support policies for high-tech industries that promote reduced dependence on imported technologies.

Thus, the decision to develop this research topic was driven by a combination of the unexplored regional specificity of tax incentives, recognition of the practical significance of the problem, and the availability of unique empirical data that enabled comprehensive research using modern analytical methods.

The scientific novelty of this research lies in the development and testing of an original methodological approach to evaluating the effectiveness of tax instruments for ensuring regional technological sovereignty. For the first time in Russian economic science, comprehensive clustering of Russian regions has been conducted based on the index of high-tech industry production, taking into account the specificity of applied tax mechanisms. The novelty of the obtained results lies in identifying and systematizing four key criteria for effective tax regulation: regulatory transparency and international standard alignment, innovation ecosystem development, public-private collaborative frameworks, and digital tax procedures. Of particular scientific value is the establishment of the relationship between regional cluster type and the effectiveness of specific tax instruments, which enables a transition from a uniform to a differentiated approach in tax regulation of technological development.

The research is grounded in the scientific hypothesis that a significant relationship exists between specific combinations of tax instruments, the institutional environment in regions and the dynamics of the high-tech industry production index. Regions with tax incentive systems carefully calibrated to industry-specific traits, workforce capabilities, and geographic attributes exhibit more resilient technological advancement and reduced susceptibility to external pressures. An additional hypothesis posits that clustering regions by tax mechanism efficacy can reveal tailored tax stimulation strategies suited to diverse regional economic profiles.

The research's practical significance stems from developing scientifically validated recommendations to enhance tax policy efficiency across federal and regional jurisdictions. The obtained results can be utilized by government authorities in formulating regional technological development strategies, designing support programs for high-tech industries, and creating special economic zones. The proposed evaluation criteria for tax mechanisms will refine the incentive system aimed at achieving technological sovereignty. Research findings offer practical value to businesses when selecting regions for high-tech production and assessing the efficacy of existing tax incentives. Furthermore, the clustering methods employed can be applied in evaluating regional investment attractiveness and forecasting the dynamics of high-tech industry development under various economic conditions.

Literature review

This study fits into a new paradigm of regional development, where institutions are understood as dynamic systems adapting to technological shifts. The key distinction of the proposed approach lies in the integration of four criteria for effective tax regulation: regulatory transparency and international standard alignment, innovation ecosystem development, public-private collaborative frameworks, and digital tax procedures. This allows institutional elements to be viewed not as isolated structures but as part of a complex system, where each component interacts with others in a context of global competition.

This approach overcomes the limitations of Michael Porter's classical cluster theory, which ignores digital aspects and sanctions pressure and inadequately describes contemporary regional realities. Instead, the study offers an understanding of institutions as dynamic elements of an innovation ecosystem, where tax instruments become not simply regulatory tools but catalysts for technological development in the face of global challenges.

Furthermore, fiscal federalism and classical institutional economics demonstrate significant limitations in the face of contemporary challenges. Fiscal federalism, focusing on the distribution of powers between levels of government, often ignores the dynamics of digital transformation and global value chains, making it inadequate for analyzing regional development under sanctions pressure. Classical institutional economics, meanwhile, insufficiently considers the role of innovative ecosystems and digital technologies in shaping regional advantages.

The systematization of key research presented in *Table 1* demonstrates the evolution of scientific understanding: from a focus on individual tax instruments (e.g., L.I. Goncharenko, A.V. Gurnak) to a comprehensive understanding of the institutional environment (e.g., S. Appelt, P.B. Saptono) and further to a systemic approach that considers multi-level determinants of technological development (e.g., M. Dębski, R. Alvarado). This confirms

the relevance of this study, which aims to develop a cluster approach to identify a favorable institutional environment for tax incentives.

Table 1 synthesizes key research on tax incentives for technological sovereignty, revealing structural trends in the evolution of scientific approaches to this complex domain. Grouping studies based on similarities in analytical contribution demonstrates the evolution of scientific understanding: from fragmented analysis of individual tax instruments to a comprehensive understanding of their place within a multi-level system for ensuring technological sovereignty. This classification does not merely catalog existing works but reveals the methodological, institutional, instrumental, contextual, and systemic aspects of the problem, creating a foundation for knowledge synthesis and identification of research gaps.

The presented grouping holds significant value for this study as it clearly demonstrates that existing scientific works, despite their merit, primarily focus on isolated aspects of the problem without offering a holistic methodology for assessing the effectiveness of tax incentives in the context of regional specificity of technological sovereignty. Literature analysis confirms the relevance of developing a cluster approach that integrates achievements from all five research groups and justifies the necessity of transitioning from analyzing individual instruments to a comprehensive assessment of the institutional environment of tax incentives as a factor in regional technological development.

The current study develops and tests the application of regional cluster analysis methods based on the high-tech industry production index, taking into account the specificity of applied tax mechanisms. For the first time in scientific literature, a comprehensive approach to assessing the effectiveness of the tax incentive institutional environment is proposed, incorporating both quantitative and qualitative indicators.

This research integrates all five aspects of previous studies into a unified analytical framework. The study is based on a unique dataset of empirical information from 85 Russian regions for 2022–2024, enabling the identification of patterns in how the tax environment influences technological development. For the first time, a large-scale empirical analysis has been conducted that confirms or refutes theoretical propositions from previous research. Four regional clusters with different characteristics have been identified, and optimal tax stimulation models have been proposed for each territory type.

Based on cluster analysis results, differentiated recommendations for improving tax policy for various regional types can be developed. Specific mechanisms for optimizing the tax incentive system, adapted to the specificity of each regional cluster, can be formed.

The current study complements previous works by proposing a system of key criteria for effective tax regulation. Thus, this research proposes a paradigm shift in the approach to tax stimulation of technological sovereignty: from analyzing individual instruments to a comprehensive assessment of the institutional environment and differentiated regional policy based on a scientifically grounded regional typology.

At the same time, a separate stage of the literature review is devoted to examining the term "technological sovereignty," as this term defines the parameters of the clustering conducted in this study. *Table 2* presents various approaches in the literature related to the study of the term "technological sovereignty".

As can be seen from the literature presented in *Table 2*, the key aspect in developing approaches to technological sovereignty includes a focus on the development of high-tech industries and the use of development indices for the relevant industries to assess sovereignty. This emphasis is placed on eliminating potential cooperation and competition between countries for technological industrial leadership. Thus, "technological sovereignty" is a state's ability to independently develop, advance, control, and ensure the security of critical technologies. The state of sovereignty can be assessed using index methods and comparisons with corresponding industry development indices in other jurisdictions.

Materials and methods

The research methodology of the study is built as a multilevel system of analytical procedures that ensures the realization of key research objectives. System-structural analysis of legal acts allowed us to decompose the institutional environment into four interacting levels: federal standards of tax regulation, their regional modifications, cluster regulations of special economic zones and corporate tax strategies, which corresponds to the introduction's requirement to identify multilevel determinants of technological sovereignty.

Table 1
Summary of prior studies

Direction	Authors	Analytical contribution
Methodology for assessing tax efficiency	A.E. Goncharenko [3]	Application of the cost of capital model when taking into account the effect of accelerated depreciation
	S.V. Bogachev, V.P. Vishnevsky [10]	Using tax elasticity to assess non-governmental organizations (NGO) revenue dynamics with the integration of digital tools
Institutional mechanisms of tax regulation	O.N. Golovchenko [2]	Justification of the role of the institutional environment as a foundation for effective tax incentives
	V.P. Vishnevsky, A.E. Goncharenko, I.V. Nikulkina, A.V. Gurnak [6]	Identifying the relationship between technological changes and the tax system, requiring adaptability of fiscal mechanisms
	S.V. Trofimov [12]	Analysis of legal barriers in tax regulation of research and development (R&D)
	Z. Mannan et al. [15]	A study of coordination mechanisms in public-private partnerships
Specific tax instruments and their impact	L.I. Goncharenko, N.G. Vishnevskaya [1]	Analysis of the specifics of tax credit as the main instrument for stimulating R&D
	A.V. Gurnak, N.A. Nazarova [5]	Empirical evidence for the dominance of the corporate income tax in the incentive structure
	O.V. Mandroshchenko [11]	A study of the dual nature of income tax: as a barrier and as an incentive
	H.M. Musaeva [9]	The effectiveness of the investment tax deduction and its role in regional development
	O.V. Staroverova [7]	Recommendations for optimizing tax incentives to attract investment in high-tech industries
Contextual factors of technological sovereignty	M. Dębski et al. [17]	The relationship between investment in human capital, innovation and taxes
	M.M. Abdul et al. [19]	Identification of infrastructure determinants of tax policy effectiveness in the regions
	A.A. Kochurova [20]	Integration of the logistics factor into the analysis of regional efficiency of tax incentives
International experience and systemic effects	T. Gross, P. Klein [4]	Development of a tax policy model in the context of endogenous innovative growth
	S. Appelt et al. [13]	Systematization of international experience of income-based tax incentives (IBTI) models and their potential for Russia
	P.B. Saptono et al. [14]	Empirical evidence for the long-term effect of tax incentives
	O.V. Antipina [8]	Universal principles of tax incentives for innovation based on international experience
Clustering of regions by level of technological development	D.R. Belousov, D.A. Matveev, N.A. Ganichev et al. [26]	Consideration of spatial aspects of technological development in the context of regions as a single ecosystem that should develop evenly
	J.L.A. Colmenero, J.P. Portela Garcia-Miguel [27]	The effectiveness of clustering for classifying regions and the use of industry development indicators in regions has been confirmed
	M. Fabińska [28]	Analysis of the resilience of regional clusters to changes in the economic environment, identification of regional development dynamics
	R. Fan, et al. [29]	Spatiotemporal patterns of innovation and high-tech industry agglomeration in 30 provinces of China from 2012 to the present

Source: Compiled by the authors.

Table 2
Summary of research on the term "technological sovereignty"

Direction	Authors	Analytical contribution
Interpretation of technological sovereignty as a stage of development of digital technologies (IT)	To.N. Hung et al. [16]	Justification of the need to integrate digitalization into tax policy as a condition for technological sovereignty
	S. Couture, S. Toupin [21]	The concept of "sovereignty" in the digital context as control over data and infrastructure
	I. Calzada [22]	Defines technological sovereignty as the protection of citizens' digital rights in the AI era
An index approach to assessing technological sovereignty based on productivity	A. Da Ponte, G. Leon, I. Alvarez [23]	A multidimensional synthetic indicator, the Technological Sovereignty Index (TSI), is being developed. It identifies key issues of technological sovereignty: access to technology and productivity management in high-tech industries
Emphasis on the reproducibility of technological processes	O. Falck, S. Falk [24]	Highlighting key challenges to technological sovereignty, including in the term the concept of reproducibility of technologies within industrial processes
Inclusion of intangible factors in the interpretation of the term	R. Alvarado et al. [18]	Expanding the concept of technological sovereignty to include intangible factors (academic environment)
	S. Mariotti [25]	Explores aspects of cooperation between countries and industrial pressure on the policy of technological sovereignty, a skeptical assessment of cooperation between countries in the issue of competitiveness of producers

Source: Compiled by the authors.

The comparative-legal method with cluster differentiation was used to operationalize the concept of adaptive tax mechanisms. This approach realizes the thesis of the introduction about the necessity to take into account regional and sectoral specifics when designing tax incentives. The empirical component combined qualitative and quantitative methods to create a multifactor evidence base. The analysis of tax instruments with a focus on concealed regulatory risks and cluster analysis of data on Russian regions made it possible to comprehensively study the instruments of tax incentives for technological sovereignty and identify institutional factors of index growth in the production of high-tech industries in Russian regions.

The selection of cluster analysis as the primary research method is justified by its unique capabilities for addressing the scientific problem at hand. Unlike traditional econometric modeling methods, which focus on establishing causal relationships between individual variables, cluster analysis enables the identification of hidden structures and patterns in multidimensional data, which is critically important for the typology of regions based on the effectiveness of tax instruments.

The proposed application of cluster analysis in this study is well-grounded and aligns with the nature of the phenomena under investigation and the research objectives. It is algorithmically transparent, as all stages of the analysis are clearly formalized and can be reproduced by other researchers. Cluster analysis also demonstrates high potential for empirical verification. Moreover, clustering can be utilized for regular monitoring of tax policy effectiveness across regions.

Particular importance is given to the method's reproducibility: all calculations were performed in the Python environment using scikit-learn, pandas, numpy, and matplotlib libraries. The source code and data can be provided for independent verification of the results, which adheres to the principles of open science.

Compared to traditional regional analysis methods (regression models, data envelopment analysis (DEA) analysis, expert assessments), the proposed cluster approach enables working with data of diverse nature without rigid distributional assumptions. This methodological flexibility is particularly valuable when analyzing complex institutional environments where variables may not conform to standard statistical distributions, allowing for a

more accurate representation of regional differences in tax policy implementation and technological development trajectories.

An integrated methodological approach is employed to evaluate the institutional significance of tax instruments for harmonizing the assessment of technological development in Russian regions, considering the country's technological sovereignty. The authors decompose the institutional environment into four interacting levels: federal tax regulation standards, regional modifications, cluster norms for special economic zones, and corporate tax strategies.

This systemic approach allows us to identify the multi-level determinants of technological sovereignty and establish a direct link between specific tax mechanisms and actual results in the development of technological sovereignty at the regional level.

Particularly important is the comparative analysis method, which allows us to compare clustering results with tax regimes. This method includes both a comparison of clusters of regions with tax preferences and a quantitative comparison, as well as an analysis of the regulatory framework and a comparative legal method with cluster differentiation.

Application of tax incentives in practice

This study aims to pinpoint critical institutional factors and tax regulatory instruments that advance technological sovereignty. Key objectives include (1) assessing current tax incentives and (2) performing a cluster analysis of Russian regions to bolster technological sovereignty. The research analyzes current regulations and empirical data on tax mechanisms supporting Russia's technological sovereignty across regions. The study aims to develop a comprehensive understanding of how a supportive institutional framework for tax incentives advances technological sovereignty, a critical step toward building a sustainable innovation economy in Russian regions. Effective tax incentives can significantly improve the competitiveness of the national economy, promote the development of innovative projects and attract investment in high technology.

Results

Empirical data analysis on high-tech industries in the context of Russian regions appears rather ambiguous. In particular, the assessment using cluster analysis of data for all regions, starting from 2022, based on the Production Index, which characterizes the scale of production in comparable periods with respect to manufacturing types of economic activities (OKVED2 — All-Russian Classifier of Types of Economic Activity), showed contradictory results. The first stage of the analysis is related to the study of data from 85 regions on the Production Index characterizing high-tech manufacturing types of economic activities (OKVED2) provided by Rosstat for 2022–2024.[1] The classification covers high-tech sectors, including pharmaceutical R&D, advanced medical materials, semiconductor electronics, and spacecraft systems, alongside medium-high-tech industries, such as medical device manufacturing, precision optical instruments, and aircraft components. Clustering was conducted using Python. A normalization procedure was performed on the data, and statistical outliers were taken into account. Some regions had extreme values, for example, the Republic of Tyva went from 6.5 in 2022 to 245.3 in 2024, and Chukotka Autonomous Okrug (AO) went from 306.7 in 2022 to 912.7 in 2024.

According to the data presented in *Fig. 1*, we can conclude that it is necessary to cluster into three to four clusters, since according to the elbow method, the largest significant bend is between the marks $k = 3$ and $k = 4$. At the same time, if $k = 4$ is chosen, only one region — Chukotka AO — will be in the cluster with the highest index growth rate, which is not representative of the general trend. This is clearly evident from *Fig. 2*, which presents visualized data on clusters of regions.

In particular, a strong gap is demonstrated not only by Chukotka AO, which is the only one in the first cluster, but also by the Republic of Tyva, which is in cluster 2 and has made an unprecedented jump in the index over three years.

Accordingly, the study concludes that there are at least three (globally — four) clusters of regions with regard to the Production Index characterizing high-tech manufacturing types of economic activity (OKVED 2). The composition of clusters by the number of regions is presented in *Fig. 3*. As can be seen from *Fig. 3*, a cluster that includes only one region is anomalous. This cluster includes only the Chukotka AO.

[1] Rosstat. URL: https://rosstat.gov.ru/folder/11189 (accessed on 25.03.2025).

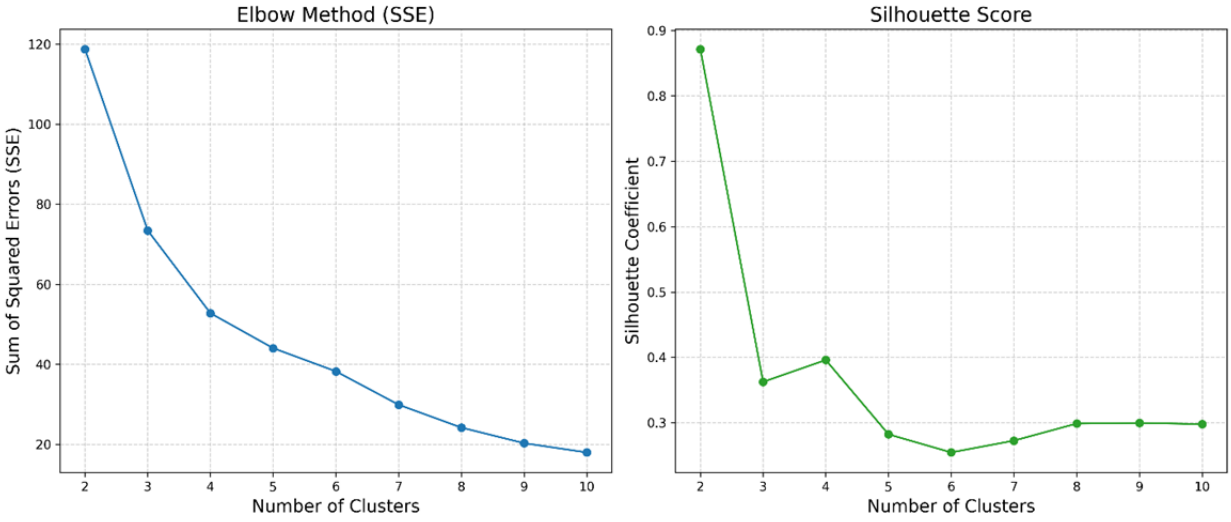

Fig. 1. **Elbow method and Silhouette coefficient in relation to data on the Production Index characterizing high-tech manufacturing economic activities**

Source: Compiled by the authors.

Fig. 2. **Visualization of clusters of regions in relation to data on the Production Index characterizing high-tech manufacturing economic activities**

Source: Compiled by the authors in mapchart.net based on Rosstat data.

Note: Statistics within the new regions of the Russian Federation are not presented in the Rosstat materials.

Discussion

Practical interpretation of clusters. As the analysis of the results of the conducted clustering showed, the clusters differ significantly in terms of the growth rates of the Index and the composition of the regions. Simultaneously, regions are consolidated into coordinated clusters featuring standardized implementation of innovation-fostering mechanisms.

The largest cluster is cluster 3. However, the industrial Production Index for this cluster is not outstanding.

The most outstanding results are demonstrated by regions from clusters 2 and 0. At the same time, cluster 0 can be described as comprising underperforming entities — regions that were unable to cope with the consequences of the sanctions pressure and whose Production Index was suppressed.

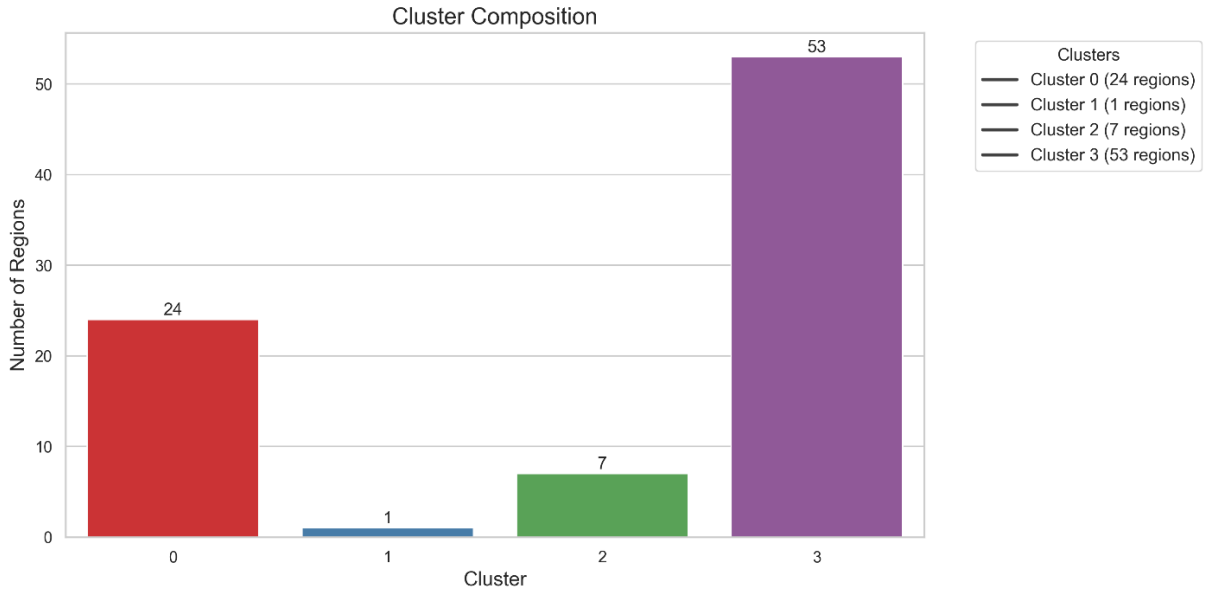

Fig. 3. **Visualization of clusters by number of regions**

Source: Compiled by the authors.

Cluster 0 groups regions characterized by either explosive growth in 2023 or a substantial decline in production in the subsequent year (primary defining factor). Examples include the Voronezh Region, Kostroma Region, Kursk Region, Lipetsk Region, Moscow Region, Tambov Region, Tver Region, City of Moscow, Komi Republic, Leningrad Region, City of Saint Petersburg, Republic of Crimea, Volgograd Region, Karachay-Cherkess Republic, Republic of North Ossetia-Alania, Republic of Mari El, Udmurt Republic, Chuvash Republic, Samara Region, Ulyanovsk Region, Sverdlovsk Region, Novosibirsk Region, Omsk Region, and Sakhalin Region.

The main characteristic of the cluster is the overlapping growth and sharp decline of the Index (more than 20 percentage points). Possible reasons are probably external economic factors (sanctions) and the subsequent decline in investment attractiveness and reduction of state financing of some projects (growing deficit).

It is sufficient to examine the characteristics of the dynamics during three consecutive years (2022 → 2023 → 2024):

Kostroma Oblast (77.4 → 141.0 → 104.8);

Samara Region (91.1 → 128.0 → 107.8);

Moscow Region (96.2 → 132.6 → 95.1);

Kursk Oblast (72.3 → 124.1 → 95.9);

Karachay-Cherkess Republic (82.5 → 144.6 → 105.7).

Sakhalin Oblast vividly illustrates how tax incentives drove index growth pre-sanctions — via new oil and gas developments and enterprise-specific reliefs on the Kuril Islands, including income, property, land, and transport tax exemptions plus reduced insurance contributions — followed by a sharp investment contraction due to unlawful sanctions.

Cluster 1 exclusively features Chukotka AO, exhibiting highly volatile production indices in high-tech manufacturing sectors during 2022–2024. As noted earlier, this region and the corresponding cluster are the result of a statistical outlier and do not fully represent a full-fledged cluster. The dynamics also appear to be sufficiently broken. Cluster peculiarities are associated with anomalous jumps in values; such sharp jumps are unlikely without obvious reasons (e.g., unique investment projects or data errors).

Cluster 2 comprises multiple regions, including Karelia, Kaliningrad, Murmansk, Kabardino-Balkaria, Tyva, Primorsky Krai, and Amur Oblast. These areas exhibit distinct geographic or economic traits, such as border locations (e.g., Kaliningrad and Amur Oblasts) or specialized resource-driven sectors (e.g., Murmansk's Arctic-focused economy and Tyva's mining industry). The cluster's defining feature is consistent growth with minor fluctuations or a temporary 2023 dip followed by a 2024 recovery, resulting in a cumulative increase exceeding 20 percentage points over three years.

The dynamics can be characterized as follows, with subclusters identified:

1. Moderate growth:

• Republic of Karelia: from 77.8 in 2022 to 99.9in 2024 (28% growth over 2 years);

• Murmansk Oblast: from78.9 in 2022 to 94.5 in 2024 (20% growth over 2 years);

• Kaliningrad Oblast:57.1% in 2022 (the lowest value among the cluster),2024: 103.7% (recovery to the average level);

• Amur Oblast: from 83.4 in 2022 to 114.6 in 2024(37% growth over 2 years).

2. Instability:

• Kabardino-Balkar Republic: Decrease in 2023 (from 90.7 in 2022 to 80.4 in 2023), then increase in 2024 (to 107.8).

• Primorsky Krai: Sharp decline in 2023 (from 100.0 in 2022 to 68.8in 2023), then recovery in 2024 (to 115.1).

3. Anomalous figures:

• Republic of Tyva: in 2022: 6.5% (the lowest value among all regions), in 2024: 245.3% (a sharp jump, an increase of 38 times in 2 years).

Steady growth indicates stable development of high-tech industries (e.g., aircraft construction, IT sector).

Cluster 3 is the largest and includes the remaining 53 regions. The cluster is characterized by stable dynamism, with all regions of the cluster growing steadily or having insignificant index dips not exceeding 20 percentage points over three years in the aggregate and for each observed year in particular. At the same time, annual index growth values rarely rose or fell above 5 percentage points. Conditionally, the cluster can be called stagnant according to the level of development of the Production Index, which characterizes high-tech manufacturing types of economic activity.

Within a cluster, subclusters are also present:

1. Regions with sustained low growth, e.g.:

• Republic of Tatarstan (from 104.4 in 2022 to 118.6 in 2024);

• Krasnoyarsk Territory (from 99.2 in 2022 to 107.4 in 2024).

2. Regions with small unstable dynamics (2022 → 2023 → 2024), e.g.:

• Penza Oblast (104.5 → 117.7 → 98.9);

• Kurgan Oblast (113.8 → 120.6 → 115.7).

The subsequent analytical phase examines regional tax incentives within clusters, assessing their institutional relevance for the index reflecting high-tech industry development.

Thus, with regard to Cluster 0, it can be noted that there are special economic zones (SEZs) in Moscow and St. Petersburg, as well as in the Lipetsk region, but there are also SEZs in the Republic of Tatarstan, which fell into Cluster 3. Moreover, certain doubts about the exclusivity of the fiscal impact of the preferential treatment of SEZs may be present due to the age of these SEZs, but it is understandable that major investments were attracted to SEZs in 2022 (inclusive), after which there was a decline due to sanctions.

This conclusion is confirmed by the fact that Kaluga Oblast also has a free economic zone (FEZ), which implies preferential treatment for high-tech industries.

In total, the cluster regions have zones with preferential tax treatment for high-tech production:

1. In the Central Federal District:

• Voronezh region: Industrial Park "Novovoronezh" (not a FEZ, but supports industrial projects), Territory of advanced socio-economic development (TASED) "Voronezh", and 9 other industrial parks;

• Kostroma region: Industrial Park "Basic" in Kostroma (specializing in machine building and production of construction materials), "Volgorechensky", "Rabochiy Metallist", TASED "Galich";

• Kursk region: industrial parks "Ponyrevsky", "AgroPark" and others;

• Lipetsk Region: Special Economic Zone (SEZ) "Lipetsk," SEZ "Chaplyginsk," and over 10 strategically located industrial parks focused on metallurgy, machinery, and advanced manufacturing;

• Moscow Region and Moscow: Skolkovo SEZ (a high-tech innovation cluster), Technopolis Moscow SEZ, industrial parks in Yesipovo, Zhukovsky, Korolev, and Dubna SEZ (specializing in science-intensive industries);

• Tambov Oblast encompasses Tambov and Michurinsky TASED zones, an industrial park, and projects focused on agro-processing and light manufacturing;

• Tver Region: Zavidovo SEZ (a tourist-recreational zone), alongside over 5 TASEDs prioritizing logistics, food processing, and machinery.

2. Northwestern Federal District:

• Leningrad Region and St. Petersburg: Territorial Development Zone (TOESR) "Leningrad Region," over 10 industrial parks, and St. Petersburg Special Economic Zone of the Technical and Innovation Type (TVT SEZ) (specializing in export-oriented manufacturing).

3. Southern Federal District:

• Republic of Crimea and Sevastopol: 13 industrial parks, including zones in coastal and moun-

tainous areas to support tourism-linked industries and agricultural exports;

• Volgograd Region: Volgograd TASED, 13 industrial parks with a focus on energy infrastructure, heavy machinery, and logistics;

• Karachay-Cherkess Republic: Agro-industrial Park (targeting agricultural exports and food processing);

• Republic of North Ossetia-Alania: 3 industrial parks specializing in food processing and small-scale manufacturing.

4. Volga Federal District:

• Republic of Mari El: Southern Industrial District industrial park (specializing in wood processing and chemical industries);

• Udmurt Republic: Glazov TASED, Sarapul industrial park, and over 10 sites supporting small and medium-sized enterprises (SMEs), machinery, and IT-enabled manufacturing;

• Chuvash Republic: TASED "Kanash", more than 10 industrial parks;

• Samara Region: Togliatti TASED, AvtoVAZ and Chapaevsk industrial parks, etc.;

• Ulyanovsk region: "Ulyanovsk" SEZ production type (PT), more than 10 industrial parks.

5. Ural Federal District:

• Sverdlovsk region: Titanium Valley SEZ — a specialized hub for aerospace, metallurgy, and high-tech manufacturing — alongside over 20 industrial parks, including the Ural Industrial-Industrial Park (UIIP), which supports SMEs and export-oriented production.

6. Siberian Federal District:

• Novosibirsk Region: SEZ "Novosibirsk" (under development during the study period), paired with TASED zones and more than 20 industrial parks. This region emphasizes information technology (IT), biotechnology, and innovation clusters, leveraging its proximity to Akademgorodok (a major scientific center);

• Omsk Region: Omsky Industrial Park, five additional sites, and Avangard SEZ — a strategic zone focused on heavy industry, petrochemicals, and logistics. The region also serves as a critical transport hub connecting Siberia to Central Asia and Europe.

7. Far Eastern Federal District:

• Sakhalin Oblast: "Mountain Air" TASED and six more industrial parks, SEZ on the Kuril Islands.

As the data reveal, the majority of Cluster 0 regions are predominantly concentrated in the European part of the Russian Federation. This geographic pattern highlights the critical role of institutional frameworks, particularly human capital characterized by skilled labor access, educational infrastructure, and innovation ecosystems. Such concentration may also reflect historical advantages in urbanization and industrial development, distinguishing these regions from those in Siberia or the Far East, where economic growth is often driven by natural resources rather than human potential. The regions are among the most populated, close to major scientific and financial centers, and do not present infrastructural difficulties for the relocation of trained personnel.

There is only one region in Cluster 1 — Chukotka AO. This region has no TASEDs and only two industrial parks: Beringovsky and Anadyr. At the same time, the region is located in the Arctic Zone of the Russian Federation (AZRF) — the largest special economic zone in the world. The special feature of the AZRF is a 50% deduction of the current tax rate applicable to new solid mineral deposits.

At the same time, the economic problems of the Chukotka Autonomous Okrug in 2023 were of a complex nature:

• climate change, destruction of infrastructure due to permafrost erosion;

• renewable energy and fish processing projects (e.g., the creation of the Beringovsky TOR) have faced delays in financing and technology supply;

• fall in investment in the mining sector: sanctions against Russian companies involved in the extraction of gold, coal and rare earth metals (e.g., Tenkergin and Sopka Rudnaya deposits) led to a 15–20% drop in production volumes. Foreign equipment required for deep processing became unavailable;

• decrease in subsidies from the federal budget. In the conditions of deficit of federal funds for 2024, the funding of Chukotka AO was reduced by 8%;

• due to the high cost of energy and logistics, small businesses (especially in trade and services) are losing money. In 2024, the number of closed trade organizations increased by 12%.

At the same time, as early as 2024, auctions for the purchase of deposits with development prospects of up to 25–30 years were held, which were favorable for subsoil users. Rusnano invested in projects for the production of components for wind

farms in the Far North, and Rosatom projects were developing. In particular, Rosatom discovered in Chukotka the largest gold reserves in Russia since 1991 ("Sovinoye" deposit). Rosatom and Chukotka AO are planning projects to develop energy infrastructure, landing strips, highways, sea berth, as well as construction of the world's first nuclear power plant of small capacity (ASMM) with a Shelf-M reactor plant with a capacity of up to 10 MW.[2]

Cluster 2 includes regions remote from federal centers (cities of federal significance). At the same time, TASEDs and SEZs are also active on the territory of the regions:

• Republic of Karelia, Murmansk region: part of the SEZs located in the territory of the AZRF include industrial parks "Karelia", "Nadvoitsy", "Petrozavodskmash", SEZ PT "Murmansk", "Monchegorsk", "Alakurtti". The regions are rich in minerals and renewable resources;

• Kaliningrad Oblast: over 10 industrial parks, including the strategically vital SEZ "Kaliningrad" (Russia's only ice-free Baltic port), which facilitates maritime trade and logistics. The region also benefits from Free Customs Zone procedures and the Special Administrative Region (SAR) "Oktyabrsky Island", designed to attract foreign investment through tax incentives and streamlined regulations;

• Kabardino-Balkarian Republic: home to a Tourist and Recreational Special Economic Zone (TR SEZ) spanning the Elbrus and Zolsky districts. This zone leverages the region's mountainous landscapes and alpine tourism potential, aiming to develop eco-tourism, hospitality infrastructure, and outdoor recreation industries;

• Republic of Tyva: features industrial parks "AgroTyva" (focused on agricultural processing) and "Kyzyl" (logistics and trade), alongside the conceptual SEZ "Khandagaity" project at the Mongolia border. This initiative aims to capitalize on transboundary trade routes and natural resource exports (e.g., minerals) to strengthen economic ties with countries of Asia;

• Primorsky Krai hosts the Vladivostok SEZ, seven industrial parks, the Free Port of Vladivostok (a pivotal Asia-Pacific trade hub), and the Russky Island Special Administrative Region, housing the Russky Innovation Science and Technology Center. This cluster emphasizes international collaboration, high-tech industries, and marine research, positioning the region as a technology and innovation hub for the Far East;

• Amur Region: 6 industrial parks, Amurskaya Territory of advanced development (TAD).

Notably, the cluster demonstrating the most significant recovery growth during the sanctions period encompassed regions featuring Special Administrative Regions (SARs). These zones were established to attract transnational corporate holding entities by excluding specific income and expense items from the profit tax base of International holding companies (IHCs). Exemptions included:

• Gains or losses from exchange rate fluctuations on foreign currency assets, receivables, and payables (excluding foreign-denominated securities).

• Earnings or costs from geological exploration, mineral extraction, and related activities under international agreements (e.g., production sharing, concessions, licenses) with foreign governments, subject to specified conditions. Additionally, the profits of Controlled Foreign Company (CFC) are tax-exempt at the International holding companies (IHCs) level under the international tax treaty of the Russian Federation, excluding states (territories) that do not provide information exchange for tax purposes with the Russian Federation.

Analysis of Cluster 3's institutional features identifies the absence of a homogeneous tax regime among its regions. This cluster comprises the Smolensk Region, home to SEZ "Stabna," and the Republic of Sakha (Yakutia), located within the Arctic zone of the Russian Federation. It also includes the Vladimir Region with SEZ "Vladimir," as well as the Irkutsk Region, Krasnoyarsk Krai, Tyumen Region, and Magadan Region — all characterized by substantial natural resource reserves. Additionally, the cluster encompasses the concept of border regions: the Jewish Autonomous Oblast and the territories of Khabarovsk Krai, Kamchatka Krai, and Zabaikalsky Krai, which currently lack free port zones or SEZs but host industrial parks and TADs.

The key institutional drivers for high-tech production growth in Russian regions include:

• Targeted tax incentives and regulatory mechanisms encompassing economic zones with tailored conditions, duty-free customs areas, Ad-

[2] Rosatom discovered the largest gold reserves in Russia since 1991 in Chukotka. URL: https://www.vedomosti.ru/business/articles/2024/01/12/1014823-rosatom-otkril-zolota?from=copy_text (accessed on 25.03.2025).

vanced Development Territories, and industrial clusters;

• Workforce accessibility and potential for human capital enhancement;

• Financial allure of the region, amplified by its strategic proximity to federal administrative hubs and enhanced accessibility to centralized governance structures. This geographic advantage supports streamlined regulatory engagement, improved infrastructure connectivity, and greater alignment with national policy initiatives;

• The presence of promising mineral reserves or strategic geographic positioning along key trade and logistics corridors are crucial factors. Apparently, it is the presence of factors related to human capital and the presence of a special tax and customs climate for doing business that became decisive in the distribution of regions into clusters according to the Production Index. Establishing a supportive institutional environment for tax incentives targeting technological sovereignty enables tax mechanisms to effectively foster innovation across Russian regions, strengthening national technological sovereignty.

Analysis of the regulatory framework of regional clusters. An analysis of the legal framework for tax incentives in Russian regions reveals significant divergence in approaches to stimulating technological development. Across the identified clusters, regions employ diverse tax mechanisms, including tailored income tax rates, property and transport tax incentives, and benefits for enterprises in Special Economic Zones (SEZs), Priority Development Areas (PDAs), Priority Social and Economic Development Areas (PSEDAs), and Special Administrative Regions (SARs).

As can be seen from *Table 3*, the most comprehensive tax incentive systems are found in the regions of Cluster 0, home to the country's main industrial and innovation centers. These regions actively utilize both federal instruments (SEZs, PDAs, and PEDAs) and their own regional incentives. In Cluster 3, which encompasses the majority of Russian regions, the legal framework is less uniform but includes some effective mechanisms to support high-tech production. Regional legislation places particular emphasis on tax incentives for investment activities and support for small and medium-sized businesses. In Cluster 2 regions, which demonstrate sustainable growth in high-tech industries, federal support instruments (SEZs, priority development areas, and regional administrative areas) predominate, while regional tax incentives are complementary.

The analysis demonstrates that Cluster 0 regions feature the most advanced regulatory systems for technological advancement, employing comprehensive tax incentives across regional and federal tiers. In Cluster 3, regional regulations prioritize individual investment initiatives and small business growth, with federal mechanisms such as SEZs, priority development zones, and the Arctic zone serving as critical drivers for investment attraction. Clusters 1 and 2 rely more heavily on federal support instruments (the Arctic zone, SEZs, priority development areas, unified administrative areas, and the Free Port of Vladivostok), demonstrating the strategic importance of these regions for the national economy. Furthermore, all clusters demonstrate a trend toward establishing reduced corporate income tax rates and property tax exemptions for organizations implementing investment projects in priority economic sectors.

Comparison with international experience. Russia's tax incentive framework for technological sovereignty, encompassing SEZs, Special Investment Contracts, and regional tax regimes, exhibits parallels and significant distinctions compared to global standards. An analysis of international experience shows that most developed and developing countries actively use specialized tax instruments to attract investment in high-tech sectors of the economy.

Russia's territorial tax regime contrasts with global practices emphasizing sector-specific and functional incentives, such as R&D tax credits, patent box systems for intellectual property income, and innovation-oriented tax deductions. The so-called Patent Box, which is used in 13 of the 27 European Union (EU) countries and provides preferential taxation of intellectual property income, holds a special place in international practice. This mechanism is not prominently featured in the Russian tax system but is widely used in the United Kingdom (UK), the Netherlands, Luxembourg, and Belgium.

Russian SEZs and TADs have much in common with China's special economic zones, the United Arab Emirates' (UAE) free zones, and Taiwan's science parks. However, their foreign counterparts often offer longer-term tax incentives, including a complete exemption from corporate income tax for up to 10–15 years. A comparative analysis of international tax regimes for stimulating technological development is presented in the following *Table 4*.

Table 3

Analysis of the regulatory framework for tax incentives and preferences in benchmark regions within clusters

Cluster	Region	Description of the norm content
0	Kostroma Oblast	Regional laws establish preferential property tax rates (up to 0.1%) and transport tax for certain categories of taxpayers, as well as a reduced income tax rate (13.5%) for organizations implementing investment projects. Residents of the Galich Priority Social and Economic Development Area (PSEDA) are granted benefits on insurance premiums, income tax, property tax, and land tax[1]
	Samara Oblast	Regional laws provide for property tax breaks for organizations implementing investment projects, as well as a 15.5% corporate income tax rate for organizations. SEZ residents are entitled to tax breaks on corporate income tax, property tax, land tax, and transport tax[2]
1	Chukotka Autonomous Okrug	Special support measures for the Arctic zone: a mineral extraction tax rate of up to 0.5% of the current rate, tax breaks on profit taxes, land and property taxes, benefits on insurance premiums, a simplified tax system, and other taxes[3]
2	Kaliningrad Oblast	The Kaliningrad SEZ offers tax breaks on profit, property, land, and transport taxes. Oktyabrsky Island offers a special administrative regime with a 0% profit tax for transnational corporations (TNCs)[4]
	Primorsky Krai	Residents of the priority development areas and the Free Port of Vladivostok enjoy tax breaks on insurance premiums, income taxes, property taxes, and land taxes, and enjoy a special customs regime. On Russky Island, there is a 0% profit tax for TNCs[5]
3	Republic of Khakassia	5% tax rate for IT organizations under the simplified tax system. Land and property tax breaks[6]
	Krasnoyarsk Krai	0% property tax for organizations implementing investment projects in priority economic sectors. Income, land, and property tax breaks for residents of the Special Economic Zone (SEZ) and the Arctic Zone[7]

Source: Compiled by the authors.

[1] Law of Kostroma Oblast of 24.11.2003 No. 153-ZO. On Property Tax of Organizations in the Territory of Kostroma Oblast. URL: https://www.nalog.gov.ru/rn44/about_fts/docs/5852697/?ysclid=lrrjyg999f135315736 (accessed on 25.05.2025); Law of Kostroma Oblast of 28.11.2002 No. 80-ZKO. On Transport Tax. URL: https://www.nalog.gov.ru/rn44/about_fts/docs/7263807/ (accessed on 25.05.2025); Law of Kostroma Oblast dated 29.12.2011 No. 172–5-ZKO. On a Reduced Tax Rate for Corporate Income Tax for Certain Categories of Taxpayers. URL: https://www.nalog.gov.ru/rn44/about_fts/docs/6955148/ (accessed on 11.08.2025); Law of Kostroma Oblast dated 20.04.2019 No. 545–6-ZKO. On Establishing a Reduced Tax Rate for Corporate Income Tax, Subject to Transfer to the Regional Budget, for Organizations That Have Received the Status of a Resident of an Advanced Development Area Created on the Territory of a Single-Industry Municipal Formation of Kostroma Oblast (Single-Industry Town)" (as amended on 24.10.2022 No. 278–7-ZKO). URL: https://www.nalog.gov.ru/rn44/about_fts/docs/10399712/ (accessed on 11.08.2025).

[2] Law of Samara Oblast of 25.11.2003. On the Tax on Property of Organizations in the Territory of Samara Oblast. URL: https://www.nalog.gov.ru/rn63/about_fts/docs/4472960/ (accessed on 11.08.2025); Law of Samara Oblast of 07.11.2005. On Reduced Rates of Tax on the Income of Organizations Transferred to the Regional Budget. No. 187-GD (as amended on 27.12.2023 No. 121-GD) // FTS: documents. URL: https://www.nalog.gov.ru/rn63/about_fts/docs/4472959/?ysclid=lrrkhuig9p659637580 (accessed on 11.08.2025); RF Government Resolution of 12.08.2010 N 621 (as amended on 03.06.2020) On the establishment of a special economic zone of an industrial and production type in the Samara Region. ConsultantPlus: reference and legal system. URL: https://www.consultant.ru/document/cons_doc_LAW_103657/92d969e26a4326c5d02fa79b8f9cf4994ee5633b/ (accessed on 11.08.2025).

[3] Federal Law On State Support for Entrepreneurial Activity in the Arctic Zone of the Russian Federation dated 13.07.2020 N 193-FZ. ConsultantPlus: reference and legal system. URL: https://www.consultant.ru/document/cons_doc_LAW_357078/ (accessed on 11.08.2025); Law dated 18.05.2015 N 47-OZ. On Certain Issues of Tax Regulation in the Chukotka Autonomous Okrug. FTS: documents. URL: https://www.nalog.gov.ru/rn87/about_fts/docs/5576459/ (accessed on 11.08.2025).

[4] Federal Law On Special Administrative Regions in the Territories of the Kaliningrad Region and Primorsky Krai dated 03.08.2018 N 291-FZ. ConsultantPlus: reference and legal system. URL: https://www.consultant.ru/document/cons_doc_LAW_304082/ (accessed on 11.08.2025); Federal Law On Special Economic Zones in the Russian Federation dated 22.07.2005 N 116-FZ // ConsultantPlus: reference and legal system. URL: https://www.consultant.ru/document/cons_doc_LAW_54599/ (accessed on 11.08.2025).

[5] Federal Law On the Territories of Advanced Development in the Russian Federation dated 29.12.2014 N 473-FZ. ConsultantPlus: reference and legal system. URL: https://www.consultant.ru/document/cons_doc_LAW_172962/ (accessed on 11.08.2025); Federal Law On Special Administrative Regions in the Territories of the Kaliningrad Region and Primorsky Krai dated 03.08.2018 N 291-FZ. ConsultantPlus: reference and legal system. URL: https://www.consultant.ru/document/cons_doc_LAW_304082/ (accessed on 11.08.2025); Federal Law of July 13, 2015. No. 212-FZ. On the Free Port of Vladivostok. ConsultantPlus: legal reference system. URL: https://www.consultant.ru/document/cons_doc_LAW_182596/ (accessed on 25.08.2025).

[6] Law of the Republic of Khakassia of 16.11.2009 No. 123-ZRH. On the tax rate when applying the simplified taxation system. FTS: documents. URL: https://www.nalog.gov.ru/rn19/about_fts/docs/5574747/ (accessed on 06.08.2025); Law of the Republic of Khakassia of 25.11.2002 No. 66. On transport tax // FTS: documents. URL: https://www.nalog.gov.ru/rn19/about_fts/docs/5600327/ (accessed on 06.08.2025).

[7] Law of Krasnoyarsk Krai dated 16.03.2023. No. 5–1641. On the Tax on the Property of Organizations // ConsultantPlus: reference and legal system. URL: https://www.consultant.ru/regbase/cgi/online.cgi?req=doc&base=RLAW123&n=306677#57OX9xUgZlbP1YOX1 (accessed on 25.08. 2025). Federal Law on Special Economic Zones in the Russian Federation dated 22.07. 2005, N 116-FZ. ConsultantPlus: reference and legal system. URL: https://www.consultant.ru/document/cons_doc_LAW_54599/ (accessed on 11.08.2025); Federal Law On State Support for Entrepreneurial Activity in the Arctic Zone of the Russian Federation dated 13.07.2020, N 193-FZ. ConsultantPlus: reference and legal system. URL: https://www.consultant.ru/document/cons_doc_LAW_357078/ (accessed on 11.08.2025).

An analysis of international experience indicates that the Russian system of tax incentives for technological sovereignty has its advantages, including a comprehensive approach to the development of territories and industries. However, to enhance the effectiveness of existing mechanisms, it would be advisable to consider implementing certain elements of international practice, such as strengthening the role of the "Patent Box" to stimulate the commercialization of intellectual property, extending tax holidays for residents of special economic zones and priority development areas, and strengthening tax incentives for R&D, similar to those used in Singapore and the UAE.

The Russian and Chinese models as export-driven developing economies may not inherently complement each other due to divergent technology transfer environments and domestic institutional frameworks for high-tech production. However, this does not exclude Russia's potential for implementing broader, sustained regional income tax incentives. Developing nations also demonstrate a distinct advantage in deploying diverse incentives to advance high-tech sectors. For example, it can be noted that the EU and the US are much slower in developing possible tax incentives for high-tech industries, which may lead to a deterioration in the competitive status of companies from these jurisdictions.

Theoretical implications and policy perspective. Achieving technological sovereignty requires favorable institutional conditions — norms and rules shaping economic behavior. Modern tax regulation advances technological progress through three core elements: targeted taxation for technology-focused enterprises, adaptive mechanisms for economic shifts, and transparent benefit criteria that cultivate trust.

Tax tools range from traditional incentives (e.g., tax holidays) to specialized mechanisms for talent and tech transfer, with regional regimes combining fiscal benefits and cluster infrastructure. These measures enhance technological sovereignty by freeing resources for R&D investment, boosting high-tech employment, and fostering self-sufficient regional ecosystems that reduce foreign dependency. Cluster-focused tax policies accelerate innovation by bridging businesses and research institutions, speeding up tech commercialization. However, their effectiveness hinges on careful design tailored to local needs, enabling synergy and rapid growth in the innovation economy.

The establishment of an optimal institutional framework for tax incentives supporting technological sovereignty is achieved through a comprehensive suite of tax mechanisms:

- R&D support via targeted tax incentives;
- preferential treatment for enterprises in special economic and technology innovation zones;
- expanded tax deduction capabilities;
- accelerated depreciation for science-intensive assets to expedite write-offs of critical R&D and high-tech production infrastructure;
- enhanced depreciation allowances for advanced machinery and technologies to drive private-sector innovation investment;
- reduced corporate tax rates for small high-tech firms to boost competitiveness in emerging markets;
- R&D tax credits enabling expense deductions from taxable income, reducing operational costs;
- customs exemptions and VAT relief for high-tech imports, including duty-free equipment lists and VAT refunds for robotics, microelectronics, and advanced manufacturing components;
- full corporate tax exemption on R&D-derived revenues to encourage sustained innovation and technology transfer investments;
- temporary tax holidays for science and technology startups, offering partial exemptions during early stages to foster entrepreneurship and scaling;
- venture capital stimulation tools;
- state-business collaboration through public-private partnerships and additional tax mechanisms.

These policies foster synergy among innovation stakeholders, speeding up commercialization and market entry of new technologies.

Tax incentives — including property and corporate tax exemptions for specific entities, targeted tax breaks, and investment tax credits — are employed to enhance investment in high-tech innovation projects. Paragraph 7 of Article 262 of the Tax Code of the Russian Federation suggests the possibility of reducing the tax basefor corporate income tax for business entities engaged in scientific and technological research and development.[3]

[3] Resolution of the Government of the Russian Federation of 29.10.2024 No. 1444. On Amendments to Certain Acts of the Government of the Russian Federation. URL: https://www.consultant.ru/law/hotdocs/86833.html (accessed on 25.03.2025).

Table 4

Summary of international tax practice of regional tax regimes for encouraging innovation

Country	Special tax regime	Description
China	Special economic zones (SEZs) and industry-specific exemptions for high-tech companies	A preferential 15% income tax rate instead of 25%, value added tax (VAT) exemption for technology transfer, and tax holidays for up to 5–10 years for SEZ residents[1]
Taiwan	Science parks (Hsinchu Science Park, Central Taiwan Science Park)	0% income tax for 5 years, exemption from customs duties and VAT on imported equipment, tax breaks for exporting companies[2]
Singapore	Enterprise Innovation Scheme (EIS) for full-service companies in Singapore	400% tax deduction on R&D expenses per year, 100% tax exemption for startups on the first S$ 100,000 of income[3]
USA	Federal R&D Tax Credit, state-specific Patent Box credits (Massachusetts, California).	R&D Tax Credit, Alternative Simplified Credit, Energy Research Credit[4]
EU countries	Patent Box	Lower corporate tax rate on income from intellectual property, tax credits and deductions for R&D, accelerated depreciation of assets[5]
United Kingdom	Patent Box	Corporate tax of 10% on income from patents and other intellectual assets developed by the company[6]
UAE	Free Zones	0% corporate tax on "qualifying income", exemption from import and export duties, no exchange controls[7]
Malaysia	Multimedia Super Corridor (MSC Malaysia)	Income tax exemption for 10 years or 100% investment tax deduction for 5 years, exemption from customs duties and sales tax on IT equipment[8]
Israel	Development zones	7.5% corporate income tax for companies in development zones, tax exemption on interest payments made by Israeli high-tech companies to foreign financial institutions[9]

Source: Compiled by the authors.

[1] Ivanova I.A., Gershman M.A., Brambila Martinez F.H. Tax incentives for science and innovation in China. URL: https://issek.hse.ru/news/1032004690.html (accessed on 03.25.2025).

[2] Central Taiwan Science Park. Investment incentives. URL: https://www.ctsp.gov.tw/english/01about/abo_incentive_measures.aspx?v=20&fr=1142&no=1148 (accessed on 03.25.2025).

[3] Inland Revenue Authority of Singapore. Enterprise Innovation Scheme (EIS) URL: https://www.iras.gov.sg/schemes/disbursement-schemes/enterprise-innovation-scheme- (accessed on 03.25.2025).

[4] OECD. United States — Inno Tax. URL: https://stip.oecd.org/innotax/countries/UnitedStates (accessed on 25.03.2025).

[5] Proposal for a Regulation of the European Parliament and of the Council Establishing a Framework *of* Measures for Strengthening Europe's Semiconductor Ecosystem (Chips Act), COM/2022/46 Final. URL: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:52022PC 0046 (accessed on 25.03.2025).

[6] HM Revenue & Customs. Use the Patent Box to Reduce Your Corporation Tax on Profits. URL: https://www.gov.uk/guidance/corporation-tax-the-patent-box (accessed on 25.03.2025).

[7] UAE Federal Tax Authority. Basic Tax Information Bulletin: Free Zone Persons. URL: https://tax.gov.ae/Datafolder/Files/Pdf/2024/CT%20Bulletin/Basic%20Tax%20Information%20bulletin-%20Free%20Zone%20Person-English.pdf (accessed on 25.03.2025).

[8] Malaysia Digital Economy Corporation (MDEC). Guidelines on Malaysia Digital (MD) Tax Incentive. URL: https://mdec.my/static/pdf/malaysiadigital/20250709%20Published%20Guidelines%20on%20MD%20Tax%20Incentive%20(Expansion).pdf (accessed on 25.03.2025).

[9] PwC. Israel — Corporate — Tax Credits and Incentives. URL: https://taxsummaries.pwc.com/israel/corporate/tax-credits-and-incentives (accessed on 25.03.2025).

The geographical concentration of innovative companies in zones with special tax conditions contributes to the formation of self-developing ecosystems, which directly affects the reduction of dependence on foreign technologies. Tax advantages for Special Economic Zone (SEZ) residents feature complete relief from property, transport, and land taxes; corporate profit tax rates are cut to 2% (federal) and 0% (regional) for the initial five-year operational phase across zones like Technopolis Moscow, Dubna, Alabuga, Lipetsk, St. Petersburg, and Innopolis. Innopolis implements a tiered structure: 5% for four subsequent periods followed by 13.5% for ten. Additional perks include subsidized land leases, duty-free raw material imports for production and export, and reduced insurance contributions, driving investment inflows, cutting operational costs, and accelerating project profitability.

Investment tax deductions reduce taxable income by amounts spent on assets (equipment, facilities) and production upgrades. For example, IT firms can deduct 3% of income when investing in R&D, lowering profit taxes. "Yandex" applied investment tax deductions to lower its taxable base for AI algorithm development. Determines the parameters[4] of the application of the federal investment tax deduction of 3% of expenses when investing funds in research and development.

Article 259.3 (paragraph 2) of Russia's Tax Code allows applying a 3x accelerated depreciation coefficient for R&D-related assets and software registered in the national database.

Under Article 258 of Russia's Tax Code, bonus depreciation enables firms to deduct up to 30% of fixed asset costs (3–20-year useful life) from taxable income, driving production modernization, enhancing investment appeal, and accelerating technological advancement through capital reallocation.

A special reduced rate of tax on profits of organizations is provided for small technology companies.[5] In the period up to 2030, constituent entities of the Russian Federation have the right to establish a reduced rate for tax credited to the regional budget. Under regional support programs, companies may receive a subsidy to compensate for part of the costs of modernizing production — up to 50% of confirmed costs.[6]

Russia's Tax Code Article 67 outlines investment tax credits as deferred payment mechanisms for companies conducting R&D, production upgrades, or innovation projects. This tool helps businesses redirect funds from tax obligations to modernization efforts, particularly benefiting tech startups and material science ventures requiring upfront capital.

Customs privileges for technology imports involve expanding the list of technological equipment that can be imported into the territory of the Russian Federation VAT-free, except for VAT refunds on imports of components for robotics and microelectronics. These incentives allowed "Mikron" to reduce its expenditures on the purchase of foreign equipment by up to 15%.

Startups within the Skolkovo and VEB.RF programs, along with R&D project participants, can benefit from tax holidays featuring a decade-long corporate income tax exemption and VAT exemption on innovative product sales.

There are also tax mechanisms that incentivize venture capital investments in promising startups and companies expecting to receive high income in the future through business expansion. Based on paragraphs 17.2 and 17.2–1 of Article 217 of the Tax Code of the Russian Federation, until 2027 residents are exempt from personal income tax on income from the sale of securities of the high-tech (innovation) sector of the economy in the amount of the tax base up to 50 million rubles. For an investor, profits from the sale of shares and stakes in Russian companies are taxed at 0% if they have been in his ownership for more than 5 years.

Public-private partnerships (PPPs) in Russia leverage state resources and business efficiency for large-scale projects. In Moscow, integrated transport hubs involve private operators with guaranteed ROI models, while sewage treatment plants utilize 5-year tax holidays to offset innovative tech

[4] Resolution of the Government of the Russian Federation of 28.11.2024 No. 1638. On the parameters of application of the federal investment tax deduction. URL: https://www.consultant.ru/law/hotdocs/87212.html (accessed on 25.03.2025).

[5] In accordance with the Federal Law No. 478-FZ dated 04.08.2023. On the development of technology companies in the Russian Federation. URL: https://www.consultant.ru/document/cons_doc_LAW_454055/ (accessed on 25.03.2025).

[6] More than 200 Moscow Region SMEs received subsidies for production modernization this year. URL: https://mosreg.ru/sobytiya/novosti/news-submoscow/bolee-200-podmoskovnykh-msp-poluchili-subsidiyu-na-modernizaciyu-proizvodstva-v-etom-godu?utm_referrer=https%3A%2F%2Fwww.google.com%2F (accessed on 25.03.2025).

costs. Regional fiscal tools vary: Skolkovo Innovation Center offers 10-year income tax deferrals and accelerated R&D equipment depreciation for startups. Kazan's medical complex ties property tax rates to free healthcare quotas. Sverdlovsk's Urals Engineering School links corporate tax deductions to graduate employment rates, creating an "education-production" cycle. Kaluga SEZ combines 5-year profit tax exemptions with enhanced depreciation for digitalized equipment, fostering industrial modernization.

Conclusion

The main results of the study confirm that effective tax regulation can become a strategic catalyst for technological progress and economic independence. The creation of clear and stable rules of tax preferences for innovative companies can significantly increase the level of business confidence. This promotes long-term investment in R&D and technological modernization. Targeted tax regimes for startups and residents of specialized zones create competitive advantages by providing access to necessary resources and infrastructure, forming self-developing ecosystems that promote the growth of high technologies. Implementing hybrid public-private collaboration frameworks with tax incentives for co-financing innovation projects minimizes financial risks and strengthens business-scientific partnerships. Digitalization of administrative procedures significantly reduces bureaucratic burdens on firms, optimizing tax instrument deployment. Harmonizing national tax laws with global standards creates new pathways for integration into worldwide innovation ecosystems. This study emphasizes the need for a systematic approach to tax regulation, which will ensure long-term competitive advantages and reduce dependence on foreign technologies.

The scientific novelty of the presented research lies in the development and application of a comprehensive methodological approach that integrates systematic-structural analysis of the regulatory and legal framework with empirical cluster analysis of regional data. Unlike existing studies, where tax instruments and the institutional environment are examined separately, this research proposes an integrated model that establishes a direct connection between specific tax mechanisms and actual outcomes in the development of technological sovereignty at the regional level. The application of cluster analysis using the Python software tool for processing Rosstat data from 85 regions for 2022–2024 not only enabled the identification of regional typology based on the level of high-tech production development but also determined which specific combinations of tax instruments exert the most significant influence on technological growth in different regional contexts. A particularly valuable methodological aspect is the data normalization procedure that accounts for statistical outliers, which allowed avoiding distortions in result interpretation and obtaining a more accurate picture of regional development trajectories.

The theoretical significance of the research lies in the creation of a conceptual foundation for understanding the mechanisms of interaction between tax instruments and technological sovereignty under sanction pressure. For the first time, a model has been proposed and empirically validated, demonstrating how four critical components — regulatory transparency and global standard alignment, innovation ecosystem maturity, public-private collaborative frameworks, and digitized tax procedures — collectively form a favorable institutional environment for tax incentives supporting technological sovereignty.

The practical significance of the results is manifested in specific recommendations for regions of different clusters: regions from Cluster 0 should focus on stabilizing the tax environment after sanction shocks; Cluster 2 regions should concentrate on developing cross-border connections and utilizing special administrative regimes; Cluster 3 regions should prioritize modernizing existing instruments considering their resource specificity. The obtained data enable federal and regional authorities to purposefully adjust tax policy, enhancing its effectiveness in supporting technological sovereignty.

In terms of future research perspectives, it is advisable to deepen the analysis of causal relationships between specific tax instruments and indicators of technological development using regression analysis methods and econometric modeling. It is also necessary to expand the research time horizon by including data from a longer period to assess the long-term effects of tax incentives. A promising direction is the detailed study of the impact of individual tax instruments (such as investment

tax credits, bonus depreciation, and preferential rates for small technology companies) on various sectors of high-tech production. Additionally, research into the relationship between the level of digitalization of tax procedures and the speed of innovation implementation in regions is relevant, which will allow determining optimal pathways for integrating digital technologies into the tax system to support technological sovereignty. These directions will enable the creation of more precise recommendations for forming a comprehensive tax regulation system capable of effectively supporting the technological development of the Russian economy under external constraints.

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