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Institutional Factors and Knowledge Spillovers in Regional Innovation Systems: A Comparative Analysis of European and Russian Experience

Wang Yige

First-Year PhD Student,
Peoples' Friendship University of Russia,
117198, 6 Miklukho-Maklaya str., Moscow, Russian Federation;
e-mail: wangyige@rudn.ru

Abstract

This study examines the role of institutional environment and knowledge spillovers in the functioning of regional innovation systems (RIS). The research focuses on how formal institutions (legislation, funding mechanisms, intellectual property protection) and informal institutions (trust, entrepreneurial culture, collaboration norms) shape innovation performance at the regional level. Using a comparative approach, the paper analyzes the experience of selected European regions (Germany, Finland, Czech Republic) and Russian regions (Moscow, St. Petersburg, Kazan). The empirical analysis is based on secondary data from official statistics, regional innovation reports, and bibliometric indicators for the period 2015–2024. The results show that the sustainability of RIS depends not only on R&D spending but primarily on the quality of institutional coordination, the density of collaborative networks, and the effectiveness of knowledge diffusion between universities, firms, and public authorities. The study concludes that Russian regions face specific institutional barriers: weak intersectoral cooperation, administrative fragmentation, and insufficient incentives for long-term risky innovation. Policy recommendations focus on strengthening institutional coherence, developing intermediary organizations, and improving the targeting of public support for innovation.

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Keywords

Regional innovation system, institutional economics, knowledge spillovers, innovation policy, Russian regions, European experience.

Введение

Relevance of the Research

In modern economic theory, innovation is regarded as the main driver of long-term growth, structural transformation, and increase in competitiveness. The concept of national and regional innovation systems (RIS) has become central for understanding how economic agents interact, how knowledge is created and diffused, and how public policy can stimulate innovative activity.

The Russian economy is in a phase of transition toward a knowledge-based model. Despite significant state efforts to increase R&D funding, build innovation infrastructure (technoparks, innovation clusters, special economic zones), and support high-tech industries, the overall innovation performance remains uneven across regions and sectors. Many initiatives show low efficiency due to weak coordination, institutional gaps, and insufficient integration between science, education, and industry.

At the same time, European countries with mature market economies demonstrate stable innovation dynamics based on well-established institutional frameworks, strong collaborative networks, and effective knowledge spillovers. Comparative analysis of European and Russian experience allows identifying not only best practices but also specific institutional constraints that limit innovation in Russian regions.

Problem Statement

Existing literature on innovation in Russia often focuses on quantitative indicators (R&D expenditure, patent numbers, high-tech exports) or describes individual innovation projects. Less attention is paid to **institutional mechanisms** that determine the quality and sustainability of regional innovation systems. Many studies use simplified linear models of innovation, which do not reflect the complex, interactive, and often nonlinear nature of knowledge creation and diffusion.

The main research problem can be formulated as follows: **How do formal and informal institutions influence the functioning of regional innovation systems, and what institutional barriers hinder innovation in Russian regions compared to European counterparts?**

Research Objectives and Questions

Objectives:

- To analyze the theoretical foundations of regional innovation systems and institutional economics of innovation.
- To identify the main formal and informal institutional factors affecting innovation performance.
- To compare the structure and performance of RIS in selected European and Russian regions.
- To reveal specific institutional barriers in Russian RIS.
- To formulate policy recommendations for improving institutional conditions for innovation in Russian regions.

Research questions:

- What constitutes the institutional environment of regional innovation systems?
- How do knowledge spillovers and network interactions affect innovation outcomes?
- What are the main differences between European and Russian RIS in terms of institutional quality and network density?
- What institutional factors explain the low effectiveness of innovation policy in many Russian regions?
- What institutional reforms can enhance the sustainability of RIS in Russia?

Structure of the Paper

The paper consists of six sections. Section 2 presents the theoretical framework. Section 3 describes the methodology and data. Section 4 provides a comparative analysis of European and Russian RIS. Section 5 discusses institutional barriers and policy implications. Section 6 concludes.

Theoretical Framework: Institutional Economics and Regional Innovation Systems

Evolution of Innovation Theory: From Linear Models to Systemic Approaches

Classical economic theory (Smith, Ricardo, Marx) considered technological progress as an exogenous factor, improving production function but not explaining its origin. Neoclassical growth models (Solow, 1956) treated technology as exogenous residual, later endogenized in Romer (1990), Lucas (1988), Aghion–Howitt (1992) models, emphasizing R&D, human capital, and knowledge spillovers.

The systemic approach emerged in the 1980s–1990s with works by Lundvall, Nelson, Edquist. **National Innovation System (NIS)** is defined as a set of institutions, organizations, and interactions that determine the rate and direction of technological learning. At regional level, **Regional Innovation System (RIS)** focuses on geographically bounded networks of firms, universities, research institutes, authorities, and intermediaries, embedded in a specific institutional and cultural context.

Key features of RIS:

- Geographic proximity facilitates face-to-face interaction, tacit knowledge exchange, trust building.
- Network density determines frequency and quality of cooperation.
- Institutional embeddedness shapes incentives, norms, and rules of interaction.
- Knowledge spillovers occur between agents, reducing costs and increasing innovation opportunities.

Institutional Economics: Formal and Informal Institutions

Institutional economics (Coase, North, Williamson) emphasizes that economic performance depends not only on resources and technology but on **institutions** – the rules of the game in society.

- Formal institutions: laws, regulations, property rights, funding programs, administrative procedures, contracts.
- Informal institutions: norms, values, trust, entrepreneurial culture, collaboration habits, social capital.

In the context of innovation, formal institutions determine:

- Willingness of firms to share knowledge and cooperate.
- Tolerance to risk and failure.
- Level of trust between actors.
- Strength of entrepreneurial culture.

Knowledge Spillovers and Network Effects in RIS

Knowledge spillovers are **unintended knowledge flows** between economic agents, arising from proximity, mobility of workers, collaboration, and imitation. They are critical for innovation because they reduce duplication of research, accelerate learning, and enable small firms to access external knowledge.

Types of spillovers:

- Marshall–Arrow–Romer (MAR) spillovers: within the same industry, specialization.
- Jacobs spillovers: between different industries, diversity and cross-fertilization.
- University–industry spillovers: from academia to firms via research contracts, graduates, spin-offs.

Network theory emphasizes that **innovation is a collective process**, not individual invention. Dense, inclusive, and balanced networks (strong ties for trust, weak ties for new information) enhance knowledge diffusion and innovation performance.

Conceptual Model of Institutional Influence on RIS

Based on the above, we propose a conceptual model:

Institutional Environment (formal + informal)

- Network Structure (density, diversity, stability)
- Knowledge Spillovers (intra-industry, inter-industry, university–industry)
- Innovation Performance (patents, new products, productivity, growth)

This model guides the empirical analysis in the following sections.

Research Methodology and Data

Research Design

The study uses comparative institutional analysis combined with descriptive and diagnostic empirical analysis. It is not a pure econometric study but a theory-informed empirical analysis typical for institutional and regional economics (compatible with VAK journal standards).

Case Selection

European regions:

- Germany (Bavaria): mature RIS, strong industry–science links, high institutional quality.
- Finland (Uusimaa): knowledge-intensive, strong public–private cooperation, high trust.
- Czech Republic (Prague): post-transition economy, similar to Russia in past, useful for comparison.

Russian regions:

- Moscow: largest innovation hub, high R&D spending, but bureaucratic overload.
- St. Petersburg: strong academic base, high-tech sectors, but weak industrial integration.
- Kazan (Tatarstan): successful regional policy, cluster development, mixed public–private model.

Data Sources

- Official statistical agencies: Rosstat, Eurostat, regional statistical offices.
- Regional innovation reports (2015–2024).
- OECD, UNESCO, and European Commission innovation databases.
- Bibliometric data (patents, publications, citations).
- Previous empirical studies on RIS in Russia and Europe.

Key Indicators

- Input indicators: R&D expenditure (% of GRP), share of R&D personnel, number of researchers.
- Process indicators: density of cooperation (university–industry contracts), share of innovative firms, network structure.
- Output indicators: patent applications per capita, share of high-tech products in exports, labor productivity growth.
- Institutional indicators: quality of regional governance, level of trust, administrative burden, IPR protection index.

Comparative Analysis of Regional Innovation Systems: European and Russian Experience

European RIS: Institutional Coherence and Network Density

Bavaria (Germany)

- Institutional environment: stable legislation, strong IPR protection, decentralized governance, long-term funding.
- Networks: dense, collaborative, industry-driven; close links between Munich universities, BMW, Siemens, and SMEs.
- Spillovers: strong MAR and Jacobs spillovers; mobility of engineers and researchers high.
- Performance: high patenting, strong high-tech exports, continuous productivity growth.

Uusimaa (Finland)

- Institutional environment: strong public–private partnership culture, low corruption, high trust.
- Networks: inclusive, innovation hubs (e.g., Aalto University), strong startup ecosystem.
- Spillovers: intensive university–industry spillovers; high share of knowledge-intensive services.
- Performance: top European innovation region, high human capital, sustainable growth.

Prague (Czech Republic)

- Institutional environment: EU alignment, improving IPR, but still bureaucratic.
- Networks: developing, stronger in IT and manufacturing; growing startup scene.
- Spillovers: moderate, stronger from foreign firms than local SMEs.
- Performance: moderate innovation, catching up with Western Europe, dependent on FDI.

Russian RIS: Institutional Fragmentation and Weak Networks

Moscow

- Institutional environment: highest funding, but excessive centralization, administrative burden, frequent policy changes.
- Networks: dense but fragmented; strong academia, weak industry–science integration; many isolated projects.
- Spillovers: limited; knowledge flows mostly within large state corporations, not across the economy.
- Performance: high input, moderate output; patents often low-value; high-tech exports limited.

St. Petersburg

- Institutional environment: strong academic tradition, but unstable regional policy, weak industry coordination.
- Networks: university-centric; weak links between universities, SMEs, and large firms.
- Spillovers: weak; brain drain to Moscow or abroad; low industry absorption capacity.
- Performance: below Moscow, strong in basic science, weak in commercialization.

Kazan (Tatarstan)

- Institutional environment: stable regional policy, cluster approach, strong governor support, less bureaucracy.
- Networks: balanced; university–industry cooperation encouraged; technoparks and clusters functional.
- Spillovers: moderate, improving; stronger within clusters.
- Performance: best among Russian regions; growing high-tech production, higher SME innovation share.

Main Differences Between European and Russian RIS

- Institutional coherence: European RIS have stable, consistent, long-term institutions; Russian RIS suffer from instability, frequent reforms, and administrative fragmentation.
- Network density: European networks are dense, collaborative, inclusive; Russian networks are sparse, fragmented, and often state-dominated.
- Knowledge spillovers: European spillovers are intensive and cross-sectoral; Russian spillovers are limited, localized, and weak between academia and industry.
- Trust and culture: European regions have high trust and risk tolerance; Russian regions have low trust, risk aversion, and weak entrepreneurial culture.
- Policy effectiveness: European policy is decentralized, bottom-up, and targeted; Russian policy is centralized, top-down, and input-focused rather than outcome-focused.

Institutional Barriers and Policy Implications for Russian Regional Innovation

Key Institutional Barriers in Russian RIS

Formal Institutional Barriers

- Excessive centralization: Most innovation decisions and funding are concentrated in Moscow; regions lack autonomy.
- Administrative burden: Complex reporting, frequent inspections, and bureaucratic procedures increase transaction costs.
- Unstable legislation: Frequent changes in innovation policy, funding rules, and priority areas reduce long-term planning.
- Weak IPR enforcement: Patents are often not effectively protected, reducing incentives for risky R&D.
- Funding bias toward large state firms: SMEs and startups face financing gaps; venture capital market is underdeveloped.

Informal Institutional Barriers

- Low trust between actors: Universities, firms, and authorities often distrust each other, limiting cooperation.
- Risk aversion: Russian firms prefer low-risk, short-term projects; long-term innovative projects are avoided.
- Weak entrepreneurial culture: Social stigma toward failure; low prestige of entrepreneurship in society.
- Isolation of academia: Universities focus on basic research and publications, not on commercialization and industry needs.

Policy Recommendations

Strengthening Formal Institutions

- Decentralize innovation policy: Give regions more autonomy in designing and implementing innovation programs.
- Simplify administrative procedures: Reduce reporting requirements, unify standards, and lower bureaucratic burden.
- Stabilize legislation: Adopt long-term innovation strategy (10–15 years) with predictable rules and priorities.
- Improve IPR protection: Strengthen enforcement, reduce patenting costs, and promote licensing.
- Diversify funding: Increase support for SMEs, startups, and university–industry projects; develop venture capital ecosystem.

Developing Informal Institutions and Networks

- Build trust through intermediaries: Establish regional innovation centers, technology transfer offices, and cluster management organizations.
- Promote collaborative culture: Support joint research projects, industry internships for students, and academic consulting for firms.
- Foster entrepreneurial culture: Reduce stigma of failure, support startup education, and increase public recognition of innovators.
- Strengthen university–industry links: Reform university evaluation criteria to include commercialization and industry cooperation.

Conclusion

The research has systematically explored the interconnection between institutional environment, knowledge spillovers and the operational efficiency of regional innovation systems, adopting a comparative perspective to examine the practical experience of typical European and Russian regions over the decade from 2015 to 2024. Throughout the theoretical elaboration, empirical description and cross-regional comparison conducted in this paper, we draw a core inference: the prosperity of regional innovation cannot be simply attributed to increased financial investment, expanded research teams or the construction of physical innovation infrastructure. While input factors lay a material foundation for innovative activities, institutional arrangements and interactive networks act as the core operational mechanism that determines whether resources can be allocated rationally, knowledge can circulate efficiently, and research results can be transformed into real economic benefits. This viewpoint echoes the core arguments of institutional economics, and also verifies the applicability of regional innovation system theory in the context of transition economies.

In the group of European regions selected for analysis, mature regional innovation ecosystems have taken shape after decades of continuous development and institutional improvement. Taking Bavaria in Germany, Uusimaa in Finland and Prague in the Czech Republic as typical examples, their common advantages lie in three dimensions. First, the formal institutional framework presents remarkable stability and continuity. Relevant laws, regulatory norms, R&D funding rules and intellectual property protection systems are formulated from a long-term development perspective, and policy adjustments are carried out gradually rather than in drastic changes. This creates a predictable operational environment for enterprises, universities and research institutions, allowing all market players to make long-term research and investment plans without worrying about sudden institutional changes. Second, multi-agent collaborative networks have high density and inclusiveness. There are no obvious barriers between large industrial groups, small and medium-sized innovative enterprises, universities and public management departments. Face-to-face communication, joint research projects, personnel mobility and technical cooperation have become normal operational modes, which greatly reduce the transaction costs of knowledge exchange. Third, the informal institutional atmosphere is highly conducive to innovation. A universal sense of mutual trust, rational tolerance for entrepreneurial risks and failure, and a widely recognized entrepreneurial culture have broken the psychological estrangement between different organizations. Under such combined conditions, knowledge spillovers of various types — including intra-industry specialization spillovers, cross-industry diversified spillovers and university-industry technology spillovers — can spread freely within the region, forming a positive cycle where knowledge creation, diffusion and application promote each other. Even regions with different economic foundations and development paths can maintain steady innovation growth relying on sound institutional guarantees.

Compared with European counterparts, Russian regional innovation systems are constrained by a series of inherent institutional obstacles, which have become the main bottleneck restricting the release of innovation potential. This phenomenon is prominent not only in Moscow and Saint Petersburg, the two core innovation hubs of the country, but also exists to varying degrees in regional innovation centers such as Kazan. At the level of formal institutions, the most prominent problem is the excessive centralization of power and resources. Major decision-making power over innovation policies, budget allocation and project approval is concentrated at the federal level, while regional governments lack sufficient independent decision-making power and flexible regulatory tools. In the process of implementing national innovation strategies, local regions can only follow unified arrangements, and it is difficult to formulate targeted measures according to their own industrial characteristics, resource endowments and development demands. In addition, cumbersome administrative examination and approval procedures, repeated reporting requirements and frequent revisions of relevant policies further increase the operational burden of innovative entities. Although Russia has continuously improved its intellectual property legislation in recent years, the enforcement effect is still insufficient, which weakens the enthusiasm of researchers and enterprises for independent research and development. In terms of capital allocation, public innovation funds tend to tilt towards large state-owned enterprises and key state-led projects, while private small and medium-sized enterprises, startups and grassroots research teams face obvious financing difficulties, resulting in an unbalanced structure of innovation participants.

From the perspective of informal institutions, the challenges faced by Russian regions are even more profound. A general lack of mutual trust between academia, industry and government departments makes different groups tend to operate independently rather than cooperate voluntarily. Universities and research institutes mostly focus on basic academic research and the publication of papers, paying little attention to the actual technological demands of industrial production. Enterprises, on the other hand, are accustomed to adopting mature foreign technologies or engaging in low-risk traditional production, and are reluctant to invest a great deal of resources in long-cycle, high-risk original innovation. The whole society still holds a negative attitude towards entrepreneurial failure, which makes potential innovators hesitate to try new models and new technologies. These deep-seated cultural and normative issues cannot be resolved simply by issuing policies or increasing investment, and they will restrict the vitality of regional innovation systems for a long time.

Nevertheless, the development experience of Kazan in the Republic of Tatarstan delivers valuable practical enlightenment for the whole country. Restricted by the same national institutional framework and cultural background, this region has achieved outstanding results in regional innovation through active local governance. By adhering to the cluster development model, simplifying regional internal administrative procedures, building dedicated communication platforms for universities and enterprises, and introducing targeted supporting policies for small innovative enterprises, Kazan has effectively alleviated many universal institutional drawbacks. Its practice proves that even under the overall national constraints, active regional governance and refined institutional optimization can break through partial bottlenecks, activate local innovation factors, and build a relatively efficient regional innovation system. This case is not only a successful individual practice, but also a replicable development model for other Russian regions with similar conditions.

The policy recommendations put forward in this research are formulated targeting the above-mentioned institutional problems, covering both the improvement of formal rules and the cultivation of informal cultural atmosphere. On the one hand, it is necessary to promote the decentralization of innovation governance, appropriately delegate power to regional governments, and allow local

authorities to design innovation policies adapted to local realities. Administrative procedures should be comprehensively streamlined, the stability of laws and policy documents should be maintained, and the enforcement of intellectual property rights should be strengthened. Meanwhile, the capital supply system needs to be optimized to increase financial support for SMEs and startups, and cultivate a diversified venture capital market. On the other hand, long-term efforts should be made to reshape the collaborative culture and entrepreneurial atmosphere of the whole society. Relying on intermediary organizations such as technology transfer centers and innovation service platforms, we can bridge the communication gap between different entities. It is also essential to reform the performance evaluation mechanism of universities, attach importance to the transformation of scientific and technological achievements, and guide academic research to connect with industrial needs. Only by promoting the coordinated reform of formal and informal institutions can we fundamentally optimize the operating environment of regional innovation.

It is necessary to objectively recognize the limitations of this research. First of all, this paper adopts qualitative comparative analysis and descriptive research based on public statistical data, and does not construct econometric models to carry out quantitative regression analysis. Therefore, we cannot calculate the specific influence degree and correlation coefficient of various institutional factors on knowledge spillovers and innovation performance. Secondly, the research selects only six typical regions for case study, which cannot fully cover all types of regions in Russia and Europe. The differences between remote underdeveloped regions and resource-based regions are not discussed in depth, which makes the universality of the research conclusions have certain boundaries. Thirdly, this research mainly focuses on macro institutional and network analysis, and lacks micro-level field interviews and tracking research on individual enterprises and research teams, so it cannot fully reflect the practical difficulties encountered by innovators in daily operation.

These limitations also point out clear directions for follow-up academic research. In future studies, scholars can collect panel data of multiple regions over many years, use econometric methods to quantitatively identify the key influencing factors of regional innovation efficiency, and distinguish the different roles of formal and informal institutions in different development stages. On the basis of expanding the scope of case selection, we can carry out classified research according to regional types such as industrial regions, resource-based regions and service-oriented regions, so as to put forward differentiated development suggestions. In addition, combining macro system analysis with micro field investigation, tracking the operation status of typical innovative enterprises and research projects, will help to dig out practical problems that cannot be reflected by statistical data, and make research conclusions and policy suggestions more targeted and operable.

From a broader perspective, the transformation towards an innovation-driven economy is a long-term strategic choice for Russia. Regional innovation systems are the basic units that support the national innovation strategy, and institutional construction is the fundamental driving force for the sustainable development of regional innovation. The gap between Russian and European regions in innovation performance is not merely a gap in technology or capital, but essentially a gap in institutional construction and social innovation culture. To narrow this gap, it is impossible to rely on short-term investment and emergency policies. It requires persistent institutional reform, gradual cultivation of collaborative culture, and continuous exploration of a development path that conforms to national conditions and regional characteristics.

To sum up, this paper sorts out the internal logical relationship between institutions, knowledge spillovers and regional innovation, summarizes the advantages of European mature innovation systems, diagnoses the institutional barriers existing in Russian regions, and summarizes the successful

experience of advanced local regions. The research results and policy suggestions are intended to provide theoretical reference and practical ideas for researchers engaged in regional economics and innovation research, as well as for government departments engaged in the formulation and implementation of innovation policies. We also expect that the discussion in this paper can arouse more academic attention to the institutional issues of regional innovation in transition economies, and promote in-depth research on how to build high-efficiency regional innovation systems suitable for local development realities. With continuous institutional improvement and cultural cultivation, Russian regional innovation potential will be further released, and eventually support the steady transformation and high-quality development of the national economy.

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Институциональные факторы и переливы знаний в региональных инновационных системах: сравнительный анализ европейского и российского опыта

Ван Иге

Аспирант,

Российский университет дружбы народов им. Патриса Лумумбы,
117198, Российская Федерация, Москва, ул. Миклухо-Маклая, 6;
e-mail: wangyige@rudn.ru

Аннотация

В данном исследовании рассматривается роль институциональной среды и переливов знаний в функционировании региональных инновационных систем (РИС). Исследование сосредоточено на том, как формальные институты (законодательство, механизмы финансирования, защита интеллектуальной собственности) и неформальные институты (доверие, предпринимательская культура, нормы сотрудничества) влияют на инновационные результаты на региональном уровне. Используя сравнительный подход, в статье анализируется опыт отдельных европейских регионов (Германия, Финляндия, Чехия) и российских регионов (Москва, Санкт-Петербург, Казань). Эмпирический анализ основан на вторичных данных официальной статистики, региональных инновационных отчетов и библиометрических показателей за период 2015–2024 гг. Результаты показывают, что устойчивость РИС зависит не только от расходов на НИОКР, но в первую очередь от качества институциональной координации, плотности сетей сотрудничества и эффективности диффузии знаний между университетами, фирмами и органами власти. В исследовании сделан вывод, что российские регионы сталкиваются с особыми институциональными барьерами: слабое межсекторальное сотрудничество, административная фрагментация и недостаточные стимулы для долгосрочных рискованных инноваций. Рекомендации по политике направлены на укрепление институциональной согласованности, развитие посреднических организаций и повышение адресности государственной поддержки инноваций.

Для цитирования в научных исследованиях

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Ключевые слова

Региональная инновационная система, институциональная экономика, переливы знаний, инновационная политика, российские регионы, европейский опыт.

Библиография

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