

# Innovation Clusters as an Institutional Platform for Russia's Technological Sovereignty

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## Abstract

Amidst escalating geo-economic fragmentation, sanctions pressure, and constrained access to foreign technology, ensuring technological sovereignty has become a systemic imperative for the Russian Federation. The contemporary stage of global economic development is marked by a deepening of scientific and technological specialization alongside an increasing vulnerability of national economies to ruptures in global value chains. This context elevates the significance of institutional frameworks for innovation that can concentrate resources, stabilize technological pathways, and sustain critical domestic competencies. This article posits innovation clusters as a pivotal institutional platform, integrating the scientific, technological, productive, investment, and human capital necessary to forge and uphold Russia's technological sovereignty. The research provides a comprehensive analysis of the role of innovation clusters in ensuring technological independence by synthesizing institutional, evolutionary, and systemic approaches, analyzing statistical data, and reviewing Russian and international cluster development practices. Methodologically, it employs institutional, comparative, and statistical analysis, supplemented by elements of comparative research. The analysis demonstrates that while innovation clusters serve as a vital mechanism for orchestrating science-business-state interaction within a "triple helix" model, their potential in Russia remains underutilized due to institutional fragmentation, scarce long-term financing, and deficient horizontal linkages. The article advances the concept of a "sovereign innovation cluster"—a deliberately constructed institutional complex oriented toward establishing a closed or controlled national cycle for developing critical technologies.

## Keywords

Innovation Clusters, Technological Sovereignty, Institutional Platform, Innovation Policy, Industrial Policy, Regional Development, Global Value Chains

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## 1. Introduction

Innovation has emerged in the 21<sup>st</sup> century as the paramount driver of national economic competitiveness, shaping growth trajectories, employment structures, and socio-economic resilience (Aghion & Akcigit, 2022). For nations with advanced scientific and technological foundations, innovative activity is the principal engine of productivity gains and value creation. For the Russian Federation, the pursuit of innovation-led development carries an added dimension: the imperative to secure technological sovereignty against a backdrop of sanctions, restricted technology transfer, and a fragmenting global marketplace.

Here, technological sovereignty denotes a state's capacity to autonomously develop, manufacture, deploy, and govern technologies critical to its core economic sectors, national security, and societal stability. This concept shifts focus from the traditional paradigm of enhancing competitiveness within a globalized economy to prioritizing the resilience, reproducibility, and independence of domestic technological value chains.

Conventional tools of industrial and innovation policy—including state-owned corporations, dedicated research institutes, and targeted subsidy programs—often prove inadequate in an era characterized by heightened uncertainty and rapid technological change. Consequently, scholarly and policy interest has grown in networked and hybrid forms of innovation organization, with innovation clusters occupying a central position. Clusters are uniquely capable of bridging the strategic objectives of the state with the practical imperatives of business and the research community.

The contemporary salience of cluster policy in Russia stems from a confluence of external and internal factors reflecting recent structural economic shifts and institutional pressures. **Table 1** delineates the key factors accentuating the relevance of cluster policy in Russia, supported by quantitative indicators.

**Table 1.** Factors driving the salience of cluster policy in the Russian federation (2018-2024).

Factor	Core Issue	Quantitative Indicators
Sanctions Regime	Constrained access to advanced technologies	35% - 40% reduction in high-tech imports
Structural Economic Shift	Reorientation of the economic base	Manufacturing share rises to ~15% of GDP
Critical Import Dependence	Vulnerability in strategic sectors	Up to 70% reliance in microelectronics (2018)
Regional Innovation Disparity	High geographic concentration of R&D	>50% of national R&D expenditure in 5 regions
STEM Personnel Deficit	Shortage of qualified specialists	Gap estimated at ~1 million professionals

The data underscore how profound external constraints and internal structural weaknesses necessitate a reinforced institutional response centered on building

robust innovation infrastructure.

## 2. Research Methodology

The scholarly analysis of innovation clusters sits at the nexus of institutional theory (North, 1991), evolutionary economics, regional development studies, and innovation systems literature (Liu & White, 2001). The seminal Porterian framework emphasizes spatial agglomeration and competitive advantage derived from specialization and localized linkages (Porter, 1998). While foundational, this market-centric view proves insufficient for addressing the imperatives of technological sovereignty, which prioritizes national resilience over global market positioning.

An institutional lens reconceptualizes clusters as constellations of formal and informal rules, norms, and organizations that structure agent interaction, mitigate opportunism, and reduce transaction costs (North, 1991). Within this paradigm, clusters function as engines for building trust, accumulating tacit knowledge (Maskell & Malmberg, 1999), and fostering durable collaboration among academia, industry, and the state.

From an evolutionary standpoint, clusters are dynamic systems where technological trajectories are shaped by path dependencies, localized learning, and market selection (Aghion & Akcigit, 2022). The concept of local technological regimes is key, defining a cluster's specialization and its adaptive capacity in the face of external shocks.

A synthesized institutional-evolutionary-systemic perspective thus frames innovation clusters as meso-level formations facilitating the co-evolution of technology, institutions, and human capital (Scoralick De Almeida Tavares et al., 2021). **Table 2** provides a comparative overview of these core theoretical approaches.

Integrating these perspectives provides a multi-paradigmatic foundation for analyzing how clusters influence the stability and sustainability of technological

**Table 2.** Theoretical frameworks for analyzing innovation clusters.

Framework	Central Concepts	Key Scholars	Analytical Contribution
Porterian (Competitive)	Agglomeration, specialized rivalry	M. Porter	Sources of regional competitive advantage
Institutional	Rules, norms, transaction costs	D. North	Governance of cooperation and reduction of uncertainty
Evolutionary	Trajectories, path dependence, learning	R. Nelson, S. Winter	Dynamics of long-term technological change
Systemic (Innovation Systems)	Interactivity, knowledge flows	B.-Å. Lundvall	Role within broader national/regional innovation ecosystems
Regional/Economic Geography	Spatial proximity, untraded interdependencies	P. Krugman	Drivers of geographic concentration and growth

development. This study employs an interdisciplinary methodological framework, drawing on institutional economics, evolutionary theory, innovation systems analysis, and regional science. This synthesis is necessitated by the complex, multi-faceted nature of innovation clusters as simultaneously economic, institutional, spatial, and policy entities.

- Institutional Analysis examined clusters as systems of formal and informal rules, coordination mechanisms, and organizational structures that govern competence reproduction.
- Evolutionary Analysis traced the development of technological trajectories within clusters, emphasizing path dependencies, learning processes, and market selection.
- Systems Analysis, informed by national/regional innovation systems literature, positioned clusters as sub-systems within the broader national innovation architecture.

Empirically, the research draws on Russian federal statistics (Rosstat), analytical reports from the Higher School of Economics (HSE), national strategic planning documents, and international indices (e.g., WIPO's Global Innovation Index). Methods included comparative analysis, structural benchmarking, and qualitative case study analysis of selected Russian clusters, ensuring robust and replicable findings.

### 3. Results

#### 3.1. The Institutional Function of Clusters: A Platform for Sovereignty

Within institutional economics, innovation clusters act as platforms that foster stable mechanisms for aligning interests and distributing risk. The “Triple Helix” model (Ranga & Etzkowitz, 2013; Lupova-Henry & Dotti, 2021) conceptualizes this platform as an interactive space among government, industry, and academia. The state assumes the role of strategic integrator and visionary, business provides entrepreneurial drive and market discipline, and academia generates fundamental knowledge and new technologies.

For policymakers, clusters are instruments for implementing industrial and science & technology (S&T) strategy. For firms, they offer avenues to reduce costs, access shared infrastructure, and accelerate time-to-market. For research institutions, they provide channels for knowledge transfer and commercialization. In the pursuit of technological sovereignty, this function expands to include the critical tasks of localizing strategic technologies and mending fractured segments of the national value chain.

Effective institutional coordination and strategic human capital development are critical for amplifying innovative output within cluster ecosystems, as demonstrated in **Table 3**.

Building on institutional analysis, we can move beyond describing extant clusters to conceptualizing their directed evolution. A “sovereign innovation cluster” is

**Table 3.** Institutional functions and implementation mechanisms of innovation clusters.

Core Function	Implementation Instruments	Anticipated Economic Impact
Coordination & Governance	Cluster management organizations, research consortia	15% - 25% reduction in transaction costs for members
Knowledge Generation & Innovation	Collaborative R&D projects, incubators/accelerators	Increased patenting activity and radical innovation
Capital Mobilization	Dedicated venture funds, public-private partnerships (PPPs)	Leveraging of private investment into strategic sectors
Human Capital Development	University partnerships, specialized training programs, talent attraction initiatives	Enhanced skill base and reduced labor market mismatches
Shared Infrastructure Provision	Technology parks, shared labs, special economic zones (SEZs)	Lowered barriers to entry for SMEs and startups

proposed as a high-density, purposefully engineered institutional platform. Its primary objective is to establish a controlled or closed-loop national cycle for the creation, deployment, and diffusion of technologies deemed critical for sovereignty. This marks a fundamental shift in goal orientation—from maximizing market share to minimizing strategic technological dependencies.

Its defining characteristic is a deliberately intensified density of internal linkages, designed to offset the deterioration of international collaboration channels. This entails developing collective resources such as common technology funds, centers of shared research equipment, collaborative engineering and testing facilities, and financing mechanisms covering the full innovation cycle—approaches aligned with leading ecosystem management practices (Ministry of Economic Affairs and Employment of Finland, 2021; Ketels & Protsiv, 2021). The state's role evolves from a passive regulator to an active system architect and lead customer for sovereign technologies.

### 3.2. Cluster Development in Russia

Russia's cluster policy, formalized in the early 2010s, has led to the establishment of dozens of innovation and science & technology clusters of varying maturity, spanning key high-tech sectors. This landscape, however, is marked by pronounced geographic concentration, mirroring broader regional disparities in innovation capacity (Vysshaya Shkola Ekonomiki, 2021) and exacerbating risks of economic polarization—a phenomenon also observed elsewhere (Su et al., 2023). **Table 4** outlines the sectoral distribution of Russia's innovation clusters, revealing the contours of its current innovation ecosystem.

The notable concentration in IT and machinery underscores the need for a policy that balances support for existing strengths with strategic diversification into other critical technology domains.

Benchmarking reveals that world-leading innovation clusters are distinguished by high startup density, vibrant venture capital markets, and deeply institutionalized collaboration (WIPO, 2024; OECD, 2023). Russian clusters currently lag in scale and integration depth (Kotsemir et al., 2021). However, in a fragmenting global order, the value of robust internal institutional mechanisms increases significantly. **Table 5** offers a high-level comparison of key innovation metrics.

**Table 4.** Sectoral distribution of innovation clusters in Russia.

Sector	Share of Total Clusters (%)
Information Technology & Software	28
Biomedicine & Pharmaceuticals	17
Advanced Machinery & Robotics	19
New Materials & Chemical Technologies	14
Other (Energy, Aerospace, etc.)	22

**Table 5.** Comparative metrics: Russia, China and USA.

Indicator	Russia	China	USA
Gross Domestic Expenditure on R&D (GERD) as % of GDP	~1.1%	~2.6%	~3.4%
Annual Venture Capital Investment (USD billions)	<10	>70	>150
Number of Clusters in Global Top-100 Rankings	1	>15	>25

The disparities in R&D intensity and venture funding highlight structural gaps that hinder the integration of Russian clusters into premier global innovation networks. Despite policy backing, Russian innovation clusters confront persistent systemic barriers: fragmented governance, underdeveloped horizontal networks (Huber, 2011; Liu et al., 2022), a dearth of “patient” capital, and significant skill mismatches. **Table 6** summarizes these core constraints and their economic ramifications.

These institutional and human capital challenges constitute the principal impediments to translating cluster potential into tangible gains in technological sovereignty.

An examination of specific clusters reveals a mixed picture of promise and persistent challenges. The Skolkovo Innovation Center (Moscow) has amassed substantial resources and talent but remains critically reliant on direct state subsidies. In contrast, Innopolis (Tatarstan) and associated regional IT clusters demonstrate a more synergistic model integrating higher education, industry, and regional development policy. This analysis suggests that the absence of clearly articulated, long-term technological “missions” diminishes policy effectiveness, replacing substantive progress with box-ticking—a finding consistent with research on mission-oriented innovation policy (Remotti, 2021; Wang et al., 2025).

**Table 6.** Systemic barriers to cluster development in Russia.

Constraint	Root Causes	Likely Economic Consequences
Insufficient Risk Capital	Immature venture market, limited institutional investment	Constrained scaling of innovative firms, “valley of death” for startups
Specialized Talent Shortages	Outward migration (“brain drain”), misalignment of education with industry needs	Erosion of core competencies, slower technology adoption
Institutional & Coordination Failures	Legacy separation of academia from industry, weak intermediary organizations	Low rates of research commercialization, duplicated efforts
Pronounced Regional Disparities	Extreme concentration of financial and human resources in Moscow/St. Petersburg	Widening inter-regional innovation divide, underutilized provincial potential

### 3.3. Clusters as an Institutional Platform for Technological Sovereignty

An examination of specific clusters reveals a mixed picture of promise and persistent challenges. The Skolkovo Innovation Center (Moscow) has amassed substantial resources and talent but remains critically reliant on direct state subsidies. In contrast, Innopolis (Tatarstan) and associated regional IT clusters demonstrate a more synergistic model integrating higher education, industry, and regional development policy. This analysis suggests that the absence of clearly articulated, long-term technological “missions” diminishes policy effectiveness, replacing substantive progress with box-ticking—a finding consistent with research on mission-oriented innovation policy (Remotti, 2021; Wang et al., 2025). **Table 7** provides a snapshot of three prominent Russian clusters.

The cases illustrate divergent development models, varying significantly in

**Table 7.** Profile of selected Russian innovation clusters.

Cluster	Core Technological Focus	Approx. Number of Resident Entities	Estimated Employment	Notable Characteristics
Skolkovo	IT, Biomedicine, Energy Tech	>3000 (startups, companies)	>70,000	Flagship national project; high visibility, heavy state dependence
Innopolis	Information Technology, Robotics	>300 (IT companies, university)	>5000	“Company town” model with integrated university; strong regional government role
Kaluga Pharma Cluster	Pharmaceutical Manufacturing	>60 (production plants, R&D)	>12,000	Focused on import substitution in pharmaceuticals; production-oriented

their levels of integration, financial sustainability, and alignment with sovereign technological goals.

To amplify the contribution of clusters to technological sovereignty, policy must evolve from targeting quantitative outputs to enabling qualitative systemic transformation. This requires a focus on cultivating resilient innovation ecosystems (Asheim & Coenen, 2005) and executing a strategic, place-based industrial policy (Berger, 2013). Priority actions should include:

1) Adopting Mission-Oriented Governance: Defining and resourcing concrete, ambitious technological challenges (e.g., sovereign microprocessor platforms, next-generation drug discovery) to focus cluster activities.

2) Creating “Patient Capital” Institutions: Establishing state-backed, professionally managed funds with long-term horizons to finance high-risk, capital-intensive sovereign technology projects.

3) Empowering the State as a Lead Customer: Using public procurement strategically to create guaranteed early markets for cluster outputs, de-risking private investment.

4) Integrating Clusters into National Foresight: Aligning cluster roadmaps with long-term national S&T and security strategies.

These directions reflect international best practices in strategic innovation management (Ketels & Protsiv, 2021). **Table 8** summarizes these priority policy vectors.

**Table 8.** Strategic directions for cluster policy reform.

Policy Direction	Primary Objective
Implement Mission-Oriented Programming	Concentrate resources on solving pre-defined, sovereignty-critical technological challenges.
Foster Applied R&D Collaboration	Increase the commercialization rate of domestic research through incentivized industry-academia projects.
Launch Targeted Human Capital Initiatives	Mitigate skill deficits in critical STEM fields through tailored education and immigration pathways.

A strategic pivot toward mission-oriented governance and long-term applied R&D support is essential to align Russian cluster policy with global shifts in innovation strategy.

## 4. Discussion

The findings engage with several contemporary scholarly debates. They corroborate the innovation systems perspective that institutional connectivity, not merely R&D spending, is vital for innovation efficacy, highlighting how weak horizontal linkages in Russian clusters (Rud & Simachev, 2020) undermine sovereignty goals. The evidence also lends support to Mazzucato’s thesis on mission-oriented policy, revealing that a lack of clear technological missions in Russia leads to the subordination of substantive outcomes to procedural compliance.

Furthermore, the analysis intersects with Global Value Chain (GVC) theory, demonstrating that many Russian “import-substituting” clusters remain dependent on foreign technological cores, thus perpetuating peripheral status. This underscores the need for a policy of “strategic coupling” focused on controlled localization of critical chain segments rather than passive integration.

Finally, in line with Rodrik’s arguments for strategic industrial policy, the proposed “sovereign innovation cluster” model represents a form of institutional selectivity—a context-specific tool for navigating sanctions and technological decoupling.

Thus, the study extends existing theoretical frameworks by applying an institutional lens to the specific challenge of building technological sovereignty through clusters in the Russian context.

## 5. Conclusion

This research concludes that securing Russia’s technological sovereignty demands a paradigm shift in the perceived role of innovation clusters. They must be reconceptualized not merely as instruments for regional competitiveness but as foundational institutional platforms for constructing resilient, reproducible, and strategically autonomous national technological circuits.

While clusters possess inherent potential as coordinators and innovation accelerators, the Russian experience reveals systemic pathologies: institutional fragmentation, frail cooperation networks, a shortage of long-term capital, and embedded import dependencies. The concept of the “sovereign innovation cluster” addresses these flaws by explicitly prioritizing technological resilience over market efficiency. It envisions a state-facilitated, mission-driven complex, underpinned by patient finance, shared infrastructure, and the state’s active role as a system architect and lead customer.

The practical implications are direct: the findings and recommendations herein can inform the recalibration of Russia’s cluster, industrial, and S&T policies. They are applicable to regional development strategies, import substitution programs, and mechanisms for fostering collaborative R&D and high-tech workforce development.

In the long run, cultivating a networked constellation of sovereign innovation clusters could form the institutional backbone of a renewed national innovation system, endowing Russia with a sustainable capacity for autonomous technological advancement in an era of geopolitical rivalry and systemic uncertainty. Future research should focus on developing metrics for “cluster sovereignty” and empirically evaluating the performance of different institutional models for sovereign cluster governance.

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## Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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