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Prospects for the development of digital innovations in public healthcare

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ABSTRACT
Relevance. The transition to a platform-based model in the public sector depends on stakeholders developing interoperability skills and a flexible technological infrastructure. Yet, the adaptation of industry-specific technologies to such platform architectures remains an open research question.
Research objective. The study aims to define the current state of digital healthcare and provide an evidence-based rationale for its development prospects in an emerging healthcare platform.
Data and methods. Topic modeling was applied to a dataset of 60 digital innovations from 56 Russian regions, implemented between 2019 and 2024 as part of regional projects for a unified digital healthcare contour. Findings were further validated using factor analysis and clustering, incorporating official statistics and data on technical and regulatory aspects of innovation adoption across regions.
Results. Collaborative business models involving all healthcare actors and remain low-priority in public health governance. Statistical analysis confirms the high importance of economic and regional aspects, while regulatory aspects that determine the order of administration and technical interaction between stakeholders also have a moderately positive impact.
Discussion. Digital innovations in public health were qualitatively and quantitatively assessed through the prism of the concept of responsible healthcare. Findings exposed a disparity: while digital innovations prioritized economic and healthcare outcomes, they consistently overlooked collaborative governance models. The results provide a foundation for future research on how innovation providers and public sector actors have adapted their business models to ensure transparency, accountability, and collaboration.

KEYWORDS
digital innovations, responsible innovations, digital platform, regional healthcare, topic modeling, factor analysis

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Определение перспектив развития цифровых инноваций в государственном секторе здравоохранения

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АННОТАЦИЯ
Актуальность. Институционализация платформенной модели функционирования в государственном здравоохранении требует от заинтересованных сторон развития компетенций в области взаимодействия и гибкой технологической базы. Измерение уровня адаптации отраслевых технологий к архитектуре экосистемы остается нетривиальной исследовательской задачей.
Цель исследования. Установить статус-кво цифрового здравоохранения для научного обоснования перспектив развития в контексте формирования платформы здравоохранения.
Данные и методы. Применен метод тематического моделирования для изучения данных о 60 цифровых инновационных решениях из 56 регио-

КЛЮЧЕВЫЕ СЛОВА
цифровые инновации, ответственные инновации, цифровая платформа, региональное здравоохранение, тематическое моделирование, факторный анализ

нов России, реализованных в период реализации региональных проектов по формированию единого цифрового контура в сфере здравоохранения в 2019–2024 годах. Результаты тематического моделирования были верифицированы посредством факторных нагрузок и кластеризации с использованием официальной статистики и данных о технических и нормативных аспектах внедрения инноваций в регионах.

Результаты. Цифровые инновации ориентированы на обеспечение устойчивости здравоохранения и экономическую эффективность в большей степени, чем на вопросы здоровья. Институализация моделей взаимодействия, направленных на вовлечение всех субъектов здравоохранения остаются низкоприоритетными в государственном здравоохранении. Факторный анализ подтверждает высокую значимость экономических и региональных аспектов в эффективности цифровизации здравоохранения. Умеренное положительную значимость имеют регуляторные аспекты, определяющие порядок административного и технического взаимодействия между заинтересованными сторонами.

Обсуждение. Цифровые инновации государственного здравоохранения были качественно и количественно оценены через призму концепции ответственного здравоохранения.

Результаты демонстрируют, что цифровые инновации сосредоточены на обеспечение экономических и управленческих результатов, тогда как принцип совместного создания инноваций систематически игнорируется. Результаты закладывают основу для будущих исследований того, как поставщики инноваций и государственные акторы адаптировали свои бизнес-модели для обеспечения подотчетности и сотрудничества.

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确定公共卫生领域数字创新的发展前景

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摘要
现实性：在公共卫生领域实现平台化运作模式的制度化，要求相关方提升协作能力并建立灵活的技术基础。衡量行业技术对生态系统架构的适应程度，仍是具有挑战性的研究课题。
研究目标：建立数字医疗的发展现状基准，为卫生平台建设背景下的发展前景提供科学依据。
数据与方法：采用主题建模方法，研究了2019–2024年俄罗斯56个地区在实施区域医疗卫生数字化一体化项目期间，60项数字创新解决方案的数据。通过因子负荷和聚类分析，结合官方统计数据以及各地区创新实施的技术和规范方面的数据，对主题建模的结果进行了验证。
研究结果：数字创新的主要侧重点在于保障医疗系统的稳定性与经济性，而非健康议题本身。旨在吸纳所有医疗主体参与的互动模式的制度化建设，在公共卫生体系中仍处于较低优先级。因子分析证实，经济与区域因素对医疗数字化的成效具有高度影响力；而监管因素——即界定相关利益方在行政与技术协作的相关因素——仅呈现中等程度的正向显著性。
结论：通过负责任医疗保健的概念，对公共卫生领域的数字创新进行了定性与定量评估。研究结果表明，数字创新主要聚焦于实现经济效益和管理成效，而创新共创原则却被系统性地忽视。这些发现为未来研究奠定了基础，有助于深入研究创新供给方与公共行动者如何通过调整其商业模式来确保问责落实与协同合作。

关键词
数字创新、负责任创新、数字平台、区域医疗、主题建模、因子分析

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Introduction

National development priorities in digital technology are focused on advancing sector-specific digital platforms[1]. However, technologies introduced over the past decade have accumulated significant legacy constraints that often limit their adaptability to the platform paradigm. This issue is particularly evident in highly regulated sectors such as healthcare, where compliance requirements reinforce dependence on legacy systems. As a result, assessing technological readiness and adaptability to platform paradigms within the public sector represents a promising direction for further research.

The success of federal initiatives largely depends on the effectiveness of regional governance systems and the reliability, completeness, and adequacy of data generated by information systems. Regional authorities, often operating under resource constraints, are responsible for ensuring the comprehensive implementation of measures that yield tangible benefits for the population.

Variations in regulation and healthcare practices across countries shape how digital technologies deliver value. In Russia, the coexistence of diverse medical systems and digital solutions from multiple vendors, combined with federal initiatives implemented across regions, highlights the need for uniform criteria to assess the effectiveness of digital solutions.

While platform approaches are often examined from technical and systemic perspectives, they also encompass economic and social dimensions of value creation (Frishammar et al., 2023). In digital healthcare, however, the external, platform-mediated interactions that enable such value remain relatively underdeveloped (Hermes et al., 2020).

Against this background, this study seeks to identify the current state of digital healthcare to provide an evidence-based rationale for its development prospects within the emerging healthcare platform. The research tasks are as follows:

1. To evaluate how the value generated by digital innovations aligns with the principles of responsible innovation in healthcare;

2. To identify and assess the gaps and catalysts in the development of regional digital healthcare.

This study applies the concept of Responsible Innovation in Health (RIH) to examine key value domains, including public health, the healthcare system, economics, organization, and the environment. Using topic modeling of implemented innovations and statistical evidence, it investigates responsible practices, identifies factors that support their institutionalization, and explores potential development pathways for digital health in Russia. The central hypothesis is that the dominance of administrative actors in public health constrains platform development, suggesting that multi-stakeholder collaboration is needed to overcome these limitations.

To address this hypothesis, the following research questions were formulated:

RQ1: How can digital innovations in the public health sector be characterized?

RQ2: How do the values underlying responsible innovation manifest themselves in the public health sector?

RQ3: What factors influence the presence or absence of responsible practices?

By examining these questions, the study moves beyond conventional assessments of digitalization efficacy and aims to identify prospects for a platform-based model in Russian digital healthcare.

Theoretical Framework

Technologies driving the digital transformation of industries, including the modernization of business processes, are key pillars of innovative development[2]. In healthcare, digital innovations are continuously developed, piloted, and adopted, encompassing new or significantly improved products, services, processes, and organizational frameworks[3]. When implemented effectively, these innovations generate the greatest value, un-

[1] Decree of the President of the Russian Federation № 309 dated 05.07.2024 "On the National Development Goals of the Russian Federation for the Period until 2030 and for the Future until 2036" [Electronic resource]. Retrieved from: http://www.kremlin.ru/events/president/news/73986 (date of access 10.12.2024).

[2] Decree of the Government of the Russian Federation dated October 28, 2020 № 1750 "On Approval of the List of Technologies Used in the Framework of Experimental Legal Regimes in the Field of Digital Innovation" // Collection of Legislation of the Russian Federation of 2020, № 44, art. 7003 (date of access 16.01.2025).

[3] Federal Law № 258-FZ dated 07/31/2020 "On Experimental Legal Regimes in the Field of Digital Innovations in the Russian Federation" // Collection of Legislation of the Russian Federation dated 2020, No. 31, art. 5017 (Part I)

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derstood as outcomes unique to each stakeholder, including the benefits of products and services and their performance in practice (Starkbaum et al., 2024; Greenhalgh et al., 2017).

Pacifico Silva and colleagues (2018) define responsible innovation in healthcare as a collaborative effort among health actors to uphold ethical, economic, social, and environmental values throughout the development, financing, dissemination, use, and discontinuation of socio-technical solutions that address health system needs. In Responsible Innovation in Healthcare (RIH) research, innovations are often treated as a generalized set of products and technologies (Lehoux et al., 2018; Van Oudheusden, 2014). By contrast, the original concept of Responsible Innovation (RI) focuses on market-based products perceived as socially useful and economically beneficial (Blok & Lemmens, 2015). While RI provides a common value framework, its application requires adaptation to specific healthcare domains, such as pharmaceuticals, clinical innovations, and digital health. Current research remains limited in domain-specific studies, with notable exceptions in medical neuroimaging and cases involving nanotechnology or artificial intelligence in healthcare (Arentshorst et al., 2016; Jansma et al., 2022; Alami et al., 2020). The main focus of this research area is to clarify the core values of responsible healthcare innovations across specialized domains and develop methodologies to assess their outcomes (MacNeil et al., 2019; Miller & Lehoux, 2020).

Implementing Responsible Innovation in Healthcare (RIH) requires policies that go beyond technology. Addressing complex societal challenges demands an active government role throughout the innovation cycle (Lehoux et al., 2023) and a clear framework for distributing risks and benefits among diverse healthcare stakeholders.

Regional economic, social, governance, and regulatory factors strongly influence the success of digital health interventions (Kim & Backonja, 2025; Hartley, 2010). It is essential to gain a better understanding of these contextual conditions to design, implement, and sustain innovations that reflect responsible principles (Verzilin et al., 2015; Alami et al., 2024).

Methodologically, research on digital health frequently employs topic modeling to uncover latent structures in user-generated content or electronic health records. Applications include telemedicine platforms, mental health apps, and diabetes management systems (Martin et al., 2025; Yi et al., 2022; Ossai & Wickramasinghe, 2023; Chiu et al., 2023; Dinsa et al., 2024). Typically, studies focus on data generated by specific digital products, forming case studies. Alongside quantitative analyses of secondary data, this approach constitutes the core of scholarly work in the field (Nielsen & Sahay, 2022).

However, the meta-level characteristics of innovations corresponding to their fundamental attributes remain largely unexplored. Addressing this gap, particularly in public health, requires new conceptual frameworks and methodological approaches that can capture both innovation outcomes and the institutional, social, and economic conditions that shape them.

Methods and Data

The research is based on a text corpus describing 60 innovative healthcare solutions from 56 Russian regions, incorporating technologies such as digital transformation tools, big data, artificial intelligence, human–machine interaction, and neurotechnology.

The corpus was compiled from two main sources, covering 48 and 12 innovations respectively:

– *Best practices in regional healthcare*: Selected by the Ministry of Health in accordance with official recommendations for identifying best practices in regional projects[4]. The dataset includes review articles and presentation materials on regional digital innovations[5].

– *Practical solutions posted on the "Polezny Orgzdrav" portal*: Administered by the Central Research Institute of Healthcare Organisation and Informatization, this source includes solutions addressing organization, health econom-

[4] Letter of the Ministry of Health of the Russian Federation dated October 20, 2021 № 29–3/I/2–17134 On Methodological Recommendations on the Procedure for Determining Best Practices in the Implementation of Regional Projects of the National Healthcare project [Electronic resource]. Retrieved from: https://base.garant.ru/402964714/?ysclid=mc4gjcwycv921429176 (date of access 16.01.2025).

[5] Website of the Ministry of Health of the Russian Federation [Electronic resource]. Retrieved from: https://minzdrav.gov.ru/poleznye-resursy/natsproektzdravoohranenie/praktiki (date of access 16.01.2025).

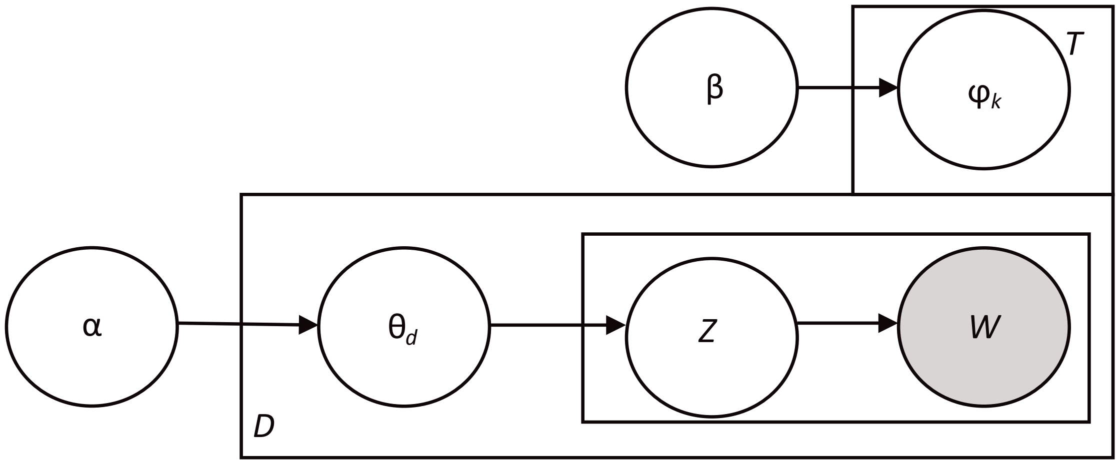

Figure 1. *The process of generating the LDA model*
Source: compiled from the materials by Blei & co-authors (2003)

ics, and digital transformation[6]. Official regional media publications on implemented innovations were also included.

The content and value of these innovations for healthcare stakeholders were analyzed using topic modeling of digital health practices, implemented via the Python library pyLDAvis (Latent Dirichlet Allocation, Blei et al., 2003). This probabilistic model identifies hidden topics through natural language processing (NLP) techniques.

The model optimizes word-topic assignments using the joint distribution of words-in-topics and topics-in-documents. The α and β parameters, controlling the distribution of topics in documents and words in topics, were set automatically to "symmetrical," assuming all topics and words are initially equivalent. The optimal number of topics was determined iteratively, selecting the solution that yielded the most interpretable topics for the research questions.

The general concept of the model is shown in Figure 1, where *D* is the set of text documents; *W* is the set of all terms used in them; *T* is the set of topics; *d* is the document; θ_d is the probability of topic *k* appearing in document *d*; φ_k is the probability of words appearing in topic *k*; *Z* is the set of hidden topic assignments for words:

The text corpus was preprocessed using stemming to find word bases, tokenization to split the text, and the introduction of stop words and keywords for document filtering. These procedures were performed using the NLTK (Natural Language Toolkit) library, adapted for the Russian language.

To visualize the topic model, the *pyLDAvis* library was used, which relies on Principal Components Analysis (PCA) to reduce data dimensionality and represent it in two dimensions:

– PC1 (first principal component): the x-axis, explaining the largest share of variance in the data;

– PC2 (second principal component): the y-axis, explaining the next largest share of variance.

Topic coherence, which measures the degree to which words within a topic share a common context, was evaluated using the Coherence Score proposed by Röder et al. (2015). This score, calculated with the Gensim library, employs pairwise semantic assessments of words based on vector representations to determine logical consistency within each topic. The mathematical formulation of topic word coherence is as follows:

$$Coh(t) = \frac{2}{N \cdot (N-1)} \sum_{i=1}^{N-1} \sum_{j=i+1}^{i=1} \log \frac{P(w_i, w_j)}{P(w_i)P(w_j)}, \quad (1)$$

where *t* is the topic; *w* is the word in the topic, *t*; *N* is the number of top words in the topic; $P(w_i)$ is the probability of the word w_i appearing in any document; $P(w_i, w_j)$ is the probability of the words w_i and w_j occurring together in one document (Röder et al., 2015).

The results are also supported by official statistics and documents for the period 2022–2024, key metrics on regional digital infrastructure and sector-specific characteristics. Indicators were se-

[6] *Polezny Orgzdrav* portal [Electronic resource]. Retrieved from: https://praktiki.mednet.ru/ (date of access 18.01.2025).

lected based on data availability for comparable periods and their relevance to the healthcare sector to ensure accuracy. An additional advantage of the dataset is the combination of infrastructure and human resource indicators (Kurochkina & Golovkin, 2024). Regional-level analysis of the following 2022–2024 indicators was conducted:

– Percentage of healthcare facilities using medical information systems (MIS) for care delivery that are interoperable with the Unified State Health Information System (EGISZ)[7];

– Number of outpatient clinics (year-end)[8];

– Percentage of healthcare organizations with Internet access among all healthcare organizations[9];

– Physician-to-population ratio per 10.000 population (year-end)[10];

– Allocation of federal subsidies to regional budgets for implementing healthcare digitalization projects under the EGISZ, in accordance with period-specific federal budget laws[11];

– Vendor status (0 — single MIS vendor in the region, 1 — multiple MIS vendors in the region)[12];

– Regulation on the State Healthcare Information System (GISZ) — (0 — not adopted, 1 — adopted)[13,14].

[7] Unified Interdepartmental Information and Statistical System (EMISS) [Electronic resource]. Retrieved from: https://www.fedstat.ru/ (date of access 20.04.2025).

[8] Ibid.

[9] Ibid.

[10] Ibid.

[11] Russian Government Portal [Electronic resource]. Retrieved from: http://government.ru/docs/all/ (date of access 10.05.2025). Note: the analysis utilized data on actual subsidy allocations to regions in accordance with federal budget laws for the respective fiscal years

[12] Protocol of the meeting on the implementation of the federal project "Creation of a Single Digital Contour in Healthcare Based on the EGISZ" of the national project "Healthcare" by the subjects of the Russian Federation dated 05/25/2023 № 55/18–5/242 [Electronic resource]. Retrieved from: https://base.garant.ru/407113112/#block_1000 (date of access 10.04.2025).

[13] Ibid.

[14] Methodological recommendations for the development of the NPA of the supreme executive authority of the subject of the Russian Federation on the GISZ of the subject of the Russian Federation and the regulations on the GISZ of the subject of the Russian Federation [Electronic resource]. Retrieved from: https://portal.egisz.rosminzdrav.ru/materials/4281 (date of access 10.04.2025).

Results

The first stage of topic modeling identified five core topics in regional digital healthcare practices, summarized in Table 1. The results indicate an above-average logical coherence of words within topics ($Coh(t)$ = 0.444), reflecting their semantic consistency while also capturing a broad range of thematic content.

Figure 2 presents a graph of intertopic distances based on the topic modeling results. The distribution illustrates the breadth of themes discussed in digital healthcare. Topic 1 is both semantically distinct (positioned far from other topics) and quantitatively dominant (containing the largest token share), highlighting its central role in the corpus. In contrast, topics 2 and 3, which relate to regional project implementation, specialist information support, and local technology adoption, exhibit similar structures, reflecting their frequent co-occurrence in the same context.

The second research stage was dedicated to uncovering evidence of responsible innovation values within regional practice descriptions. For this purpose, a feature for entering keywords was added, which made it possible to focus the LDA model. Document filtering enables the system to focus on processing relevant documents (d) based on keywords and reduces the influence of dominant topics. The keywords were compiled based on the «value domains» of responsible innovation in healthcare (Pacifico Silva et al., 2018). The modeling results and the most interpreted topics are presented in Table 2.

These topic modeling outcomes should be interpreted critically. Core dimensions of digital health innovations include public health, healthcare systems, and their economic foundations. Topics related to emergency care management, drug provision, care for cardiovascular patients, and information system integration align with the objectives of the national project to build a unified digital healthcare framework (EGISZ)[15]. Despite the federal project's goals to engage diverse stakeholders in digital healthcare processes, the prevailing healthcare delivery model remains

[15] Passport of the federal project "Creation of a Unified Digital Contour in Healthcare Based on the Unified State Information System in the Field of Healthcare (EGISZ)" [Electronic resource]. Retrieved from: https://static-0.minzdrav.gov.ru/system/attachments/attaches/000/046/712/original/FP_Cifrovoj_kontur_zdravooxraneniya.pdf?1565344851 (date of access 20.12.2024).

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Table 1

Key topic categories of regional digital healthcare practices

№	Topic category	Key words	% of all tokens
1	Organization and provision of medical care	Organization, medical, system, information, primary, consultation, assistance, government	23.1
2	Implementation of regional healthcare projects and their monitoring	project, clinic, monitoring, implementation, regional, indicators, patient	22.7
3	Information support for specialists at the municipal level	Informational, assistance, research, provision, specialist, district, municipal	18.7
4	Electronic healthcare in the activities of medical organizations	patient, electronic, record, implementation, cabinet, department, healthcare	17.9
5	Physician-patient interaction through information technology	physician, patient, consultation, booking, referral, population, health, digital	17.7

Source: calculated by the authors based on the text corpus

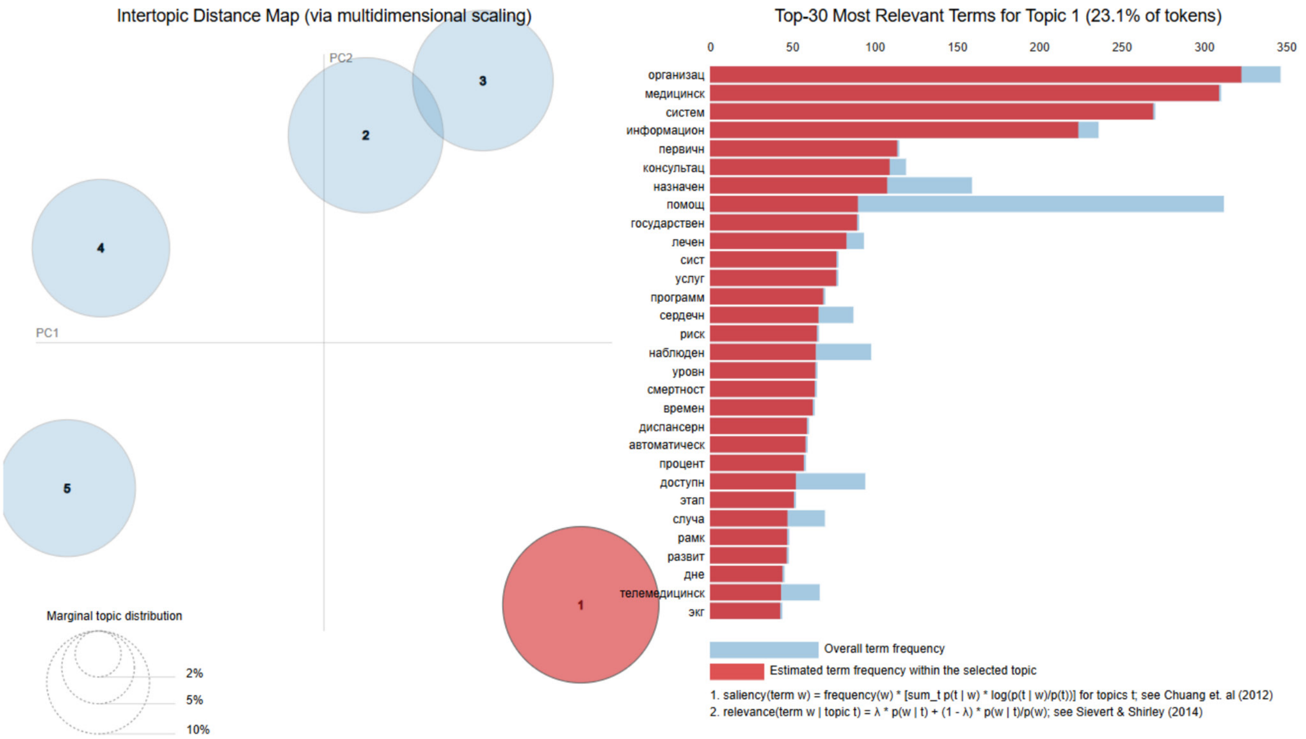

***Figure 2.** Intertopic distance map of regional digital innovation practices*

Source: calculated by the authors based on the text corpus

traditional, primarily focusing on physician-patient interactions. At the same time, the terms "physician" and "patient" represent the most frequently occurring lexical items across the entire text corpus, particularly in topic categories 2, 4, and 5. This establishes the central narrative of the analyzed documents: digital health projects enhance healthcare accessibility for patients, while technology implementation helps streamline the work of medical professionals and the healthcare system as a whole.

The search for environmental narratives was not successful because the results did not match the search parameters. Currently, the environmental domain of technology is the least relevant in the field of digital healthcare due to the urgent need to ensure medical effectiveness, the complexity of an objective assessment of such technologies and the limited number of potential vendors of such technologies (Alami et al., 2023). Meanwhile, innovations aimed at improving the environment are allocated as a separate expense item for organiza-

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Table 2

Results of topic modeling on the manifestation of responsible innovation aspects in regional practices

Value domain / Coherence score	Keywords for filtering the text corpus	Number of topics for the model	Topic categories
Population health / 0.552	health, risk, improvement, quality, ethics, legal, legal, social, inequality, accessibility	7	Improving the efficiency of health services; Implementing projects in the field of children's healthcare; Organizing medical care for patients at high risk of cardiovascular diseases; Managing the availability of the regional health system.
Health system / 0.680	Inclusivity, accessibility, efficiency, dynamism, speed, level, quality, sustainability	8	Quality management of medical services and integration of information systems; Improving the operational efficiency of services through digital technologies; Treatment and risk management during hospitalization; Models of organization of medical care; Accessibility and satisfaction with the quality of care; Ensuring the operation of medical institutions; Monitoring the condition of patients and the drug provision.
Economic / 0.721	Frugality, resources, efficiency, optimization, economics, finances, costs, innovation	6	Optimization of costs and resources via digital technologies; Investing financial resources in the organization of emergency care; Improving the efficiency of services through information support; Financial and human resources for the implementation of projects.
Organizational / 0.353	business, platform, model, organization, vendor, company, value, users, social, needs	7	Physician's work and interaction with the patient; Organization of remote medical care; Public health status and disease monitoring.
Environmental / 0.345	negative, emission, ecological, environment, sustainable,	5	Follow-up of patients with cardiovascular diseases; Diagnosis of cardiovascular diseases.

Source: calculated by the authors based on the text corpus

tions[16]. Healthcare organizations mostly carry out "healthy" innovations voluntarily (31 organizations) in order to comply with environmental legislation (35 organizations). At the same time, the main goal of eco-friendly innovations was to reduce noise levels, soil, and water or air pollution, which is applicable only to medical devices used directly in the treatment of diseases.

Despite the high coherence score for economic topics, the organizational domain, reflecting a business's intent to generate societal value, is largely absent. Within the public health paradigm, innovation value is primarily realized through government provision. Other stakeholders, such as IT solution providers, pharmaceutical and specialized technology companies, social and educational organizations, and non-core government agencies, remain largely outside the discussion.

The topic modeling results can be cross-validated with statistical data and official documents describing regional infrastructure and health IT regulations, which govern interoperability with medical information systems, pharmaceutical organization systems, other information systems, information interaction participants, and data composition.

To reduce the dimensionality of the indicator space, factor analysis with Varimax rotation was applied. During the study period, the identified factors explained, on average, 60% of total variance. The Mann–Whitney U test showed comparable factor load matrices across study periods, demonstrating the stability of indicators over time:

– Matrix2022 and Matrix2023: p-value = 0.399;

– Matrix2022 and Matrix2024: p-value = 0.594;

– Matrix2023 and Matrix2024: p-value = 0.749.

[16] Website of the Federal State Statistics Office. Information on the use of digital technologies and the production of goods and services related to them (results of statistical observation on F. № 4-innovations) [Electronic resource]. Retrieved from: https://rosstat.gov.ru/statistics/science (date of access 20.04.2025).

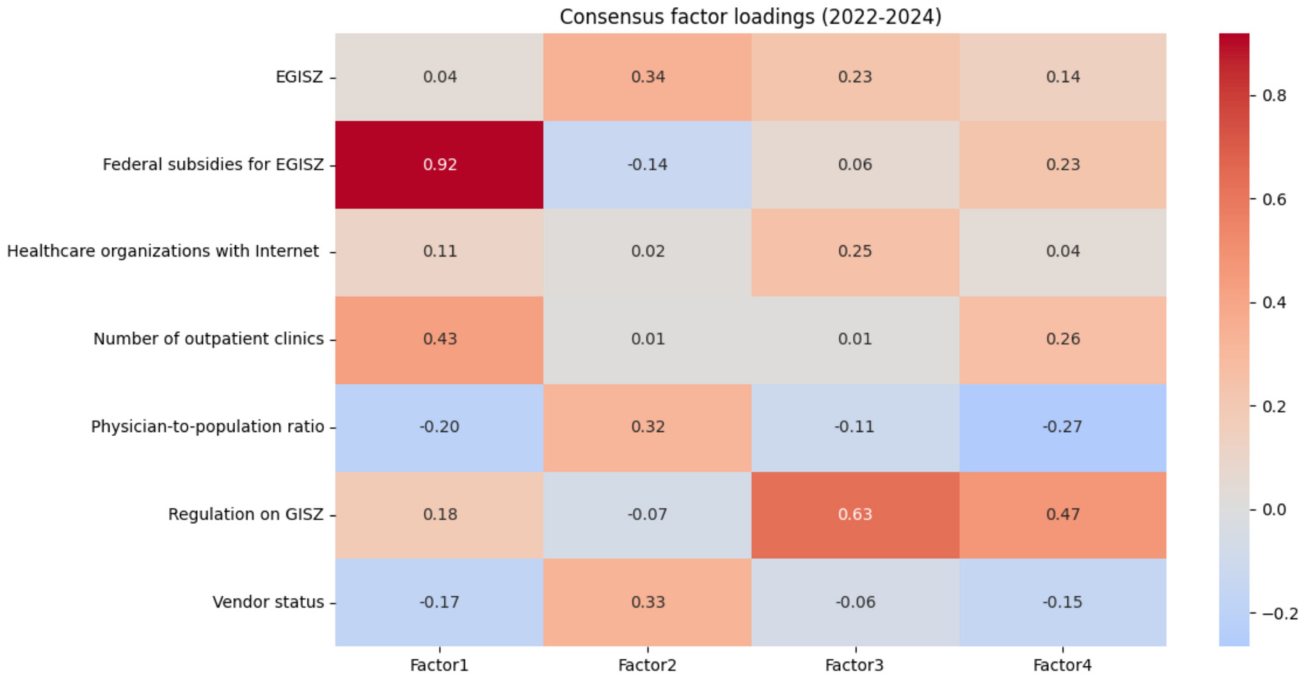

Figure 3. *Consensus factor loadings of selected indicators (2022–2024)*

Source: calculated by the authors based on statistical observations and administrative records

Table 3

Cluster analysis using Gaussian mixture model

Indicator	Matrix2022	Matrix2023	Matrix2024	Indicator retention stability
EGISZ	Cluster 0	Cluster 0	Cluster 1	2/3
Vendor status	Cluster 0	Cluster 1	Cluster 0	2/3
Healthcare organizations with Internet	Cluster 0	Cluster 0	Cluster 0	3/3
Regulation on GISZ	Cluster 0	Cluster 0	Cluster 0	3/3
Physician-to-population ratio	Cluster 1	Cluster 0	Cluster 0	2/3
Number of outpatient clinics	Cluster 2	Cluster 2	Cluster 0	2/3
Federal subsidies for EGISZ	Cluster 2	Cluster 2	Cluster 2	3/3

Source: calculated by the authors based on factor loadings

Figure 3 shows the consensus (average) factor loadings, indicating the degree of correlation between indicators and factors.

To identify and interpret the factors, we utilized Gaussian Mixture Modeling (GMM), a machine learning technique which calculates the membership probability of each indicator across all factors. The results are presented in Table 3. Further, three GMM clusters were identified, representing the core structure of the indicator data. The average values of factor loads for each GMM cluster and their interpretation (names) are presented in Table 4.

Financial and administrative factors, measured by total subsidies and the number of medical organizations, have a strong influence on digital healthcare. Combined regional characteristics, such as the use of multi-vendor information systems by healthcare organizations, their integration with the unified state information system, and medical staffing levels, play a critical role in shaping the digital ecosystem. Regulatory and technological elements exert a moderately positive effect on these factors. Standardization through regulations supports the implementation of platform principles, accounting for up to 20 % of factor loadings during the study period.

For spatial analysis, hierarchical clustering with the Gower distance metric was applied to assess regional similarities. Three homogeneous

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Table 4

Average factor loads across GMM clusters

GMM cluster	Factor 1	Factor 2	Factor 3	Factor 4
Regulatory and technological elements (0)	−0.0002	0.0044	0.2331	0.0955
Regional features (1)	−0.0417	0.9673	−0.0666	0.0176
Financial and administrative elements (2)	0.8063	−0.1000	0.0360	0.1671

Source: calculated by the authors based on GMM results

Figure 4. *Spatial representation of hierarchical clustering results*

Source: calculated by the authors based on statistical observations and official documents

Table 5

Results of hierarchical clustering of regions

Indicator	Cluster 1	Cluster 2	Cluster 3
Number of regions	35	34	16
Cluster distance (Gower distance metric)	0.16	0.11	0.19
EGISZ (%, mean)	89.48	91.68	87.30
Number of outpatient clinics (mean)	99.24	53.39	79.38
Healthcare orgs with Internet (%, mean)	93.22	94.42	92.16
Physician-to-population ratio	37.48	36.53	41.19
Federal subsidies (thousand rubles)	81589.46	69752.23	47462.11
Vendor status	0 %	100 %	100 %
Regulation on GISZ	91.4 %	100 %	12.5 %

Source: calculated by the authors based on statistical observations and official documents

clusters were identified, and their spatial distribution is shown in Figure 4[17]. The average values for the clusters are shown in Table 5.

Cluster 1 comprises regions with well-developed medical infrastructure but average digital infrastructure indicators. These regions feature more than one vendor of medical information systems and have the highest average volume of subsidies for implementing regional projects to build EGISZ. This may indicate the economic feasibility of using a single vendor's services. Typical regions include Moscow Oblast, St. Petersburg, Krasnodar Krai, and Tatarstan.

Cluster 2 is characterized by high digitalization and strong workforce capacity. A defining

[17] Regions with missing values for the study indicators are displayed as Cluster 0 in the spatial representation.

Figure 5. *Factors influencing the presence or absence of responsible practices*
Source: compiled by the authors based on the results of assessments of topic modeling and calculations

feature is the universal adoption of regulations on GISZ and the presence of a single vendor. Typical regions include Belgorod Oblast, Tula Oblast, Samara Oblast, and the Komi Republic.

Cluster 3 comprises crisis regions where digitalization indicators are below average. In the vast majority of these regions, regulations on GISZ have not been approved, which may also indicate the positive impact of regulatory frameworks governing interactions between information systems and healthcare participants. Typical regions include Ivanovo Oblast, Kursk Oblast, Chechnya, and Chukotka. Moscow's inclusion in this cluster appears to be an outlier due to its lack of project implementation subsidies.

Discussion

In addressing *RQ*1, the identified topics in descriptions of innovative practices cover diverse aspects of the healthcare system, including care delivery optimization, technology implementation, and monitoring of innovation project outcomes. The comparable distribution of token shares across topics confirms the structural diversity and multi-topical nature of digital health innovation descriptions. These categories also align with the objectives of creating a digital healthcare framework aimed at improving system efficiency through digital technologies.

For *RQ*2*,* we found a fundamental distinction between the contexts of innovation development and implementation, reflecting the dominant role of key drivers, primarily government or business. Economic aspects of innovation and overall healthcare system performance are strongly emphasized, consistent with the government's mission to protect citizens' health and ensure access to quality care[18]. Organizations, including in the field of healthcare, using sustainable business models ("hybrid" organizations), are focused primarily on health goals rather than economic benefits, and represent high value to stakeholders (Haigh & Hoffman, 2012). Government institutions are the closest to this format, yet topic analysis shows that organizational factors play a minor role in actual digital health innovation cycles.

The translation of innovation value largely occurs through government-led efforts, observable across all analyzed domains. However, the responsibility for implementing technologies and the potential for digitalization also depends on vendor priorities, which are often overlooked in evaluations of healthcare technologies (Lehoux et al., 2025; Thapa & Iakovleva, 2023). In oligopolistic digital health markets, where developers define customer needs, proprietorial innovations may undermine organizational factors.

Currently, there is no clear consensus on the measures required to establish a highly productive ecosystem of medical innovations. As noted, the conditions under which innovations are de-

[18] Federal Law № 323-FZ dated 21.11.2011 "On the Basics of Public Health Protection in the Russian Federation" // Collection of legislation of the Russian Federation of 2011, № 48, art. 6724

veloped and applied significantly affect their social value. Topic modeling and statistical analysis identify critical institutionalization factors for responsible public sector practices, providing an evidence-based response to *RQ*3 (Figure 5).

The lack of platform-level interaction among stakeholders across the healthcare system limits the effectiveness of innovative development. This can lead to fragmented initiatives, conflicting stakeholder interests, reduced innovation activity, and low implementation efficiency. Solutions often remain isolated with limited application, diminishing the synergistic effects of interinstitutional collaboration and increasing transaction costs.

Effective communication within the ecosystem relies on mutual benefit among stakeholders. The technological infrastructure that supports these communication channels enables participants to create unique offerings for one another, accumulate knowledge about stakeholder needs and broader market challenges, scale implemented decisions and technologies, and increase transparency of market actions.

Research limitations

For the portion of the textual corpus derived from the "Polezny Orgzdrav" portal, official regional media publications were used to supplement innovation-related information. This approach may limit the representation of alternative perspectives. The statistical data analyzed covered only part of the implementation period for the digital healthcare contour project. Nevertheless, it incorporated indicators from official project meeting protocols, which are considered more reliable than open-source data. The ecological value domain in the context of digital innovations remains largely unexplored in routine practice, representing a frontier in fundamental research. However, its relevance is likely to grow, as collaboration will become critical in addressing environmental challenges.

Conclusion

The quantitative assessment of value alignment (Task 1) revealed that the organization and provision of medical care is the primary focus of digital innovations, accounting for 23.1% of all tokens. Topic modeling further showed that economic and systemic (sector-wide) value domains were dominant, with coherence scores of 0.721 and 0.680, respectively. Project-related patterns even surpassed health-specific values (coherence score 0.552). Coordination of efforts and platform-based interaction received the lowest score (0.353), indicating minimal interaction between healthcare stakeholders, while environmental considerations proved largely irrelevant.

For Task 2, identifying and assessing development gaps and catalysts, financial and administrative factors demonstrated the greatest significance (factor loading 0.8063). Regional digital differentiation, which is expressed through digital infrastructure, vendor services, and medical staffing, ranked second in importance (factor loading 0.9673). Even under government-led management, regulated interactions between stakeholders and digital services were the third most important factor for digitalization effectiveness. Regions with low regulation of interactions (16 out of 85) exhibited lower digitalization success, whereas 35 leading regions using multi-vendor services achieved comparable digitalization rates, albeit with costs 71.9% higher, highlighting the economic rationale for system unification to support platform goals.

Thus, the theoretical significance of the work is to confirm the applicability of the concept of responsible innovation to the context of the administrative economy, and not just market systems. The work enriches the research of areas of values at the meta-level of innovation, rather than narrow cases, and their manifestation in public health. In the healthcare system, financial and economic efficiency can conflict with platform openness, as public systems are optimized for reporting and fund disbursement rather than generating cooperative health value. Consequently, RIH principles are refracted through the specific governance context of public health.

Practically, the study identifies a development perspective for digital innovations, emphasizing the advisability of digital unification policies for regional clusters and their economic justification. Proper regulation of interactions between stakeholders and digital services is highlighted as a necessary step. Regional governments must adapt locally used innovations to enable platform expansion. Currently, the focus remains on physicians and patients, while the potential range of participants, including management bodies, related industries, and niche digital solution vendors, remains underutilized. Given the diversity of digital solutions across regions, formal coordination mechanisms are necessary to maximize stakeholder value. This is particularly relevant for crisis regions, where information interaction is underdeveloped. These findings open avenues for future research on how public-sector innovation providers adapt business models to ensure transparency, accountability, and cross-regional collaboration.

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Critical metals and minerals of Kazakhstan and other central Asian countries: institutional barriers and strategic export policy

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ABSTRACT

Relevance. Central Asia holds vast reserves of critical metals and minerals such as lithium, nickel, aluminum, copper, uranium, and rare earth elements, offering strong potential for integration into global value chains. However, its resource-dependent export model and institutional barriers hinder investment and industrial processing. Kazakhstan, with the region's largest resource base, plays a key role in shaping its critical metals and minerals strategy.

Objective. The study aims to develop an evidence-based strategic framework for Kazakhstan's export policy in critical metals and minerals, taking into account other Central Asian countries. It relies on comparative analysis, institutional assessment, and scenario-based forecasting.

Methods and Data. The methodology combines time-series analysis of export dynamics using data from international trade databases (UN Comtrade and ITC Trade Map), forecasting for 2025–2027, a comparative institutional analysis of the models of Australia, Chile, and Kazakhstan, as well as an evaluation of regulatory quality based on international indices and analytical sources.

Results. Modeling indicates a steady rise in Central Asian exports to Europe and Asia but also highlights structural imbalances and institutional barriers that hinder a transition from a resource-based model to sustainable development. Using Kazakhstan as a case study, the study proposes a framework emphasizing deeper processing, export diversification, and integration of environmental, social, and governance (ESG) standards.

Conclusions. Central Asia holds strong potential to contribute to the global energy transition, with Kazakhstan best positioned to lead a long-term export strategy. The proposed framework combines national and regional perspectives to foster industrialization, attract investment, and strengthen the region's role in the global economy.

KEYWORDS

critical metals and minerals, rare earth metals, Central Asia, export policy, institutional barriers, sustainable development, resources, investments

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Критически важные металлы и минералы Казахстана и других стран Центральной Азии: институциональные барьеры и стратегическая экспортная политика

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АННОТАЦИЯ
Актуальность. Центральная Азия располагает значительными запасами критически важных металлов и минералов, включая литий, никель, алюминий, медь, уран и редкоземельные элементы, что создаёт потенциал для интеграции в глобальные цепочки добавленной стоимости. Экспортная модель региона при этом сохраняет сырьевую направленность и институциональные барьеры, ограничивающие приток инвестиций и развитие переработки. Казахстан, обладая крупнейшей ресурсной базой, выступает естественным центром формирования региональной стратегии в сфере критически важных металлов и минералов, от успеха которой зависит и региональная динамика.
Цель исследования — формирование научно обоснованной стратегической основы экспортной политики в сфере критически важных металлов и минералов для Казахстана с учётом положения других стран Центральной Азии, на основе сравнительного анализа международных практик, а также институциональной оценки и сценарного прогнозирования.
Методология и данные. Методология опирается на анализ временных рядов экспортной динамики по данным международных торговых баз UN Comtrade и ITC Trade Map, прогнозирование на 2025–2027 годы, сравнительно-институциональное исследование моделей Австралии, Чили и Казахстана, а также оценку качества регулирования по международным индексам и аналитическим источникам.
Результаты. Математическое моделирование показало устойчивый рост экспортных потоков стран Центральной Азии в направлении Европы и Азии, при этом выявлены структурные диспропорции и институциональные ограничения, препятствующие переходу от сырьевой модели к модели устойчивого развития. На примере Казахстана разработана стратегическая рамка, включающая углубление переработки, диверсификацию экспортных направлений и внедрение стандартов экологической, социальной и корпоративной ответственности.
Выводы. Центральная Азия обладает значительным потенциалом участия в глобальном энергетическом переходе, однако именно Казахстан способен сыграть ключевую роль в формировании долгосрочной экспортной стратегии. Предложенная стратегическая рамка обеспечивает сочетание национального и регионального уровней, создавая предпосылки для индустриализации, привлечения инвестиций и укрепления позиций региона в мировой экономике.

КЛЮЧЕВЫЕ СЛОВА
критически важные металлы и минералы, редкоземельные металлы, Центральная Азия, экспортная политика, институциональные барьеры, устойчивое развитие, ресурсы, инвестиции.

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ДЛЯ ЦИТИРОВАНИЯ
Panzabekova, A. Zh., Duisen, G. M., Kopbossynova, A. N., Zhanbozova, A. B. (2025). Critical metals and minerals of Kazakhstan and other central Asian countries: institutional barriers and strategic export policy. *R-Economy*, 11(4), 406–429. doi: 10.15826/recon.2025.11.4.022

哈萨克斯坦及中亚其他国家关键金属与矿物：制度壁垒与战略性出口政策

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摘要
现实性：中亚拥有丰富的关键金属和矿产资源，包括锂、镍、铝、铜、铀和稀土元素，具备融入全球价值链的潜力。然而，该地区的出口模式仍以原材料为导向，且存在制度性障碍，限制了投资流入和加工业发展。哈萨克斯坦拥有最大的资源基础，是制定区域关键金属和矿产战略的天然枢纽，该战略的成败将决定区域格局。
研究目标：结合其他中亚国家的实际情况，通过对国际实践的比较分析、制度评估和情景预测，为哈萨克斯坦关键金属和矿产领域的出口政策制定科学的战略框架。
数据与方法：该方法基于对联合国商品贸易统计数据库和国际贸易中心贸易地图中出口动态时间序列数据的分析，对2025–2027年进行预测，对澳大利亚、智利和哈萨克斯坦的模式进行比较制度研究，并基于国际指数和分析来源对监管质量进行评估。
研究结果：数学建模显示，中亚国家对欧洲和亚洲的出口流量呈稳定增长态势，同时揭示了阻碍从资源型模式向可持续发展模式转型的结构性失衡和制度性约束因素。以哈萨克斯坦为例，本文构建了一个战略框架，包括深化加工、出口方向多样化以及实施环境、社会和企业责任标准。
结论：中亚地区在全球能源转型中拥有巨大潜力，而哈萨克斯坦尤其能够在制定长期出口战略方面发挥关键作用。拟议的战略框架连接了国家和区域层面，为工业化进程、投资吸引及巩固该地区在全球经济中的地位奠定了基础。

关键词
关键金属和矿产、稀土金属、中亚、出口政策、体制壁垒、可持续发展、资源、投资

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Introduction

Technological development and the accelerating shift toward low-carbon energy are driving unprecedented demand for critical metals and minerals (CMMs). Modern technologies, including electric vehicles, batteries, solar panels, wind turbines, microelectronics, and telecommunications, rely heavily on lithium, nickel, cobalt, copper, aluminum, and rare earth elements. These resources are becoming the backbone of the digital and "green" transformation of the global economy.

This study addresses the following question: under what institutional and strategic conditions can the countries of Central Asia, particularly Kazakhstan, leverage their critical metals and minerals (CMM) resources to transition from raw-export dependence to sustainable participation in global value chains? In other words, our task is to identify an export policy framework that would enable the rising global demand for CMMs to generate long-term competitive advantages and modernization drivers, rather than fueling another cycle of "resource volatility."

According to the International Energy Agency, between 2017 and 2022, global demand for lithium tripled, cobalt consumption rose by 70 %, nickel by 40 %, and the overall market reached 320 billion USD[1]. The high concentration of production in a few countries, primarily China, has increased dependency risks (Mancheri et al., 2019). This concentration has made Western economies strategically vulnerable, prompting intensified efforts to diversify supply sources (Kowalski & Legendre, 2023). In response, the USA and the EU have adopted national strategies that encourage domestic production, foster international alliances, and pursue forms of "resource nationalism", including control over foreign extraction, to reduce dependence on China. (Xu, 2024; Zakirov, 2025). Against this backdrop, mineral-rich regions, including Central Asia, have come into focus as potential new nodes in global supply chains.

Central Asia holds substantial reserves of uranium, lithium, aluminum, copper, chromium,

[1] International Energy Agency. (2023). *Critical minerals market review 2023*. Paris: IEA. https://www.iea.org/reports/critical-minerals-market-review-2023 (date of access: 13.05.2025)

manganese, zinc, and rare earth elements (Guseinov & Sultonazarov, 2024). Collectively, the five countries of the region account for roughly 39 % of global manganese ore reserves, 30 % of chromium, 20 % of lead, and 12–13 % of zinc, as well as significant shares of titanium, uranium, and rare metals[2]. This highlights the region's strong strategic potential in the critical metals and minerals sector — a potential that calls for a carefully designed export policy. According to the US Geological Survey, at least 384 deposits and occurrences of rare and rare-earth metals[3] have been identified across Central Asia, confirming its status as a promising supplier of strategic raw materials for the global energy transition (Issatayeva et al., 2024). In several countries of the region, export revenues from metals already equal or surpass more traditional export categories. In Kazakhstan, copper export revenues exceeded those from natural gas for the first time in 2020, while in Uzbekistan, critical minerals, primarily copper and zinc, accounted for over 11 % of total exports (Zakirov, 2025). However, resource abundance alone does not create added value. Without domestic processing capacity, predictable regulatory frameworks, and diversified sales channels, the region risks remaining locked into the role of a supplier of semi-finished materials.

The wealth of CMMs offers the countries of Central Asia unique opportunities. On the one hand, it enables them to diversify resource-dependent economies traditionally focused on oil, gas, gold, and cotton by entering the rapidly expanding market for high-tech raw materials (Rao, 2024). For Kazakhstan and Uzbekistan, critical metals could become new "growth points," reducing dependence on hydrocarbons and gold while securing a new niche in global value chains (Issatayeva et al., 2024). This potential is reinforced by geography: Central Asia borders China and is close to major markets in Europe and South Asia, which simplifies export logistics. Concrete steps toward integration into global value chains are already underway. Between 2022 and 2024, the EU signed strategic partnerships with Kazakhstan and Uzbekistan on critical raw materials, including joint "roadmaps" for industry development. Meanwhile, the USA launched the C5+1 Critical Minerals Dialogue, expressing its readiness to invest in mining and processing rare metals in Central Asia in cooperation with local governments. These initiatives reflect the West's growing interest in using the region's resources to diversify global supply chains and offset China's monopoly. This situation creates a fundamental crossroads: external initiatives provide a window of opportunity, but their success ultimately depends on domestic institutions, more specifically, the quality of mining regulation, ESG compliance, processing depth, and logistical connectivity.

On the other hand, Central Asian countries face a difficult challenge: how to convert growing global demand for CMMs into long-term development while avoiding the traps of resource dependence and environmental degradation. International experts warn that simply expanding extraction without proper governance may deepen existing structural imbalances, increase vulnerability to global price fluctuations, and cause damage to the environment (Kowalski & Legendre, 2023). The global experience of the "resource curse" shows that inflows of raw-material revenues, if not properly managed, can lead to stagnation in non-resource sectors and institutional distortions (Sachs & Warner, 2001). For Central Asian countries, which already struggle with limited diversification, weak institutions, and ecological challenges, the risk of repeating this trajectory is very real (Pomfret, 2019). The key strategic question, then, is whether investments in CMMs can drive sustainable growth or deepen the region's dependence on raw materials. To meet this challenge, export policy must reduce revenue volatility, stimulate local processing, and comply with environmental requirements.

Kazakhstan, Uzbekistan, Tajikistan, and Kyrgyzstan are seen as promising suppliers of critical resources for the global energy transition — a perception reinforced by growing interest from the European Union, the United States, and China (Zhiyenbayev, 2025). However, the region's export model remains largely resource-based as low processing depth and limited market diversification

[2] Caspian Policy Centre. (2024, February 23). *The C5+1 Critical Mineral Dialogue: What It Means and How We Got Here*. Caspian Policy. Retrieved from: https://www.caspianpolicy.org/research/central-asia/the-c51-critical-mineral-dialogue-what-it-means-and-how-we-got-here/ (date of access: 13.03.2025)

[3] USGS (United States Geological Survey)*. (2016).* Rare Earth Element (REE) and Rare Metal occurrences in Central *Asia: Inventory [Data set]*. U.S. Geological Survey. Retrieved from: https://data.usgs.gov/datacatalog/data/USGS:595a5be7e4b0d1f9f052831d (date of access: 13.05.2025)

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continue to hinder integration into global value chains[4]. This gap between resource endowment and institutional readiness defines the core focus of this study.

The main obstacles are institutional and structural. Limited transparency in subsoil regulation, low integration of ESG standards, and insufficient processing capacity constrain a sustainable export policy. According to Ernst & Young (2023), geopolitics, sustainability requirements, and supply security represent the key global risks for the mining industry. For Central Asian countries, these challenges are further compounded by social and environmental imbalances and dependence on a single external market.

In this context, Kazakhstan, with its vast resource base and stronger institutional capacity, occupies a central position in shaping the region's export strategy. The country's subsoil contains 99 of the 118 elements in the periodic table, including lithium, beryllium, tantalum, and uranium (Zhiyenbayev, 2025). However, the focus on raw exports persists, highlighting the need for a strategic framework that draws on the experiences of resource-oriented economies such as Australia and Chile.

Therefore, the analytical logic of this article combines resource, institutional, and strategic perspectives within a unified theoretical framework.

The study operates on two levels: quantitative assessment and forecasting of export flows encompassing the entire Central Asian region, while the strategic framework is developed specifically for Kazakhstan as the key regional actor. This design enables us to combine regional and national perspectives and formulate applied policy recommendations relevant to neighboring states. It also tests the hypothesis that Kazakhstan serves as the most likely "anchor" node of a regional strategy, with adjacent countries reinforcing it through a functional distribution along the value chain.

The study seeks to develop a strategic framework for Kazakhstan's critical metals and minerals export policy, drawing on international experience, institutional analysis, and the Central Asian context.

To achieve this goal, the study addresses the following objectives:

– to analyze the trends and structure of exports of CMMs in Central Asian countries, identifying imbalances and barriers that hinder deeper processing and integration into global value chains;

– to examine international experience in integrating critical resources into value chains, using examples from Australia, Chile, and other resource-oriented economies, and to identify the institutional conditions that enable them to overcome dependence on raw material specialization;

– to develop a strategic export policy framework for Kazakhstan aimed at sustainable growth, technological modernization, and export diversification.

The practical significance of the study lies in the potential application of the proposed framework in drafting the National Strategy for Critical Metals and Minerals, planning processing clusters, and coordinating interregional initiatives and partnerships with key consumer countries, including the European Union, Japan, and the Republic of Korea. The proposed approach helps balance economic efficiency, technological independence, and environmental sustainability, creating conditions for the long-term integration of Kazakhstan and other Central Asian countries into global value chains.

Theoretical Framework

The global literature on CMMs, especially rare earth elements, shows sustained interest in issues of resource security in the context of technological transformation. CMMs are highly important for the functioning of the modern economy, particularly energy, digital technologies, and defense industry, while having limited possibilities for extraction or processing, which creates risks of supply disruptions (Graedel et al., 2013; Barteková & Kemp, 2016). International organizations and national governments define the list of CMMs according to three criteria: economic significance, supply risk, and lack of available substitutes[5]. In academic literature, they are considered strategic re-

[4] OECD (2024). *Diversifying Kazakhstan's exports: Institutions, policies and infrastructures.* Organisation for Economic Co-operation and Development. Retrieved from: https://www.oecd.org/content/dam/oecd/en/publications/reports/2024/06/diversifying-kazakhstan-s-exports_6db7322e/7f9cd8aa-en.pdf (date of access: 13.05.2025)

5 CRM Alliance. (n.d.). *Critical Raw Materials (CRMs)*. Retrieved from: https://www.crmalliance.eu/critical-raw-materials (date of access: 13.05.2025)

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sources that ensure not only economic growth but also technological and national security.

The growing imbalance between global demand for such resources and their limited supply has led to the recognition of CMMs as strategic resources from economic, political, and environmental perspectives (Kooroshy et al., 2015; Gajendra et al., 2025). At the same time, CMMs have become an integral part of the "green" and digital transformation of the global economy. These resources are critical for the production of batteries, electric motors, microelectronics, renewable energy technologies, and other high-tech products (Zhou et al., 2017). CMMs are highly versatile, which gives them cross-sector significance, but their extraction and processing impose serious environmental costs. These environmental consequences pose a significant challenge to sustainable development in the sector. Contemporary research stresses the need to align industrial development with environmental protection, including the integration of Environmental, Social, and Corporate Governance (ESG) principles in mineral resource management (Wan & Wen, 2017; Stern & Valero, 2021; Pommeret et al., 2022). This perspective reflects the concept of a "just transition," which argues that the development of low-carbon technologies must consider the socio-environmental consequences of critical material extraction (Brown et al., 2024). Sustainable CMM management therefore requires increasing production while minimizing environmental harm and complying with international standards for responsible resource use.

Importantly, the global transition to a low-carbon economy does not reduce, but rather sharply increases demand for critical minerals. The spread of electric vehicles, renewable energy, and digital technologies means that more minerals are required per unit of new infrastructure than before. According to the International Energy Agency, in the 2020s, the average amount of mineral resources needed to build a new power generation facility is 50 % higher than in 2010 due to the growing share of renewable energy sources[6]. The World Bank estimates indicate that decarbonizing global energy by 2050 will require about 3 billion tons of various critical materials[7]. This surge in demand makes it necessary to modernize the export policies of resource-supplying countries to avoid vulnerability and supply instability (Mealy & Teytelboym, 2022; Ayres & Peiró, 2013). In other words, states with rich CMM reserves are compelled to develop strategies for integrating into new global supply chains, otherwise they risk remaining mere raw-material appendages in the context of growing competition for resources. Moreover, the dominance of developed countries in controlling technology and final production exacerbates challenges for developing resource economies. Therefore, without improvement in national institutions and policies, it may be difficult to monetize the mineral wealth of such economies.

A substantial body of research is devoted to the institutional conditions for effectively integrating critical resources into global value chains. The experience of several resource-oriented economies shows that strong institutions and proactive industrial policy can enable countries to move beyond raw-material specialization. In Australia and Chile, for example, a clear delineation of the roles of the state and business, government support for deep processing of raw materials, stimulation of R&D, and facilitation of access to international markets have contributed to the creation of more resilient export models (Mealy & Teytelboym, 2022; Cheng et al., 2024). Australia, for instance, has established a transparent regulatory framework and attracted investment in the processing of lithium and rare metals, enabling partial localization of battery and magnet production (Kowalski & Legendre, 2023). Chile, endowed with large reserves of copper and lithium, has strengthened its mining and metallurgical sector through stable fiscal policy (e. g., a copper revenue fund) and partnerships with international corporations, though it continues to strive to increase the share of high value-added exports (Solimano, 2017). In African countries such as Botswana, institutional reforms and agreements with multinational companies (for example, in diamond min-

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[6] International Energy Agency (2021). The Role of Critical Minerals in Clean Energy Transitions. Paris: IEA. Retrieved from: https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions (date of access: 13.05.2025)

[7] World Bank. (2020). Minerals for climate action: The mineral intensity of the clean energy transition. Washington, DC: World Bank. Retrieved from: https://commdev.org/publications/minerals-for-climate-action-the-mineral-intensity-of-the-clean-energy-transition/ (date of access: 13.05.2025)

ing) have helped channel part of the revenues into domestic development and increase processing localization (Acemoglu & Robinson, 2012).

On the contrary, states with institutional rigidity and an unfavorable investment climate show slow progress up the value chain, high dependence on raw-material exports, and a limited processing base (Graedel et al., 2013; Gajendra et al., 2025). For example, many Central African countries remain raw-material suppliers (of cobalt, coltan, etc.) to the global economy with almost no processing involvement, often due to shortcomings in governance and infrastructure (Addison & Roe, 2018). Thus, the institutional factor is recognized as decisive when resource economies attempt to diversify exports: sustainable integration into global value chains requires a predictable regulatory environment, investor rights protection, development of human capital and technology, as well as a coordinated sector development strategy (Auty, 1993; Hausmann et al., 2008).

Despite significant reserves of critical minerals and metals, Central Asian countries remain weakly integrated into the discourse on global resource security. As noted by Vakulchuk and Overland (2021), the region has the potential to become an important supplier of critical minerals for the global green economy, yet the lack of coordinated policy and low levels of local processing significantly limit this potential. Systematic studies of export strategies, investment barriers, and institutional environments in Central Asian countries in relation to the critical minerals sector are virtually absent in international literature. For example, Kazakhstan, Uzbekistan, and Kyrgyzstan possess reserves of lithium, uranium, and rare earth elements, but available data on their integration into global value chains are fragmented (Vakulchuk & Overland, 2021). Nevertheless, amid the global search for new supply sources, interest in Central Asia is increasing, as the region is viewed as a promising yet underexplored contributor to the critical minerals sector.

Early specialized publications on Central Asian countries converge on the view that a shift away from raw-material export specialization towards industrialization and deeper raw-material processing in the region is necessary. An OECD review on Kazakhstan also notes that the continued orientation towards raw-material exports reflects the low competitiveness of the processing sector as well as infrastructural and institutional barriers hindering integration into global value chains[8]. In particular, underdeveloped transport logistics, limited access of SMEs to financing, and incomplete adoption of quality standards impede the export of high value-added products. It is essential to adopt international environmental and social standards to secure Western investment and ensure sustainable supply chains (Stern & Valero, 2021; Tamula et al., 2024). In a similar vein, analysts view the resources of Central Asia as a new field of competition among world powers, emphasizing that only by improving the internal investment climate and governance transparency can countries in the region profitably capitalize on their mineral wealth without becoming dependent on a single party[9].

Confirming these findings, Kuur et al. (2024) conducted an analysis of the level of ESG adoption (environmental, social, and corporate governance principles) in Kazakhstan in light of sustainable development goals. The authors pointed to a decline in the country's rankings in international sustainability indices and highlighted institutional and informational gaps that hinder the advancement of environmentally responsible investments and the disclosure of non-financial reporting according to global standards. Without systemic measures to strengthen ESG infrastructure — from better environmental regulation to greater transparency in mining — Kazakhstan will struggle to move from raw material exports to a sustainable, strategic critical materials policy (Kuur et al., 2024). This conclusion also applies to other Central Asian countries, where environmental and social impacts of extractive projects are becoming increasingly important for international partners and investors.

Despite the emergence of some analytical works and reports, a large part of the literature on Central Asia remains descriptive and does not of-

[8] OECD. (2024). Diversifying Kazakhstan's exports: Institutions, policies and infrastructures. Organisation for Economic Co-operation and Development. Retrieved from: https://www.oecd.org/content/dam/oecd/en/publications/reports/2024/06/diversifying-kazakhstan-s-exports_6db7322e/7f9cd8aa-en.pdf (date of access: 13.05.2025)

[9] Stockholm International Peace Research Institute. (2024). Critical Minerals and Great Power Competition. SIPRI. Retrieved from: https://www.sipri.org/sites/default/files/2024–10/critical_minerals.pdf (date of access: 13.05.20

fer comprehensive conceptual solutions. There is a clear lack of studies that systematically analyze the institutional conditions for developing export policy and compare regional practices with successful models from resource-driven economies. The absence of such a comparative and comprehensive perspective hinders the development of effective strategies: solutions that proved effective in Australia or Chile have not been adapted and tested in the context of the post-Soviet economies of Central Asia. This gap underscores the need for a comprehensive approach to devising a "new generation" export policy in the critical minerals sector that would combine economic efficiency, institutional reform, and environmental sustainability.

Thus, despite the breadth of available work covering technological, environmental, and certain institutional aspects of critical minerals management, the academic literature reveals a clear shortage of comprehensive studies devoted to the strategic conceptualization of export policy in Central Asian countries. This gap is particularly evident in Kazakhstan, where abundant critical mineral resources have not yet been accompanied by the development of a long-term model for integration into global value chains. This study seeks to fill this gap. Drawing on a comparative analysis of international practices and taking into account regional institutional, economic, and environmental realities, it develops an evidence-based strategic framework for Kazakhstan's export policy (with consideration of other Central Asian states) in the CMM sector. This will lay the groundwork for a transition from a fragmented raw material export model to a sustainable system integrated into the global economy and ensuring a balance between economic benefit, technological modernization, and the principles of sustainable development.

Methods and Data

The study's methodological framework relies on an interdisciplinary approach that combines methods of applied economic analysis, institutional economics, and comparative research.

The work was structured in several stages. The first stage involved analyzing and forecasting the dynamics of mineral raw material exports from Central Asian countries to Europe and Asia using time series analysis methods. The initial data on the value of exports of ores, metals, and precious stones (SITC Rev.4 groups: 27–29, 68–69, 667, 971) for the period 2015–2023 were obtained from the UN Comtrade and ITC Trade Map international databases. To forecast the period 2025–2027, a linear trend model was applied, with parameters estimated using the least squares method. The choice of a linear specification was determined by the stable upward trend in export flows and the absence of pronounced seasonality. The model's adequacy was assessed using the coefficient of determination (R^2) and residual analysis to ensure a statistically reliable forecast of the region's short-term export activity. Even though the model has limitations in data and parameters, it remains adequate for its purpose, providing a scenario-based assessment of key directions for CMM export policy rather than a universal forecast. Such an approach aligns with global research practice, where models are employed as tools for identifying imbalances and testing hypotheses rather than as definitive predictions of trends. The results of this modelling will help establish broad guidelines and highlight institutional factors that require priority attention. The model can be refined and expanded as more data become available; however, even at the current stage, it demonstrates analytical value for developing strategic decisions.

The second stage aimed to identify relevant solutions that have ensured the successful integration of resource-oriented economies into global value chains. To this end, Australia, Chile, and Kazakhstan, differing in their levels of export diversification, were compared. The comparison was conducted across several criteria: the degree of localization of raw material processing; diversification of export markets; investment attraction tools; the institutional framework of state regulation; and the implementation of ESG standards and sustainable development.

Sources of information on institutional models included materials from the OECD, World Bank, UNCTAD, as well as national strategies for industrial and mining development in the respective countries, including the state programs of the Republic of Kazakhstan and analytical reviews by Eurasian Resources Group.

The third stage involved an institutional analysis based on the concepts of new institutional economics. The focus was on assessing the quality of institutions in the areas of subsoil use regulation, licensing, resource property rights allo-

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cation, and state–private sector interaction. This analysis drew on international indices (Worldwide Governance Indicators, Resource Governance Index) and expert interviews that reflected perceptions of barriers to implementing investment projects and the level of institutional integration of Central Asian countries into global rare earth metals markets.

These stages enabled a comprehensive assessment of export policy, combining trade data and institutional analysis to produce strategic recommendations for Central Asia, especially Kazakhstan.

Results

The countries of Central Asia are evolving into major players in the CMM market due to their vast mineral reserves (Huseynov & Sultonazarov, 2024). Figure 1 shows estimated reserves of key minerals in Central Asia, highlighting the region's potential for integration into global strategic supply chains.

These data highlight Central Asia's significant resource potential in the field of CMMs, including rare metals:

1) Manganese ores (38.60 %) — Central Asia, particularly Kazakhstan, holds over one-third of the world's manganese reserves, positioning the region as a key strategic player in global metallurgy, especially in the production of alloyed steels and battery materials.

2) Chromium ores (30.07 %) — Central Asia ranks among the global leaders in chromite reserves, used in metallurgy and the chemical industry. This creates opportunities for advancing local processing and exporting high-tech products.

3) Lead ores (20 %) — Accounting for one-fifth of global reserves, the region plays an important role in supplying raw materials for energy-intensive and engineering industries. Lead is critical for battery and cable manufacturing. Kazakhstan's share of the global lead market is nearly 3 %. In 2021, the country ranked 8th in the world by reserves (2 million tonnes) and 12th by production (40,000 tons). Global annual demand for lead is expected to rise from 11.6 million tons in 2022 to 13.4 million tons by 2031.

4) Zinc ores (12.60 %) — Substantial zinc resources strengthen the region's export potential. Zinc is widely used in construction, automotive manufacturing, and anti-corrosion coatings. Kazakhstan accounts for nearly 5 % of the global zinc market and ranked 7th worldwide in 2023 with reserves of 6.7 million tons. In 2022, 70 % of Kazakhstan's zinc exports went to Turkey, Russia, and China.

5) Titanium ores (8.70 %) — A high-tech strategic metal used in aerospace, medical, and defense industries. The region's reserves provide a strong foundation for developing innovation-driven industrial clusters.

Central Asia and especially Kazakhstan thus possesses vast and diverse reserves of critical metals and minerals that offer significant strategic advantages (Figure 2).

With efficient resource use and advanced processing technologies, the region could establish it-

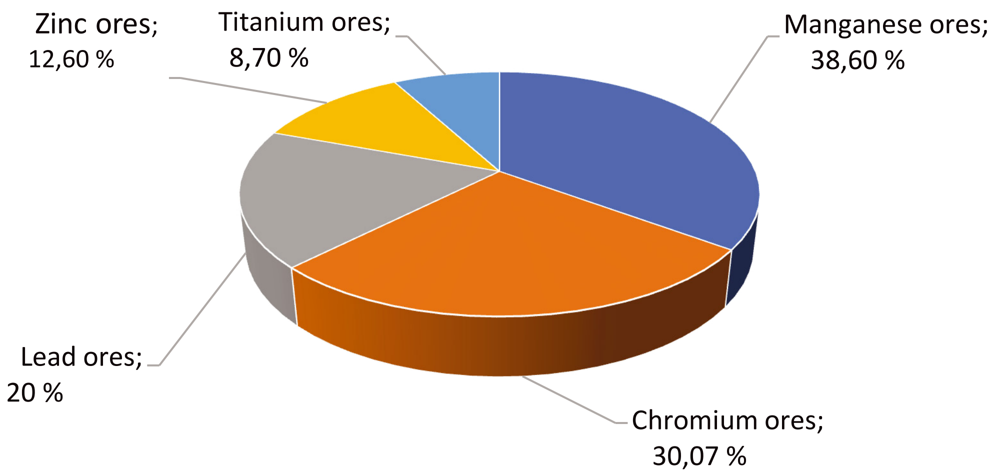

Figure 1. *Share of Central Asian countries in the world reserves of certain types of mineral raw materials (%)*
Source: Guseinov & Sultonazarov (2024)

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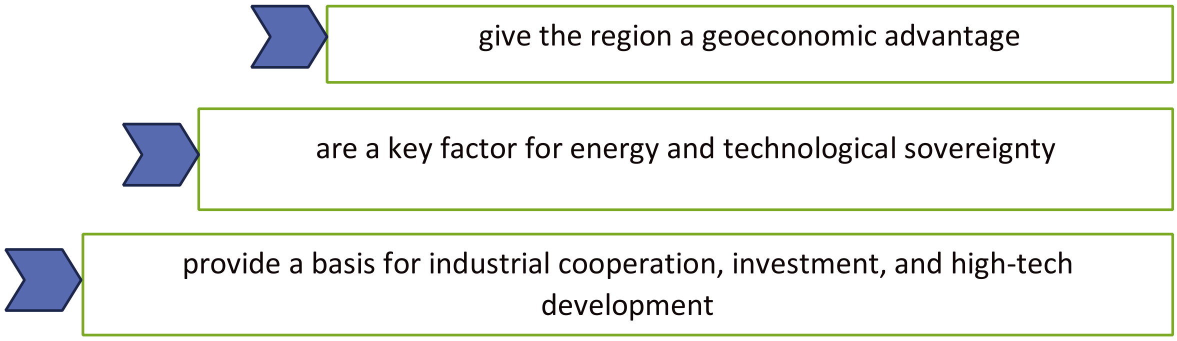

Figure 2. *The strategic importance of CMMs for the geoeconomic and technological development of Central Asia*

Source: Compiled by the authors

self as a global leader in CMM production for the green and digital economy.

Kazakhstan has the potential to compete with China, which currently dominates the production of rare earth elements (accounting for 70 % of global output), including metals such as scandium, yttrium, and the 15 lanthanoids. These elements are widely used in the manufacture of computers, turbines, and vehicles. The United States and the European Union are showing strong interest in investing in large-scale mining projects in Kazakhstan, as their heavy dependence on Chinese rare earths has prompted a search for alternative supply sources. These developments show that the issue of critical minerals export has already reached the international level.

Central Asian countries, rich in critical minerals, could be key to global technological progress and the energy transition. Their CMM reserves are seen in the SWOT analysis as a major strength and opportunity provided that internal weaknesses and external risks are addressed (Table 1).

Monazite, zircon, apatite, xenotime, pyrochlore, allanite, and columbite are among the most common rare metals and minerals in Central Asia, found in large volumes in the Kazakh steppe, the Tian Shan mountains, and the Pamirs. The substantial potential for extracting rare earth elements points to promising opportunities for resource development. Even now, minerals and metals account for over 50 % of Kyrgyzstan's exports and more than 30 % for Uzbekistan and Tajikistan, according to the International Energy Agency.

These minerals are vital to modern technology and industry, from electronics and energy to aerospace and agriculture, underscoring their importance for technological advancement and global economic growth.

The export of ores, metals, and precious stones is not dominated by a single country, such as China, but split between two major consumers, although Asia's share is gradually increasing (Figure 3). This rising demand from Asia underscores the need for a targeted export strategy for CMMs to reduce market dependence and fully leverage the region's potential.

To determine the forecast values of the indicators «Export of ores, metals, and precious stones from Central Asia to Europe and Asia, thousand USD» for 2025–2027, a trend model was used.

Initially, the hypothesis of the absence of anomalous observations in the time series was tested. This hypothesis was confirmed using Irwin's criterion.

The approximation of the original data was performed using a first-degree polynomial. The parameters of the chosen growth curve were estimated using the least squares method. As a result, the following trend models were obtained:

— For the export indicator to Europe:

$$y_t = 6\,173\,583{,}57 + 600\,335{,}68t; \qquad (1)$$

— For the export indicator to Asia:

$$y_t = 4\,016\,694{,}29 + 1\,149\,075{,}54t. \qquad (2)$$

The quality of the resulting models was assessed in two directions: testing adequacy and evaluating model accuracy.

To test model adequacy, the residual series were examined, that is, the differences between the levels calculated by the model and the actual observations. The most important properties of the

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Table 1

SWOT analysis of Central Asian countries' position regarding CMMs

S	W
– significant reserves of CMMs give the region a geo-economic edge; – strategic location between Europe and Asia aids market access; – rising demand for CMMs from countries undergoing the energy transition (EU, China, USA, etc.)	– insufficient processing and technological backwardness: limited raw material processing capacity within the region; – low investment in research and innovation in the mining and processing industries; – dependence on raw material exports rather than creating added value domestically
O	**T**
– economic development and diversification — investments in mining and processing enterprises can stimulate job creation, infrastructure development, and technology transfer, enhancing overall economic resilience; – strategic partnerships and foreign investment — inflows of capital and expertise can support other economic sectors, improve infrastructure, and build human capital through education and training programs sponsored by foreign partners; – increased strategic importance on the global stage	– seeking to develop their mineral wealth, Central Asian countries may become overly dependent on one or more external powers for economic stability; – environmental degradation (water pollution, soil degradation, and habitat destruction); – socio-economic imbalances — foreign investment inflows and a focus on CMM extraction may worsen inequality in Central Asian countries; – geopolitical competition; – price fluctuations in global raw material markets

Source: Compiled by the authors

residual component are as follows: a mean value equal to zero, randomness of residuals, and conformity to the normal distribution law.

The results of the residual series analysis for model adequacy testing are presented in Tables 2 and 3.

To assess the accuracy of the models, the mean relative approximation error was calculated:

$$E_{rel.} = \frac{1}{n}\sum_{i=1}^{n}\frac{|e_t|}{y_t}\cdot 100\ \% \qquad (3)$$

— For the indicator of exports to Europe: $E_{rel.} = 6{,}38$;

— For the indicator of exports to Asia: $E_{rel.} = 8{,}11$.

These values indicate a sufficient level of model accuracy. Therefore, the models are of good quality and can be used for forecasting. To calculate the point forecast, the relevant variable values were substituted into the constructed models. For the interval forecast, a confidence interval was determined at a significance level of $\alpha = 0{,}05$.

The results of the point and interval forecasts for 2025–2027 are presented in Tables 4 and 5.

The modeling and forecasting results of the examined indicators are presented graphically in Figures 4 and 5.

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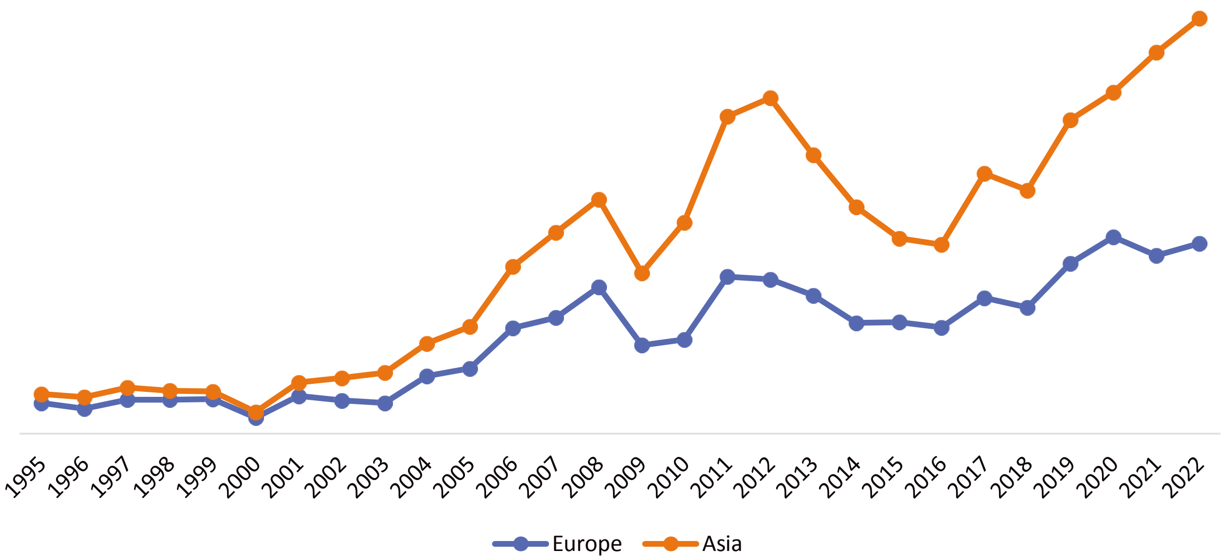

Year	Europe	Asia	Year	Europe	Asia
1995	1524230	448448	2010	4695257	5875797
1996	1245829	584628	2011	7844200	8018874
1997	1697551	617496	2012	7737592	9065874
1998	1711496	448490	2013	6920646	7018178
1999	1718583	394647	2014	5556343	5804768
2000	797297	288738	2015	5567913	4206993
2001	1897074	677675	2016	5310850	4153842
2002	1678623	1105244	2017	6784154	6220330
2003	1540868	1508041	2018	6305547	5873181
2004	2873796	1640208	2019	8533675	7182873
2005	3252805	2114345	2020	9843199	7239856
2006	5280296	3095310	2021	8923897	10150810
2007	5811244	4259455	2022	9519303	11258245
2008	7327809	4420455	2023	10114709	12365680
2009	4429577	3616301	-		

Source: Compiled by the authors

Figure 3. *Export of ores, metals, and precious stones from Central Asia to Europe and Asia (1995–2023), thousand USD*

Source: Guseinov & Sultonazarov (2024)

The calculations and models show high accuracy and reliability, confirmed by acceptable error levels and residual normality. The forecasted export values of ores, metals, and precious stones from Central Asia to both Europe and Asia for 2025–2027 indicate a stable upward trend in the region's foreign economic activity.

The interval forecasts, at a significance level of α = 0.05, cover a wide range, indicating persistent uncertainty linked to global economic and political factors. Nevertheless, they provide a reliable assessment of possible development scenarios. The growth in export indicators, particularly toward Asian markets, highlights the region's increasing importance in in-

Table 2

Model adequacy test for the indicator of exports to Europe

Tested Property	Statistic Used		Threshold	Conclusion
	Name, calculation formula	Value obtained		
Randomness	"Peaks" criterion (turning points) $p > \left[\frac{2}{3}(n-2) - 1{,}96\sqrt{\frac{16n-29}{90}}\right]$	2 > 1	1	Adequate
Normality	RS criterion $RS = \frac{e_{\max} - e_{\min}}{S}$	3.17	2,67–3,69	Adequate
Equality of the expected value of residual series levels to zero	Student's t-statistic $t_{obs.} = \frac{\lvert \bar{e} \rvert}{S}\sqrt{n}$	0	2.57	Adequate

Source: Compiled by the authors

Table 3

Model adequacy test for the indicator of exports to Asia

Tested Property	Statistic Used		Threshold	Conclusion
	Name, calculation formula	Value obtained		
Randomness	"Peaks" criterion (turning points) $p > \left[\frac{2}{3}(n-2) - 1{,}96\sqrt{\frac{16n-29}{90}}\right]$	2 > 1	1	Adequate
Normality	RS criterion $RS = \frac{e_{\max} - e_{\min}}{S}$	3.12	2,67–3,69	Adequate
Equality of the expected value of residual series levels to zero	Student's t-statistic $t_{obs.} = \frac{\lvert \bar{e} \rvert}{S}\sqrt{n}$	0	2.57	Adequate

Source: Compiled by the authors

Table 4

Point and interval forecasts of the indicator «Export of ore, metals, and precious stones from Central Asia to Europe» for 2025–2027

Year	Point forecast, thousand USD	Interval forecast, thousand USD	
		Upper bound	Lower bound
2025	11,576,604.68	6,372,308.79	16,780,900.57
2026	12,176,940.36	6,615,290.10	17,738,590.62
2027	12,777,276.04	6,853,848.63	18,700,703.44

Source: Compiled by the authors

Table 5

Point and interval forecasts for the indicator «Export of ores, metals, and precious stones from Central Asia to Asia» for 2025–2027

Year	Point forecast, thousand USD	Interval forecast, thousand USD	
		Upper bound	Lower bound
2025	14,358,374.11	8,862,086.77	19,854,661.45
2026	15,507,449.64	9,633,758.26	21,381,141.02
2027	16,656,525.18	10,400,758.84	22,912,291.51

Source: Compiled by the authors

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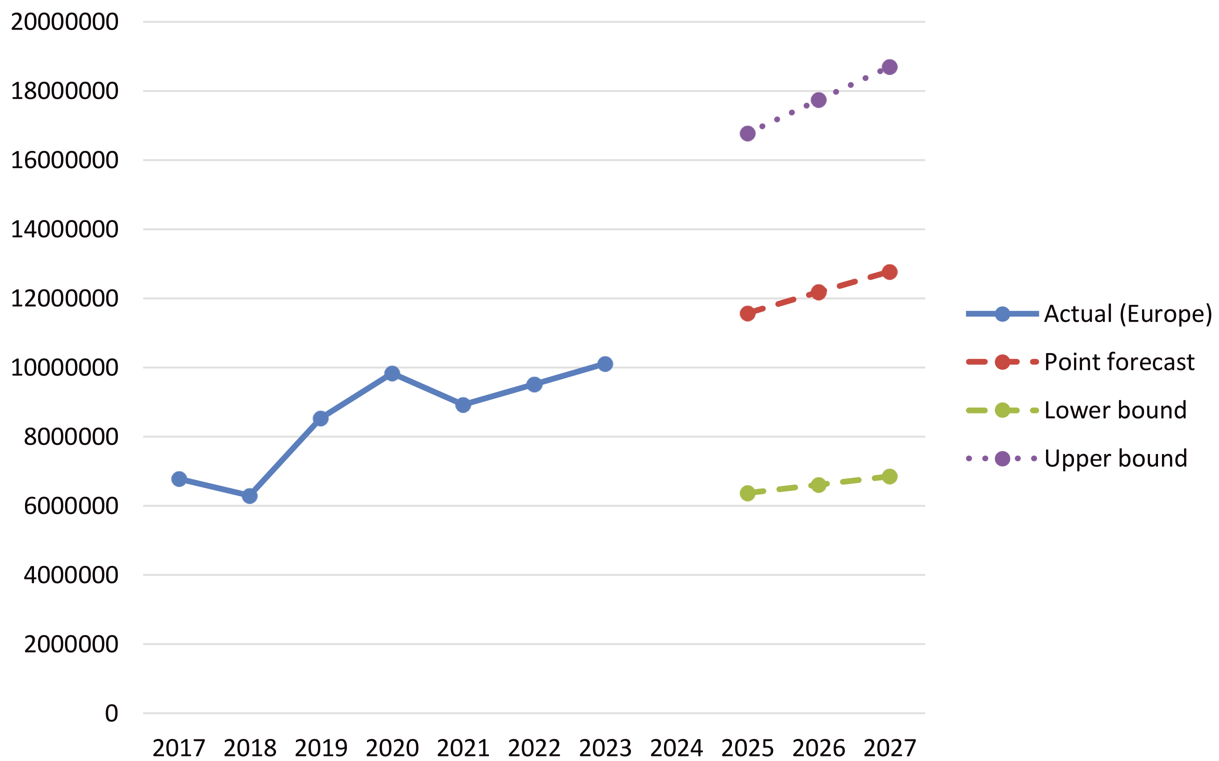

Figure 4. *Point and interval forecasts of "Export of ores, metals, and precious stones from Central Asia to Europe" for 2025–2027, thousand USD*
Source: Compiled by the authors

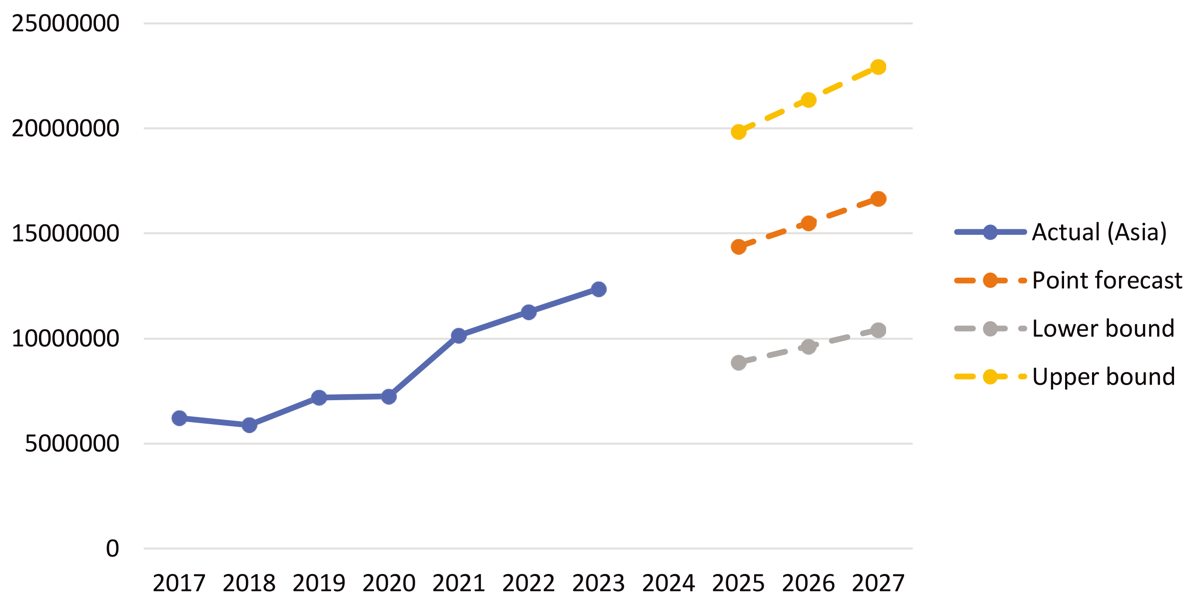

Figure 5. *Point and interval forecasts of the indicator "Export of ores, metals, and precious stones from Central Asia to Asia" for 2025–2027, thousand USD*
Source: Compiled by the authors

ternational trade in raw materials and reinforces the need for continued modernization of infrastructure, logistics, and export management systems. According to the models, critical metals, whose global demand is rising, are expected to make the largest contribution to this growth.

Our findings can be applied in strategic planning, the design of export programs, investment projects, and the implementation of interregional initiatives within the framework of Eurasian cooperation.

Amid growing global demand for critical resources and rare earth metals, Central Asia faces a dual challenge: on the one hand, the region possesses significant natural potential; on the other, it lacks a unified integration model or a specialized regional structure capable of coordinating export strategies across all Central Asian countries. Despite the existence of organizations such as the EAEU, CSTO, SCO, CIS, and various multilateral dialogue platforms, none serve as a universal mechanism encompassing all Central Asian states or the major Eurasian powers — Russia, China, and India (Table 6).

This increases fragmentation in approaches to managing strategic natural resources and complicates the development of a coordinated export policy grounded in common interest and cooperation. Lessons from resource-rich countries (such as Chile in copper, Australia in lithium and rare earth elements, and Norway in oil and gas) show that a successful resource strategy requires institutional consolidation, a transparent regulatory environment, and export cooperation.

Among Central Asian countries, Kazakhstan possesses world-significant reserves of uranium, chromium, zinc, manganese, copper, and phosphorites. In total, Kazakhstan has 233 mining sites and deposits, of which 151 belong to local companies — some state-owned, others private. The largest is the state company Saryarka (Table 7).

The largest deposits are developed by three corporations jointly owned by local and foreign investors: Eurasian Resources Group (ERG), Kazakhmys Corporation, and KazZinc. The largest of these is ERG, which in 2020 controlled one-third of the country's mining and metallurgical production. ERG is the world's largest producer of high-carbon ferrochrome and one of the largest producers of aluminum, iron ore, copper, and cobalt in the former Soviet Union.

Uzbekistan is rich in deposits of ferrous and non-ferrous metal ores, as well as uranium. Kyrgyzstan's mineral base includes deposits of precious, non-ferrous, rare metals, and non-metallic resources. Tajikistan is rich in uranium deposits, aluminum ores, and polymetallic ores (Table 8).

Many of Central Asia's resource reserves require further exploration and study.

Drawing on their analysis and forecasts, we propose projects in three areas — export programs, investment projects, and interregional initiatives. These proposals are designed as strategic, forecast-based measures built on the following:

1. Results of modeling and forecasts for ore and metal exports for 2025–2027 (point and interval estimates);

2. SWOT analysis of the potential of the Central Asian region;

3. Geoeconomic trends (demand for rare earth elements, diversification of supplies to the EU and Asia, sustainable supply chains),

Table 6

Major regional integration groups and international organizations involving Central Asian countries

<table>
<tr><th colspan="2" rowspan="2">Countries</th><th colspan="4">Organizations</th></tr>
<tr><th>EAEU</th><th>SCO</th><th>CSTO</th><th>CIS</th></tr>
<tr><td rowspan="5">Central Asia</td><td>Kazakhstan</td><td rowspan="2">Participant</td><td rowspan="3">Participant</td><td rowspan="3">Participant</td><td rowspan="6">Participant</td></tr>
<tr><td>Kyrgyzstan</td></tr>
<tr><td>Tajikistan</td><td rowspan="2">–</td></tr>
<tr><td>Turkmenistan</td><td>–</td><td rowspan="2">–</td></tr>
<tr><td>Uzbekistan</td><td>Observer</td><td rowspan="4">Participant</td></tr>
<tr><td rowspan="3"></td><td>Russia</td><td>Participant</td><td>Participant</td></tr>
<tr><td>China</td><td></td><td rowspan="2">–</td><td rowspan="2">–</td></tr>
<tr><td>India</td><td></td></tr>
</table>

Source: Compiled by the authors

Table 7

Location of mining companies operating in Central Asia, particularly in Kazakhstan

Legal address/company name	Mineral	Deposit
Kazakhstan		151
Saryarka	Cu, Fe, Mn, Mo, Ni, Co	14
Dzharkulskoye	Fe	5
Arman	Mn	4
Nadezhdinskoye	Fe	3
Tau-Ken Samruk	Cu, Fe, Mo, W	3
Other small local companies	other minerals	122
Multinational		30
Kazakhmys Corporation and KAZ Minerals (Kazakhstan, Singapore, UK)		
Kazakhmys	Cu, Zn	25
KazMinerals Plc Bozshakol	Cu	1
Idygei Project	Cu	1
Itauiz Project	Cu	1
Tamdy-Sainbulak Project	Cu	1
Kazakhmys and Metals of Central Asia	Cu	1
Eurasian Resources Group (ERG) (multinational)		28
TNC "Kazchrome"	Cr, Mn, Si-Mn	11
Aluminium of Kazakhstan	Al, Ga	10
Sokolov-Sarbai Mining and Processing Production Association	Fe	6
Kazakhstan Aluminum Plant	Al	1
Kazzinc (Kazakhstan, Switzerland)		13
KazZinc	Cu, Pb, Zn, Cd, Ag, Se, Te, In	8
Zhairem Mining and Processing Plant (subsidiary of KaZinc)	Cu, Mn	5
Russia	Cu, Zn, Pb	5
China	Fe, Al, Cu	3
Belgium	Te	1
Turkey	Cr	1
UK	Cu	1

Source: U.S. Geological Survey. (2023). Mineral commodity summaries 2023. U.S. Department of the Interior. https://doi.org/10.3133/mcs2023

Table 8

Estimated reserves of major mineral resources in Central Asian countries, %, including critical resources

Resource	Country				
	Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan
Uranium	13.0	less than 0.1	less than 0.1	-	2.0
Copper	~4,0	less than 0.1	less than 0.1	less than 0.1	~0,5
Aluminum (bauxite)	~0,7	less than 0.1	less than 0.1	less than 0.1	~0,2
Rare earth metals	1.0	less than 0.1	0.1	less than 0.1	0.1
Nickel	2	less than 0.1	less than 0.1	less than 0.1	~0,2

Sources: EI Statistical Review (2025). Statistical Review of World Energy. Retrieved from: https://www.energyinst.org/statistical-review (date of access: 15.06.2025); World nuclear association (2025). Uranium Supply. Retrieved from: https://world-nuclear.org/information-library/nuclear-fuel-cycle/uranium-resources/supply-of-uranium. (date of access: 15.06.2025)

Table 9

Strategic initiatives for CMM export policy, drawn from the research findings

№	Proposal (program)	Objective	Key areas	Description
1	Export program: "Eurasia Metals"	Increasing the volume and added value of raw material exports (ore, non-ferrous and rare earth metals) from Central Asian countries to Europe and Asia	Diversification of the export range	Shifting from raw material exports to exports of semi-finished and finished products (e.g., alloys, cathodes, metal concentrates)
			Development of logistics corridors	Strengthening the Trans-Caspian International Transport Route (TITR) and rail logistics through Kazakhstan, Uzbekistan, and Turkmenistan
			Long-term contracts	Contracts with major Asian and European metallurgical companies with fixed pricing policies and investment commitments
			Digital supply control platform	Implementation of a blockchain- and AI-based traceability and analytics system for export operations
2	Investment project: Rare Metals Valley — Kazakhstan	Creation of an industrial technopark and cluster for processing rare earth and non-ferrous metals in central Kazakhstan	Creation of a next-generation metallurgical complex	Purification, refining, alloying, and packaging
				Engineering center and laboratories for applied R&D in metal extraction, utilization, and recycling technologies
				Training center: professional courses in rare earth metallurgy, chemistry, logistics management, and export
			Investment volume	~$250 million (of which 30 % are private, 30 % are international, and 40 % are government subsidies)
3	Interregional initiative: Eurasian Mineral Alliance (EMA)	Coordination of extraction, processing, and export policies for critical minerals among Central Asian countries, the EAEU, and partners from the EU, China, and South Korea	Creation of a common regulatory framework	Standards for environmental, social, and technological responsibility (ESG)
			Joint forecasting and regulation of exports	Introduction of a quota system and priority markets
			Creation of the Eurasian Sustainable Mineral Supply Fund	Infrastructure support, financing of strategic projects
			Technology exchange	Creation of an exchange platform between scientific institutions, business and the government in the field of "green metallurgy"
			Establishment of an annual EMA Forum	Discussion of macroeconomic, trade, logistics and ESG issues

Source: Compiled by the authors

4. Sustainable Development Goals (SDGs) and strategies for industrial cooperation within the framework of the EAEU and SCO (Table 9)

Expected results from implementing these programs include the following: a 20–25 % increase in metal exports to the EU and Asia by 2030; GDP growth in participating countries through industrialization and adoption of digital solutions; geoeconomic strengthening of Central Asia's position as a key raw-material hub; and increased employment and skill levels among local workforces.

Kazakhstan can ensure uninterrupted supply of CMMs and help meet growing global demand driven by the energy transition and the expansion of the electric vehicle market. Kazakhstan has export potential in nine product groups, including critical metals it already exports and others with untapped potential, most notably lithium, nickel, and rare earth metals. Kazakhstan has demon-

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Table 10

Investment projects

	Investment project	Investor's country	Region	Cost, million dollars
A	Construction of a mining and beneficiation plant for lithium extraction and processing	Germany	East Kazakhstan	470
B	Processing of pegmatite ores to produce lithium oxide concentrate (Asubulak pegmatite deposit)	Germany	East Kazakhstan	180

Source: AIFC Authority (2024). Reserves of critically important raw materials allow Kazakhstan to become a leading supplier in the context of the energy transition. Retrieved from: https://aifc.kz/ru/novosti/zapasy-kriticheski-vazhnogo-syrya-pozvolyayut-kazahstanu-stat-vedushhim-postavshhikom-v-ramkah-energeticheskogo-perehoda/ (date of access: 06/15/2025)

strated comparative advantages in the global market for copper, zinc, aluminum, silver, and lead. Rare earth metals are seen as potential resources for emerging exports that could give Kazakhstan a competitive edge in the world market.

Kazakhstan accounts for nearly 4% of the global copper market. In 2023, it ranked 11th in the world in copper reserves with 20 million tons. In 2022, Kazakhstan's top three copper export destinations were China, Turkey, and the UAE.

Kazakhstan's share of the global aluminum market is less than 1%. In 2023, it ranked 11th worldwide in bauxite reserves (160 million tons) and 10th in bauxite production (4.3 million tons). In 2022, the top three export destinations for Kazakh aluminum were Turkey, Italy, and Greece.

Metals with export potential that remain underdeveloped include the following:

1. Nickel — Kazakhstan is among the world's top 20 countries in nickel reserves, holding about 1.5 million tons, or 2% of global reserves. However, current global demand is low. Annual global demand for nickel is expected to rise from the current 3 million tons to between 3.9 and 5.8 million tons by 2030, and to between 4.8 and 6.5 million tons by 2050.

2. Lithium — Kazakhstan's geological services already cooperate with companies from Germany, South Korea, and the UK on exploration and development of lithium deposits in East Kazakhstan. In March 2024, the Korean Institute of Geological-Geophysical Research and Mineral Resources discovered a new lithium deposit in East Kazakhstan with a 5.3% lithium content, valued at about $15.7 billion. Kazakhstan's lithium deposits are concentrated in Yubileynoye, Verkhne-Baymurzinskoye, Bakennoye, Akhmetkino, Medved-

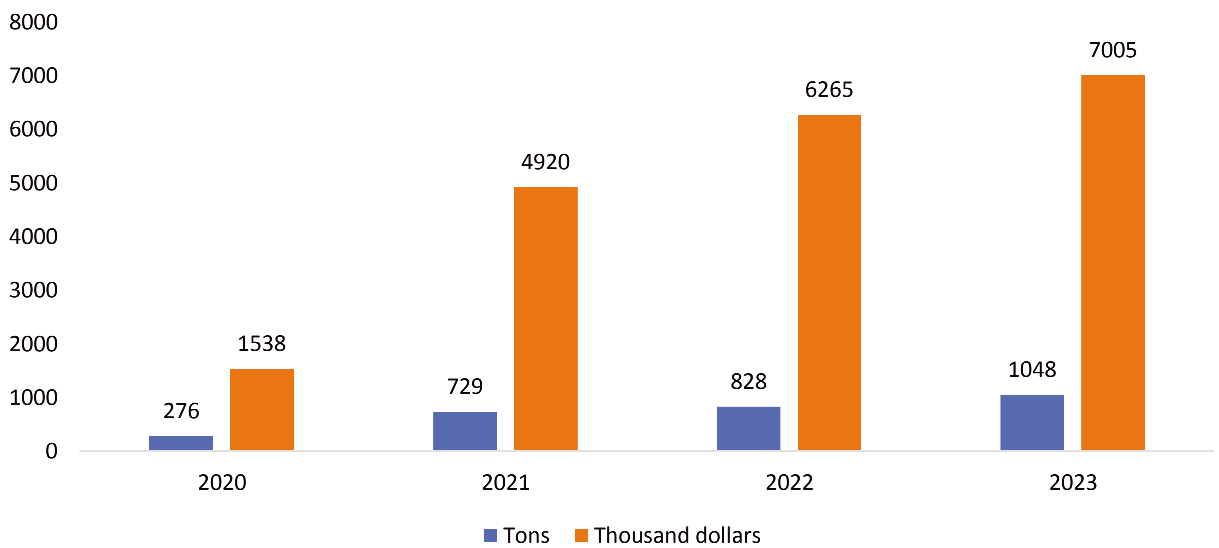

Figure 6. *Dynamics of Kazakhstan's CMM exports (HS codes 280530 and 284690)*

Source: Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan, https://stat.gov.kz/(date of access: 15.06.2025) ka, and Akhmirovskoye. Currently, Kazakhstan's lithium reserves and projects are concentrated in East Kazakhstan Region (Table 10).

Since 2020, Kazakhstan's export of rare and rare-earth metals has increased 4.6 times in dollar terms and 3.8 times in real terms. In December 2023, Kazakhstan adopted the Comprehensive Development Plan for the Rare and Rare-Earth Metals Industry for 2024–2028, under which it plans to invest 2.4 billion tenge (~$5.3 million) over the next five years in developing rare metals and RRM mining. In May 2024, the Senate of Kazakhstan stated that the country's potential resources of rare metals and RRM could include around 5,000 deposits worth $46 trillion. The dynamics of Kazakhstan's exports of rare earth metals (HS codes 280530 and 284690) are shown in Figure 6.

Since 2005, about 16.4 % (USD 67 billion) of Kazakhstan's total foreign direct investment has gone to the metallurgical industry, including critical minerals. Developing a strategic export policy for the CMM sector — drawing on the experiences of resource-oriented countries such as Australia and Chile — helps Kazakhstan set priorities, tackle structural challenges, and transition toward processing, sustainability, and ESG-focused investment.

A comparative analysis of resource-oriented economies such as Australia, Chile, and Ka-

Table 11

Analysis by criteria, justification of the strategic framework

Criterion	Kazakhstan	Australia	Chile	Lessons and strategic goals for Kazakhstan
Type of resources and scale of extraction	Extensive but underutilized potential for rare earth metals, uranium, and lithium	Leader in lithium extraction, rare earth metals (Mount Weld)	Lithium, copper, but not rare earth metals	Inventory and digitize its CMM resources, based on geological exploration and modeling of promising deposits, including rare metals in tailings
Export strategy focus	Raw material export, partial shift to processing	Balanced model: raw materials + processing	Export of raw materials mainly serving the interests of TNCs	Shift from a raw-material model to a value-added model by investing in domestic processing capacity
Added value (localization)	Low	Medium	Low	Implement government incentives and tax benefits for enterprises processing CMMs in Kazakhstan
Foreign investment	Attracting investment from Russia and China	Diversified portfolio (EU, USA, Japan)	Limited market	Diversify investment sources by forming partnerships with ESG-oriented countries and funds
Sustainable development policy (ESG)	Initial stage of impementation	ESG standards, especially regarding water use and biodiversity	Strong environmental oversight	Integrate ESG criteria into licensing, certification, and export contracts
Government regulation	State monopolies, licensing, low transparency	Transparency, auctions, international standards	State monopolies, partially closed processes	Introduce transparent tender mechanisms to encourage SME participation and implement digital resource management
Economic diversification	Low	High	Moderate	Link CMM exports to the creation of a cluster for producing "green technologies," including hydrogen energy, batteries, and electronics
Logistics	Good, Trans-Caspian route	Developed ports and railways	Good (copper — via northern ports)	Modernize logistics with a focus on multimodal export corridors through the Caspian, especially to the EU
Problems and challenges	eco-protests, raw material dependency	Competition with China, pressure on the environment	Resource curse, social conflicts	Proactively engage with local communities and environmental NGOs by introducing corporate social responsibility commitments

Source: Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan https://stat.gov.kz/

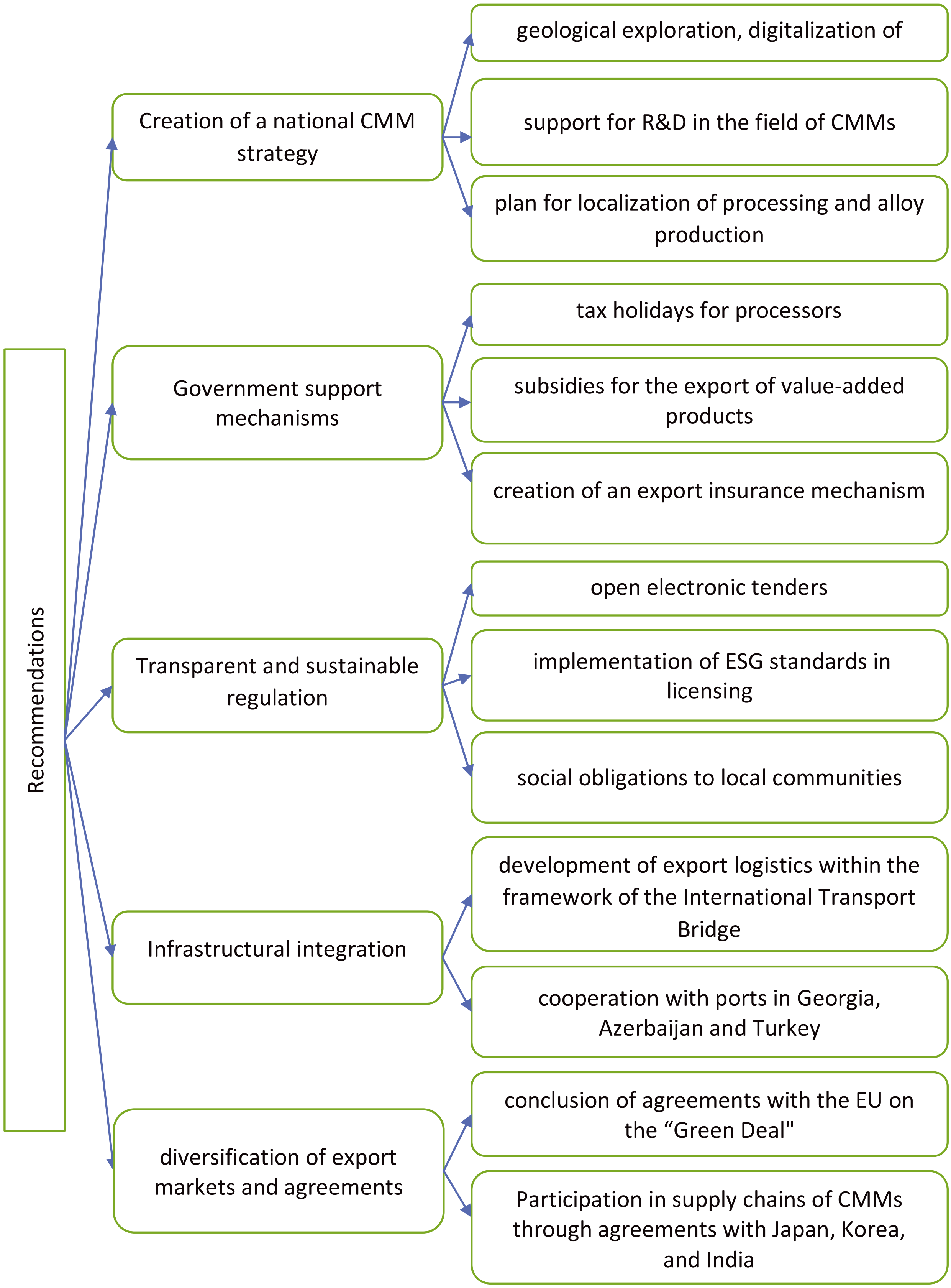

Figure 7. *Recommendations for the strategic framework*
Source: Compiled by the authors

Table 12

Analytical rationale for Kazakhstan's CMM export policy priorities

№	Priority	Analysis	Application
1	Balance between raw-material exports and processing localization	Kazakhstan possesses large reserves of CMMs, including uranium and lithium. In global practice: Australia develops processing with participation from the EU and Japan, while Chile maintains a raw-material orientation. Kazakhstan would benefit from a mixed approach.	Diversified exports, reduced price vulnerability, increased employment, and enhanced technological capacity
2	Reducing dependence on a single market	China is the largest importer and processor of rare earth metals. Australia's experience shows the effectiveness of diversification through alliances (USA, EU, Japan) and new transport routes. Kazakhstan could leverage the Trans-Caspian transport corridor.	Expanded export geography, reduced geo-economic risks, strengthened bargaining position
3	Institutional resource management	State companies ("Kazatomprom") play a large role in Kazakhstan. Chile ensures transparency in state support, while Australia promotes open competition and partnerships. Kazakhstan needs to reform its regulatory environment.	Increased investment attractiveness, inflow of private capital, improved risk management, and sustainable sector development

Source: Compiled by the authors

zakhstan supports the development of a strategic framework for export policy in the CMM sector, outlining key priorities and important lessons for Kazakhstan (Table 11).

Kazakhstan has a unique potential to develop a national export strategy for CMMs, drawing on the best practices of leading countries. However, it is important to avoid the pitfalls of resource dependence and to strengthen domestic processing, sustainability, and transparency (Figure 7).

Australia's experience shows that institutional maturity and an ESG-oriented policy not only attract investment but also retain technology. In the short term, Kazakhstan needs to develop an export-industrial roadmap linked to global value chains in the field of CMMs (Table 12).

For Kazakhstan to successfully implement its export policy in the CMM sector, it is essential to strengthen its domestic processing capacities, reduce dependence on a single export market (such as China), and modernize the institutional framework for resource management. This modernization should involve building strategic partnerships, enhancing infrastructure cooperation, and developing a smart, forward-looking approach to resource diplomacy. Kazakhstan should also strengthen institutional mechanisms that ensure transparency in licensing and land allocation, protect investors (including through reforms in arbitration and state guarantees), integrate ESG principles into project evaluations, and improve coordination between central and regional authorities.

Conclusion

This study proposes an evidence-based strategic framework for Kazakhstan's CMM export policy, considering international experience and regional specificities. The framework builds on three key steps. First, an analysis of current trends and export structures in Kazakhstan and other Central Asian countries identified the sector's main imbalances and bottlenecks. Second, a comparative study of resource-oriented economies, including Australia and Chile, highlighted institutional conditions that support a shift from raw-material dependence. Third, these findings informed the development of a strategic export policy framework with clear priorities and project proposals targeting sustainable growth, technological modernization, and export diversification.

The research revealed significant institutional obstacles constraining the development of the sector. Despite substantial CMM reserves, Kazakhstan's exports remain largely resource-oriented, with limited processing and a strong dependence on a single external market — China. A weak regulatory environment and insufficient coordination limit investment inflows and local value-added production, increasing the sector's vulnerability to external shocks. These institutional findings highlight the need for structural reforms to deepen processing and reduce export dependence.

In response to these challenges, the study proposes a "next-generation export strategy" built around three key priorities: gradual localization of raw material processing and an increase in the value-added share of production; reducing export dependence through the development of Trans-Caspian logistics and the establishment of partnerships with alternative importers (the EU, Japan, and the Republic of Korea); institutional modernization, including greater transparency in licensing, the adoption of ESG standards, and the promotion of private investment in the sector. The proposed project initiatives are designed to support the practical implementation of this strategy by fostering the creation of processing clusters and strengthening international cooperation in the CMM sphere.

The findings confirm the strategic importance of CMMs for Kazakhstan's successful green transition, technological sovereignty, and long-term sustainable economic growth. Comprehensive implementation of the proposed measures would accelerate the country's industrial and innovative development and strengthen its position in global value chains for critical resources. Kazakhstan has the potential to become a central hub in strategic CMM supply chains, provided that institutional consolidation and the execution of a next-generation export policy are ensured.

A limitation of the study lies in the absence of dynamic scenario evaluation under conditions of external instability, as well as the reliance on secondary data and expert assessments in the institutional analysis. Future research should focus on developing quantitative models to assess the impact of export policy on GDP structure and employment, along with a deeper examination of regional coordination mechanisms among Central Asian countries in the CMM domain.

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An ecosystem approach to regional policy-making for Russia's creative sector

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ABSTRACT
Relevance. Regional and municipal policies supporting creative industries are more effective when integrated into the broader ecosystem and aligned with its internal logic. Their success depends on the ability to reflect and communicate the sociocultural code of the territory, which calls for a shift from a purely sectoral approach to territorially tailored support measures.
Objective. The study aims to design a creative industries ecosystem that reflects local identity and supports the implementation of tailored regional policies for the sector.
Methods and Data. Using a comprehensive approach, the study treated regional creative industry support as an integrated ecosystem. Methodology also included comparative and institutional analysis, classification, and conceptualization. Empirical sources encompassed strategic documents, industry forum outcomes, and the authors' earlier research, notably a validated typology highlighting the varying importance of local identity across creative industries.
Results. The article outlines a concept of a regional support ecosystem where creative industries transmit and shape local identity, ensuring its dynamic development. The study proposes an iterative algorithm for developing individualized policies for the support of creative industries, encompassing the stages of diagnostics, strategy formulation, implementation, and evaluation. State support measures are classified according to the significance of local identity for different types of creative industries. The study's contribution to the field lies in integrating the concepts of local identity and the ecosystem approach in the context of the creative economy.
Conclusions. The proposed algorithm can guide the transformation of a territory's cultural heritage and unique resources into competitive creative outputs, promoting economic growth, preserving cultural diversity, strengthening social capital, and supporting sustainable regional development.

KEYWORDS
creative economy, creative industries, regional policy, local identity, support measures

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Экосистемный подход к формированию индивидуализированной региональной политики поддержки креативных индустрий

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АННОТАЦИЯ
Актуальность. Эффективность мер региональной и муниципальной политики поддержки креативных индустрий существенно возрастает в том случае, если политика становится имплицитной частью экосистемы, вытекающей из ее внутренней логики и усиливающей ее конкурентные преимущества. Успех региональной политики напрямую детерминирован ее способностью аккумулировать и транслировать социокультурный код

КЛЮЧЕВЫЕ СЛОВА
креативная экономика, креативные индустрии, региональная политика, локальная идентичность, меры поддержки

территории. Это требует перехода от отраслевого подхода к территориально-ориентированному, где меры поддержки «встраиваются» в локальный контекст.
Цель исследования — сформировать экосистему управления и поддержки креативных индустрий на основе локальной идентичности в целях реализации индивидуализированной региональной политики.
Методы и данные. В основе исследования лежит системный подход, позволивший рассмотреть региональную политику поддержки креативных индустрий как целостную экосистему. Также были применены методы сравнительного и институционального анализа, классификации и концептуализации. Эмпирическую базу составили стратегические документы, результаты отраслевых форумов и предыдущие исследования авторов, включая апробированную типологию креативных индустрий по значимости локальной идентичности.
Результаты. Авторами определены контуры концепции региональной экосистемы поддержки, в которой креативные индустрии выполняют роль транслятора и модератора локальной идентичности, обеспечивая ее динамичное развитие. Предложен итеративный алгоритм формирования индивидуализированной политики поддержки креативных индустрий, включающий этапы диагностики, стратегирования, реализации и оценки. Меры государственной поддержки классифицированы в зависимости от значимости локальной идентичности для различных креативных индустрий. Научная новизна работы заключается в интеграции концептов локальной идентичности и экосистемного подхода в контекст креативной экономики.
Выводы. Предложенный алгоритм позволяет трансформировать культурное наследие и уникальные ресурсы территории в конкурентоспособные креативные продукты, обеспечивая тем самым не только экономический рост, но и сохранение культурного разнообразия, укрепление социального капитала и устойчивое развитие регионов.

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基于生态系统方法构建个性化区域创意产业支持政策

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摘要
现实性：当区域和市政层面的创意产业扶持政策成为生态系统的内在组成部分，顺应其内在逻辑并增强其竞争优势时，其有效性将显著提升。区域政策的成功与否直接取决于其积累和传承地域社会文化特征的能力。这就要求政策制定方式从行业导向转向区域导向，将扶持措施融入当地实际情况。
研究目标：构建基于地方特色的创意产业管理和支持生态系统，以便实施个性化的区域政策。
数据与方法：本研究以系统性方法为基础，将创意产业的区域支持政策视为一个完整的生态系统进行考察。研究还采用了比较分析、制度分析、分类和概念化等方法。实证基础包括战略文件、行业论坛成果以及作者既往研究成果，其中包含已通过验证的基于地方特色重要性的创意产业类型学。
研究结果：作者概述了区域支持生态系统的概念，其中创意产业扮演着地方认同的传播者和调节者，确保其动态发展。研究提出了一种迭代算法，用于制定针对创意产业的定制化支持政策，该算法包括诊断、战略制定、实施和评估四个阶段。政府支持措施根据地方认同，对不同创意产业的重要性进行了分类。这项工作的创新之处在于将地方认同和生态系统方法的概念融入到创意经济的语境中。
结论：研究所提出的算法能够将地域文化遗产与独特资源转化为具有竞争力的创意产品，从而不仅促进经济增长，还能有效保护文化多样性、增强社会资本并推动区域可持续发展。

关键词
创意经济、创意产业、区域政策、地方特色、支持措施

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Introduction

Creative industries are a strategic priority in Russia's regional economic policy, calling for tailored strategies that would leverage each territory's unique potential. Speaking at the Russian Creative Week forum, the President of Russia stressed that the sector's dynamic growth relies on national traditions and the cultural diversity of the country's multiethnic population[1]. This emphasis is echoed in the Presidential Decree, which identifies the safeguarding, promotion, and protection of traditional Russian spiritual and moral values as a national priority[2].

In this context, local identity becomes a key resource for the sustainable development of territories, where authenticity acquires the status of a new kind of currency. A focus on a territory's cultural code, history, and crafts helps preserve its unique identity and generate a multiplier effect for sectors such as tourism, education, and construction, thus highlighting the need for regional strategies that follow the principle of *individualization* and are aligned with local identity.

A key principle guiding the development and state support of creative industries through 2030, as outlined in Russia's strategic documents, is the ecosystem approach. This approach ensures that all support mechanisms for creative industries and entrepreneurship in Russia's regions are comprehensive and accessible, covering cultural, economic, and all other relevant aspects of activity.

This study *aims* to design an ecosystem for managing and supporting creative industries, grounded in local identity to inform individualized regional policy for the sector. To this end, the following objectives are set:

1. To demonstrate the defining role of local identity in building the structure of a regional ecosystem for supporting creative industries;

2. To develop a framework for designing individualized regional policies for creative industries.

[1] A. Druzhinin. Putin welcomed the participants and guests of the Russian Creative Week. Official website of Russia's news agency TASS. Retrieved from: https://tass.ru/obschestvo/25159779 (date of access: 31.10.2025).

[2] Decree of the President of Russia No. 309 of May 7, 2024, "On the National Development Goals of Russia for the Period until 2030 and for the Longer Term up to 2036." Retrieved from: http://www.kremlin.ru/acts/bank/50542 (date of access: 31.10.2025)

Theoretical Framework

The ecosystem approach in the context of creative industries

In the broadest sense, an ecosystem is defined as an economic community of market participants who produce goods and services and organize their activities according to a common strategic direction set by one or several leading players (Moore, 1993). Applied to entrepreneurial activity, the ecosystem approach offers several advantages: first, it helps clarify the goals of an ecosystem, ensuring mutual efficiency and survival (Iansiti & Levien, 2004), and, second, it helps identify the following key domains: cultural environment, supportive policy, access to financing, quality human capital, markets, and institutional infrastructure (Isenberg, 2010).

The key characteristics of ecosystems described in research literature include, first, a large number of loosely connected participants who rely on one another to ensure mutual efficiency and survival (Iansiti & Levien, 2004). Second, ecosystems facilitate the mobilization of resources from other firms and their collaboration to generate value (Aarstad et al., 2010). Third, ecosystems are dynamic and systemic, encompassing numerous actors, processes, and institutions, while their organizational boundaries remain blurred and flexible (Adomavicius et al., 2007). Fourth, an ecosystem is inherently multilateral, as relationships among its actors cannot be reduced to simple bilateral interactions (Adner, 2017).

In the context of creative industries, the ecosystem approach serves as a conceptual framework for understanding the sector's complex, dynamic, and multifaceted nature. It is noted that although microenterprises make up the majority of businesses in the sector, its contribution to the economy is quite significant (Barker, 2018). Building on this perspective, Makieva and Sanzhina (2024) argue that the ecosystem approach is particularly useful for developing the network structure of creative industries.

Novikov and Makieva (2024), using regional ecosystem theory, examined how the development of network nodes and the strength of their connections influence creative networks, as well as the factors that stimulate the growth of creative industries in regional contexts. Other studies have applied an ecosystem approach to describe the creation and functioning of creative clusters (Abuzyarova, 2023; Busalova, 2021).

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However, there is still a lack of research on the components of support ecosystems for the creative industries, including actors, support measures, and infrastructure, especially regarding different support levels (federal, regional, municipal) and the influence of local identity.

Characteristics of regional policy for the management and support of creative industries

Support for the creative industries at the regional level is primarily aimed at integrating them into socio-economic development strategies, including the creation and promotion of digital and innovative ecosystems, as well as providing financial support and facilitating collaboration (Dmitriev & Shakurov, 2024). Through the creative industries, cities become centers for cultivating artistic, technological, and intellectual talent, all of which contributes to a higher quality of life. Experts argue that the focus should increasingly shift toward smaller towns, where timely and targeted support measures can generate a new impetus for development through creative industries[3].

To capitalize on territorial advantages, authorities must design creative industry policies that reflect the region's unique characteristics and local identity. The choice of the region as the unit of analysis is justified by differences in regional economies that affect their capacity to generate creative products (Novikov & Makieva, 2024), highlighting the need for tailored models of government support for the creative industries (Boos et al., 2024). Importantly, the differences in priorities across Russia's regional socio-economic policies reflect significant regional disparities, resulting from the uneven distribution of resources and key production factors (Dobrusin, 2023). Most regions offer the essential conditions for creative industries, including a "critical mass" of creative professionals and entrepreneurs, a well-developed educational and research environment, and accessible creative spaces (Novikov & Makieva, 2024).

Currently, Russia has already established the foundations for regional policies supporting creative industries, with normative and methodological frameworks largely in place and relevant institutions operational (Mordanov, 2022). The new law (Arts. 5, 10, Law No. 330-FZ) recognizes the creative sector as a key driver of regional development, reflecting the cultural, social, and economic characteristics of each territory. Priority is given to state support for creative industries, alongside measures to strengthen the impact of small businesses and local brands (Evmenov & Nasibullin, 2024).

Boos et al. (2024) argue that, in order to design effective regional socio-economic strategies, it is necessary to understand the factors shaping creative industries. The most significant factors include the availability and maturity of human capital, the structure and potential of the local creative community, institutional architecture, the economic and geographic context, communication strategy, and territorial branding.

Key competitiveness factors, such as economic structure, location, demographics, infrastructure, and foreign economic relations, are also considered, as they provide economic advantages linked to local or regional levels. A well-designed policy for the creative industries sector should account for feasibility, guiding principles, objectives, and expected sector outcomes (Efimova & Bryukhanova, 2023).

Methodology

The study relies on a comprehensive approach, which frames regional policies for supporting creative industries as a holistic ecosystem. A key tool is the construct of local identity, introduced in our earlier publications, which divides local identity into material and symbolic components (Turgel et al., 2023). This methodological approach is aimed at breaking down and operationalizing a territory's identity, viewing it as a dynamic, multi-level whole. In the context of creative industry support, the approach focuses on identifying and organizing unique attributes, such as cultural heritage, crafts, local skills, landscapes, narratives, and symbols, that shape lasting perceptions of the territory and serve as resources.

Combining the ecosystem approach with an individualized regional policy, we applied our typology ("dynamic conservation", "transformation", "generation") to the list of creative industries approved by the Ministry of Economic Development[4], thereby further expanding the conceptu-

[3] Center for Strategic Research (CSR). Support Measures for the Creative Economy April 2023.Retrieved from: pcmna42fzndj1heh0my43n1x2d8l87ot.pdf (date of access: 11.11.2025).

[4] Order No. 266 of April 23, 2025, "On the Approval of the List of Types of Economic Activity in the Field of Creative Industries Based on the All-Russian Classifier of Types of Eco-

al framework. These industries were grouped into three categories according to the significance of local identity: high, medium, and low. If identity elements are analyzed and a territory's symbolic capital is incorporated into the strategies of specific creative sub-sectors, then support measures can be customized at the territorial level depending on the significance of local identity for each industry group or cluster (Turgel et al., 2023; Derbeneva et al., 2024). Industries where local identity is highly significant are supported at the federal, regional, and municipal levels. Industries for which local identity holds medium significance receive support at the federal and regional levels while industries characterized by the minimal significance of local identity rely solely on federal support.

Using comparative and institutional analysis, classification, and conceptualization, we structured the research object and developed an algorithm for individualized regional policy.

The empirical base of the study included both secondary and primary sources. We analyzed official strategic planning documents, including Presidential Decree No. 309, the Concept for the Development of Creative Industries, and the Regional Standard for Creative Industries, as well as materials from industrial forums. The study drew on our previous research, including the validated typology of creative clusters, to ensure continuity and reinforce the proposed approach (Turgel et al., 2023; Turgel et al., 2025).

The study was conducted in several stages. In the initial analytical stage, we reviewed academic literature and the current regulatory framework to establish the theoretical foundation. In the second, methodological stage, we developed a typology of creative industries based on local identity and constructed a model of the ecosystem of actors. In the third, project-generalization stage, these results were applied to develop an iterative algorithm for designing and implementing individualized regional policy.

Results

Using local identity to strengthen the support ecosystem for creative industries

In regional policies supporting creative industries, local identity serves several key functions. First, it provides authenticity and differentiation, enabling regions to offer a unique market proposition. Creative products and services rooted in a local cultural code gain competitiveness and value, as they cannot be replicated elsewhere without losing their significance. Second, local identity helps create a shared space of understanding among participants in the creative economy, supporting trust, common values, and the development of denser and more resilient networks typical of creative clusters. Third, it is a crucial resource for territorial branding, influencing investment appeal, tourism, and the region's ability to attract and retain creative talent.

In this context, local identity proves to be a key strategic asset and an essential element of regional policy supporting creative industries. Local identity is understood as the set of unique cultural codes, historical narratives, symbolic resources, and established practices tied to a specific territory. The support ecosystem for creative industries is conceived as a dynamic, self-developing environment in which local identity acts as a central resource and driver of economic and sociocultural development. The network approach at the heart of this ecosystem frames the creative industries as a single, integrated economic actor (Novikov & Makieva, 2024).

However, creative industries differ in the extent to which they rely on local identity. Applying the construct of local identity to the analysis of creative industries in Chelyabinsk, Sverdlovsk and Perm regions, we were able to distinguish three levels of significance. High significance appears in industries whose products are deeply tied to the specifics of the place[5], corresponding to the "dynamic conservation" model. Medium significance corresponds to the "transformation" model and describes industries with products that retain a moderate connection to local identity. Low significance reflects the "generation" model, which includes industries whose products do not depend on local features or cultural traditions (Fig. 1).

Each type of creative industry requires tailored consideration, depending on the signifi-

nomic Activity." Available at: http://publication.pravo.gov.ru/document/0001202505270011?ysclid=mi5pbl9mam39948848 (date of access: 21.10.2025)

[5] Article 3 of Federal Law No. 330-FZ of August 8, 2024, "On the Development of Creative (Artistic) Industries in Russia," defines a creative product as the result of intellectual activity or a set of such results, as well as goods, work, or services whose added value arises from the use of intellectual property results and/or means of individualization.

	Creative industries	Dynamic conservation	Transformation	Generation
		Significance of local identity		
		high	medium	low
1	Recreation and entertainment	+		
2	Cultural heritage	+		
3	Folk arts and crafts	+		
4	Gastronomy	+		
5	Cinema, TV films and animation		+	
6	Performing arts		+	
7	Art industry		+	
8	Book publishing		+	
9	Fashion		+	
10	Music		+	
11	Architecture and urban planning		+	
12	Design			+
13	Software			+
14	Media			+
15	Video games			+
16	Advertising and PR			+

Figure 1. *Distribution of creative industries by the significance of local identity*
Source: developed by the authors

cance of local identity. This applies both to the actors responsible for managing the industry and to the specific support measures they implement.

The ecosystem of interaction among actors in the creative industries

A significant factor in developing policies to support creative industries is the need to establish long-term relationships among all actors involved in and responsible for the development of the region's creative industries: higher education institutions, executive authorities, businesses, and others (Myzrova et al., 2024). The activities of these actors should be seen as part of the support ecosystem for creative industries (Figure 2). At each level — federal, regional, and local — actors perform specific roles depending on their resources, authority, and ability to influence different types of creative industries according to the significance of local identity.

Federal Level. Federal-level actors define the overall legislative framework and development agenda for creative industries, as well as devise support measures for creative industries that do not include local identity as a separate component (Figure 2). The main federal actor responsible for developing the strategy for the development of the creative economy through 2036 and for monitoring its implementation is the Ministry of Economic Development. Federal actors offer grants and other financial support for local creative initiatives, playing a key role in fostering creative in-

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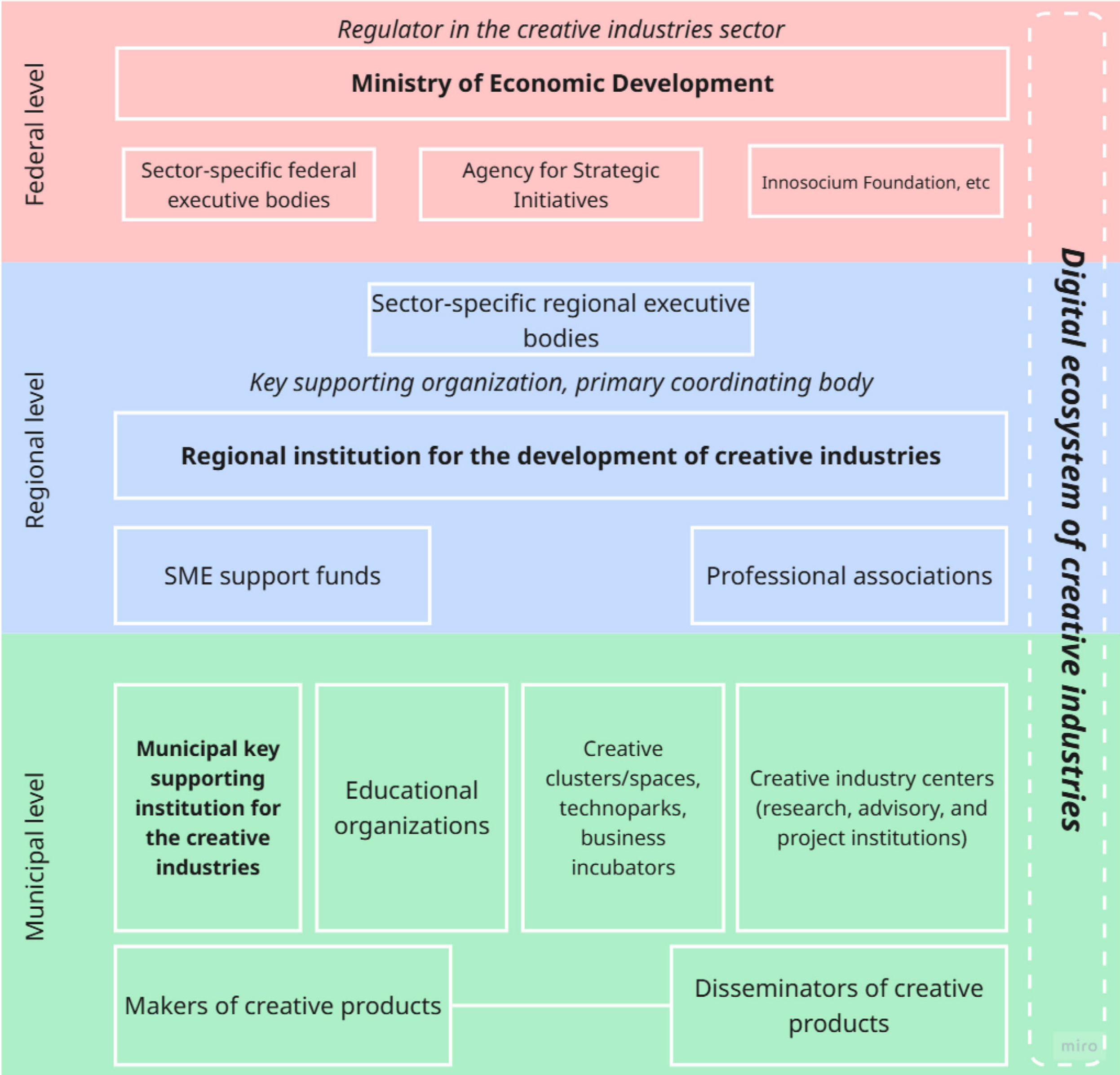

Figure 2. *Ecosystem of actors in the creative industries*
Source: Developed by the authors

dustry development in resource-limited remote territories[6].

Regional Level. The regional level is a key link in determining the regional strategy for developing creative industries[7]. Additionally, actors at this level, such as professional associations and sectoral development institutions, are crucial providers of specialized support measures for creative industries, they serve as a bridge between local and federal actors. In particular, regional centers for supporting small and medium-sized enterprises act as operators for implementing federal support measures. According to the aforementioned standard for creative industry development, regions can develop their own

[6] Presidential Foundation for Cultural Initiatives. Available at: https://xn —80aeeqaabljrdbg6a3ahhcl4ay9hsa.xn — p1ai/?utm_mediu&clckid=de210c62&ysclid=mi5r26vwbh872430143; Presidential Grants Foundation. Available at: https://xn —80afcdbalict6afooklqi5o.xn — p1ai/ (date of access: 15.11.2025)

[7] Regional Standard for the Development of Creative Industries. Official website of the Agency for Strategic Initiatives. Available at: https://asi.ru/creative/standart/?ysclid=mhvto8ys7s669635332 (date of access: 10.11.2025)

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policies for managing and supporting creative industries. We agree with Rivchun et al. (2024) that this support mechanism should include three elements: first, there should be a document defining the priorities for developing the region's creative industries; second, there should be a developed system of support measures; and, finally, there should be a key institution for the development of creative industries in any organizational form (departments of regional ministries and administrations, non-profit organizations).

Municipal Level. Since local identity is tied to specific places, it can only be recognized at the subterritorial level. Consequently, regional and local actors should take responsibility for supporting industries where local identity is highly significant, enabling the development of targeted support measures for industries that preserve local traditions and values. At present, the role of municipal-level actors in management is not defined in either federal or regional legislation, leading to departmental fragmentation in the development of creative industries. As a result, the rapid development of creative industries occurs primarily in regional administrative centers, leaving second-tier cities without adequate support. The role of municipalities in supporting creative industries should be clearly defined and formalized in federal and regional strategic documents. Key municipal-level tools include the establishment of creative clusters, management of municipal property (e.g., offering preferential rents to creative industry actors), organization of festivals and large-scale cultural events, and fostering a favorable urban environment for creative businesses. The implementation of these measures also requires establishing a dedicated municipal support organization for the sector.

Conceptualization of an individualized regional policy for supporting the creative industries

The purpose of an individualized regional policy to support creative industries is to build a sustainable, recognizable, and competitive ecosystem of creative industries in the region — one that converts the territory's distinctiveness into a stable asset capable of supporting long-term and multifaceted regional development. Consequently, an effective individualized policy should aim to identify, activate, and capitalize on the intangible resource embedded in local identity. In this context, local identity becomes a core principle and a substantive foundation for shaping an individualized regional policy.

In other words, only a distinctive framework that directs attention to the region's creative specialization and the prospects of its creative industries can ensure their systematic and effective growth. Its implementation requires a strategy with a "roadmap" and a set of strategic initiatives. Together, these elements make local identity a central factor in shaping an individualized regional policy, which transforms the region's creative potential into a meta-resource and drives development on a fundamentally new basis by integrating moral and ethical priorities at both national and regional levels (Bulochnikov, 2024). The role of local identity in regional policy is to serve as a reference point for diagnostics, a core resource for creating competitive advantages, and, at the same time, a central criterion for evaluating the effectiveness of managerial decisions.

Such an individualized policy can also use the uniqueness of local identity to identify niche opportunities and avoid direct competition with major cultural centers. The distinctiveness of a territory — expressed in folklore, craft techniques, linguistic features, and historical narratives — serves as "raw material" for creating new meanings and contemporary artistic forms. As a result, this creative engagement becomes a starting point for the revitalization of tradition and its integration into the global cultural context. A peripheral location begins to be perceived as a significant and distinctive cultural center. In other words, a symbolic revalorization of the territory takes place, both economically and culturally. Regional identity acquires a dynamic character and becomes open to dialogue, creating a foundation for intercultural communication and the region's soft power.

The development of an individualized regional policy for supporting the creative industries should rest on several key principles:

– The principle of *deep diagnostics*, which is fundamental and reveals the structure of identity in its historical, cultural, environmental, social, and technological layers;

– The principle of deep diagnostics underlies the second principle — *selective stimulation of creative potential* — which focuses on identifying sectors and practices that are closely aligned with the core elements of local identity and have the greatest potential to work synergistically (Kazakova, 2020);

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– The principle of *"creative fields"* prioritizes the establishment of open platforms and interaction spaces over direct subsidies, as the former enable the translation of local meanings into contemporary creative products and services.

The output of creative industries should go beyond individual products to form a coherent narrative about the territory for the outside world. In order to achieve this, the region should be strategically positioned in global markets, leveraging its uniqueness rooted in local identity as a key competitive advantage.

Algorithm for developing an individualized regional support policy

An individualized regional policy represents a continuous cycle: from identity diagnostics, through selective support and the creation of an institutional environment, to the production of authentic products and the formation of a new, enriched image of the territory. This, in turn, feeds back into the identity itself, transforming it into a dynamic, contemporary state.

The perspective described above views algorithm development as *an iterative process of strategic management designed to create an adaptive institutional environment that activates the territory's endogenous potential through selective support for particular creative clusters and projects.*

The key principles of the proposed algorithm are cyclicality and iterativeness. In other words, after the final stage of monitoring and evaluation, the process returns to diagnostics to adjust the policy. Studying trends and growth patterns in creative industries helps determine the primary avenues for their development and support. This approach allows policy to be systematized and adapted to the characteristics of each region, taking into account geographic location, infrastructure, availability of highly skilled personnel, local culture and traditions, economic potential, and other factors (Smolyanova, 2022; 2023). It also fa-

Table 1

Algorithm for developing an individualized policy to support creative industries

	Description	Tasks	Tools	Result
STAGE 1. Stage of multidimensional diagnostics and identification				
First iteration	Diagnostics and mapping ("Identity Audit")	Identify and showcase the unique qualities and creative potential already present	Analysis based on the local identity construct	Priority setting
Second iteration	Strategizing and clustering ("Defining the project's DNA")	Use the audit to determine strategic priorities and create thematic clusters	Identification of "growth points" Formation of thematic clusters	Strategic document defining priority clusters and their target images
Third iteration	Design and individualization of support measures	Develop targeted, not just universal, support measures for each industry/cluster	Combining support measures at different levels	Maximizing the impact of support measures
STAGE 2. Implementation of creative industry support policy				
Fourth iteration	Implementation and launch of pilot projects	Activate the process on the ground to deliver fast, tangible results	Support for pilot projects Establishing of a "single window"	Emergence of the first "success stories" and concrete products that reinforce the region's brand
Fifth iteration	Communication and promotion ("The story, not the product")	Communicate the value of projects to internal and external audiences	Identity-based branding Storytelling Event creation	Hosting festivals, exhibitions, and markets that showcase a "living" identity
Sixth iteration	Monitoring, evaluation and feedback ("Continuous development")	Assess the effectiveness of the policy and making adjustments	Maintaining an ongoing dialogue with the creative community to identify new challenges and opportunities	Annual review and adjustment of support measures based on key performance indicators: economic, socio-cultural, and reputational

Source: Developed by the authors

Table 1

Measures for the support of creative industries based on the significance of local identity

<table>
<tr><th colspan="2">Creative industries</th><th>Federal level</th><th>Regional level</th><th>Municipal level</th></tr>
<tr><td>High significance of local identity</td><td>Recreation and entertainment
Cultural heritage
Folk arts and crafts
Gastronomy</td><td rowspan="3">Economic measures: targeted loans, guarantees, grants, tax incentives, export promotion

Organizational measures: establishment of the Creative Russia online platform; establishment of a specialized federal development institute; creation of a network of co-working spaces and fab labs; federal acceleration programs; federal educational programs

Legal measures: adoption of federal regulatory acts aimed at supporting the creative industries</td><td rowspan="2">Economic measures: regional grants; rental subsidies; regional tax incentives (property tax, land tax)
Organizational measures: establishment of creative clusters; educational programs in cooperation with regional universities; regional accelerators; setting up a regional body for creative-industry development
Legal measures: adoption of a regional-level regulatory act aimed at supporting creative industries (e. g. Strategy for the Development of Creative Industries)</td><td>Economic measures: micro-grants from the municipal administration; establishment of equipped municipal spaces available for free or at a discounted rate
Organizational measures: creation of a network of public spaces; organization of city events; appointing a municipal coordinator for creative industry development; producing and promoting Creative City maps with routes to workshops, studios, and art objects
Legal measures: Incorporating creative industries into the city's socio-economic strategy</td></tr>
<tr><td>Medium significance of local identity</td><td>Cinema
Performing arts
Art industry
Book publishing
Fashion
Music
Architecture and urban planning</td><td rowspan="2"></td></tr>
<tr><td>Low significance of local identity</td><td>Design
Software
Media
Video games
Advertising and PR</td><td></td></tr>
</table>

Source: developed by the authors

cilitates the development of individualized pathways for the growth of regional creative industries tailored to local conditions and needs (Efimova, 2023).

The algorithm begins with the first stage of multidimensional diagnostics and identification, which involves a comprehensive audit of the region's creative-capital potential. This includes not only a quantitative inventory of creative-industry actors but also a qualitative analysis of their network interactions, the identification of "bottlenecks" in value-creation chains, and an assessment of the integration of these actors into global and local cultural and economic flows.

At the end of the first stage, the region's strategic positioning is determined, and its unique value proposition is identified through an analysis of competitive strengths such as cultural heritage, specialized skills, and niche markets. Key policy priorities focus on raising prosperity, improving living and working conditions, and enhancing health and well-being (Leonova, 2023).

A fundamental task at this stage is to establish a classification of the creative industries that reflects the characteristics and unique aspects of the different sectors in the creative field. A clear and well-substantiated classification is a prerequisite for conducting a detailed analysis (Sopina, 2021). Assessment of economic performance, innovation capacity, and investment potential underpins the identification of the most developed creative sectors. This process requires a comprehensive approach combining both quantitative and qualitative methods of analysis (Prilepina, 2022).

The result of the first stage is the development of support measures for the creative industries depending on the significance of local identity (Table 1).

The *second stage* involves the implementation of a creative-industry support policy grounded in the principles of collaborative governance. This approach can help involve actors at all levels as fully as possible in the policy-making process. At this stage, working groups should be established in order to bring together representatives of public authorities, leaders of the creative industries, and the academic community through strategic sessions and foresight sessions (Smolyanova, 2022).

The final phase of the second stage covers monitoring and feedback, which ensure the flexibility of the policy, as well as the identification of the most effective practices suitable for scaling. For this purpose, a monitoring system should be established to measure not only traditional economic metrics, but also cultural and social indicators, including the quality of urban environment, innovation growth in related spheres, and cultural identity. The policy thus functions as a self-learning system, adapting to changes and sustaining the regional creative ecosystem's resilience and competitiveness in the long term.

Conclusions

The study emphasizes the central role of local identity as a key factor in developing regional ecosystems for supporting creative industries. A territory's unique cultural code, historically established symbolic resources, and social narratives constitute the core of its creative sector's specialization, resilience, and competitive advantages.

The analysis highlights the need to move beyond standardized approaches toward individualized policies grounded in the structure and content of local identity. Such policies aim to identify and activate territory-specific growth points and foster an institutional environment that encourages self-organization and effective use of local resources.

The study proposes a conceptual algorithm for designing these individualized creative industry policies, based on an assessment of local identity potential. This algorithm can guide the development of regulatory, infrastructural, and financial instruments tailored to the distinctive characteristics of a territory's creative industries.

Overall, a focus on local identity can enhance the effectiveness of national and regional support programs and serve as the foundation of a development model where economic success is aligned with the tasks of preserving cultural diversity and strengthening regional social capital.

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Inbound foreign direct investment in Asia-Pacific countries: the long-term impact of trade and economic agreements

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ABSTRACT
Relevance. Over the past three decades, the Asia-Pacific region has attracted more than half of the world's foreign direct investment (FDI), most of it staying within the area. Trade and economic agreements designed to lower barriers have played a key role in attracting FDI across the region. However, research on the effects of these agreements is limited and often focuses on individual economies. Given the area's economic diversity, the long-term impact of such agreements on FDI inflows, as well as how these effects compare with global trends, remains unclear.
Research Objective. The study aims to provide quantitative estimates of the long-term impact of trade and economic agreements on accumulated FDI inflows in the Asia-Pacific region.
Data and Methods. The study uses a structural gravity model with panel data on bilateral FDI flows between Asia-Pacific countries for 1992–2023. The dependent variable was compiled from international and national databases. Estimates were obtained using the Poisson pseudo-maximum likelihood method.
Results. The long-term positive direct effect of agreements came primarily from extended free trade zones (FTA+), which increased FDI inflows by 35 %. Other trade agreements had little direct effect, while bilateral investment agreements actually restrained FDI inflows. The study also found the following accumulated effects: FTA+ and investment agreements boosted FDI inflows by 37 % and 16 %, respectively, whereas trade agreements without provisions to facilitate FDI reduced inflows by 59 %.
Conclusions. In their investment interactions Asia-Pacific countries adopt different long-term strategies. Some promote FDI through FTA+ and investment agreements, in line with global patterns, while others limit foreign capital via trade agreements that lack measures to reduce FDI barriers.

KEYWORDS
foreign direct investment, integration, trade agreements, investment agreements, direct effect of trade and economic agreements, accumulated effect of trade and economic agreements, Asia-Pacific region

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Прямые иностранные инвестиции в страны Азиатско-Тихоокеанского региона: долгосрочное влияние торгово-экономических соглашений

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АННОТАЦИЯ
Актуальность. За последние три десятилетия Азиатско-Тихоокеанский регион привлек более половины мировых прямых иностранных инвестиций (ПИИ), большая часть которых осталась в регионе. Торгово-экономические соглашения, направленные на снижение барьеров, сыграли ключевую роль в привлечении ПИИ в регион. Однако исследования влияния этих соглашений ограничены и часто сосредоточены на отдельных

КЛЮЧЕВЫЕ СЛОВА
прямые иностранные инвестиции, интеграция, торговые соглашения, инвестиционные соглашения, прямой эффект

экономиках. Учитывая экономическое разнообразие региона, долгосрочное влияние таких соглашений на приток ПИИ, а также сравнение этого влияния с мировыми тенденциями, остаются неясными.
Цель исследования. Цель исследования — дать количественную оценку долгосрочного влияния торгово-экономических соглашений на накопленный приток ПИИ в Азиатско-Тихоокеанском регионе.
Данные и методы. В исследовании используется структурная гравитационная модель с панельными данными о двусторонних потоках прямых иностранных инвестиций (ПИИ) между странами Азиатско-Тихоокеанского региона за 1992–2023 годы. Зависимая переменная была составлена на основе международных и национальных баз данных. Оценки получены с использованием метода псевдомаксимального правдоподобия Пуассона.
Результаты. Долгосрочный положительный прямой эффект соглашений был обусловлен, главным образом, расширением зон свободной торговли (ЗСТ+), что увеличило приток ПИИ на 35%. Другие торговые соглашения оказали незначительное прямое влияние, в то время как двусторонние инвестиционные соглашения фактически ограничили приток ПИИ. Исследование также выявило следующие кумулятивные эффекты: ЗСТ+ и инвестиционные соглашения увеличили приток ПИИ на 37% и 16% соответственно, тогда как торговые соглашения без положений, способствующих привлечению ПИИ, сократили приток на 59%.
Выводы. В своем инвестиционном взаимодействии страны Азиатско-Тихоокеанского региона придерживаются различных долгосрочных стратегий. Некоторые страны стимулируют ПИИ посредством ЗСТ+ и инвестиционных соглашений, следуя мировым тенденциям, в то время как другие ограничивают иностранный капитал посредством торговых соглашений, в которых отсутствуют меры по снижению барьеров для ПИИ.

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ДЛЯ ЦИТИРОВАНИЯ
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亚太地区外国直接投资：贸易协定的长期影响

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摘要
现实性：过去三十年间，亚太地区吸引了全球一半以上的外国直接投资（FDI），其中大部分资金留在该地区。旨在降低贸易壁垒的经济贸易协定在吸引FDI方面发挥了关键作用。然而，关于这些协定影响的研究有限，且往往聚焦于单个经济体。鉴于该地区的经济多样性，此类协定对FDI流入的长期影响，以及这种影响与全球趋势的比较情况，仍不明确。
研究目标：该研究的目的是量化贸易经济协定对亚太地区累计外国直接投资流入的长期影响。
数据与方法：本研究采用结构引力模型，利用1992年至2023年亚太地区国家间双边外国直接投资（FDI）流量的面板数据。因变量的构建基于国际和国家数据库。该估值是采用泊松伪最大似然法计算得出的。
研究结果：这些协议的长期积极直接效应主要源于自由贸易区（FTA+）的扩大，这使外国直接投资（FDI）流入增加了35％。其他贸易协议的直接影响微乎其微，而双边投资协议实际上限制了FDI流入。研究还发现了以下累积效应：FTA+和投资协定分别使外国直接投资流入量增加了37％和16％，而未包含促进外国直接投资条款的贸易协定则使流入量减少了59％。
结论：在投资互动方面，亚太地区各国采取了不同的长期战略。一些国家遵循全球趋势，通过自由贸易协定+和投资协定来刺激外国直接投资，而另一些国家则缺乏降低外国直接投资壁垒的措施，通过贸易协定来限制外国资本。

关键词
外商直接投资、一体化、贸易协定、投资协定、贸易经济协定的直接效应、贸易经济协定的累积效应、亚太地区

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Introduction

Cross-border investment is central to today's global economy, which makes it essential to examine the factors that shape foreign direct investment (FDI)[1]. Among the various theories of FDI[2], Dunning's paradigm (1981) is the most recognized for its integrative perspective. It suggests that a company's decision to invest abroad rests on three advantages: ownership, location, and internalization. The first advantage entirely depends on the characteristics of the investing company, while the second and third depend on the specific political and economic conditions in the host country (Gastanaga et al., 1998). There are some differences between the economic effects of outgoing (outflow) and incoming (inflow) FDI. Effects of outgoing FDI primarily benefit certain segments of a national economy's corporate sector, allowing companies to access foreign markets, reduce overall costs, and increase the competitiveness of their goods or services (Faeth, 2009). In contrast, incoming FDI produces a wide range of effects: it expands market capacity, encourages the setup of new production facilities with a strong export orientation, enables access to advanced foreign technologies, and helps raise employment and household incomes (Hassan, 2022).

Location and internalization advantages influence the dynamics and structure of FDI through factors such as market size, production costs, and the political and economic risks of host countries (Faeth, 2009). Since capital flows contribute to global welfare and expand international trade (Anderson, 2017), attracting FDI becomes a key objective of national economic policy. In this context, governments, particularly in developing countries, face the task of creating long-term conditions that make their economies more attractive to investors[3]. One effective way to achieve this is by lowering barriers to foreign capital, for example through trade and economic agreements designed to stimulate investment and support economic growth.

It should be noted that the Asia-Pacific region (APR), of which Russia is a part, is the largest sub-global economy, accounting on average for about 60 % of global GDP in 1992–2023, up from 55 % in 1992 (USD 14 trillion) to 63 % in 2023 (USD 66.6 trillion)[4]. The APR includes more than 50 countries and economic territories, including some of the world's largest economies (the USA, China, and Japan)[5]. APR countries have received a significant development boost through bilateral and multilateral integration agreements that reduce barriers to economic interactions. In the context of this study, three major groups of trade and economic agreements can be distinguished: bilateral investment agreements; advanced trade agreements containing provisions to simplify FDI flows; and other trade agreements that do not contain such provisions (Larch et al., 2023). One of the key aspects of economic interactions among APR countries has been the exchange of FDI, a factor that has grown increasingly significant over time. Indeed, over the past three decades, the APR has accounted for more than half of the world's accumulated FDI inflows.

This study aims to provide a long-term assessment of the impact of trade and economic agreements on accumulated FDI inflows in the APR. The research algorithm comprises the following tasks: 1) analyzing the dynamics of accumulated FDI and trade and economic agreements in the APR; 2) compiling the dataset and selecting the evaluation methodology; and 3) assessing the long-term impact of trade and economic agreements

[1] Foreign direct investment (FDI) refers to actions carried out by a resident of a foreign economy (the direct investor or parent company) with the aim of establishing a long-term interest in an enterprise that is a resident of the domestic economy (the enterprise receiving the investment or its foreign subsidiary). A long-term interest implies the existence of sustained relationships between the foreign direct investor and the enterprise. It is generally considered that owning more than 10 % of an enterprise's equity is sufficient for a foreign investor to exert influence over its management. For more on this, see: Foreign direct investment: Inward and outward flows and stock. Retrieved from: https://unctadstat.unctad.org/datacentre/dataviewer/US. FdiFlowsStock (date of access: 01.02.2025).

[2] Neoclassical, monetary, and institutional approaches, transaction cost theory, and others.

[3] Support for FDI outflows is practiced by a small number of relatively large open economies with a developed corporate sector.

[4] World Economic Outlook Database/IMF. Retrieved from: https://www.imf.org/en/Publications/WEO/weo-database/2025/april (date of access: 01.06.2025).

[5] During this period, the contribution of countries to the region's total GDP changed, mainly due to the rapid growth of China, Southeast Asian countries (SEA), and other countries in the APR (including Russia), as well as a recession in Japan's economy. In 1992, China accounted for 4 % of the region's total GDP, Southeast Asian countries 3 %, Japan 29 %, the USA 47 %, and Russia 1 %. By 2023, China's share had risen to 27 %, Southeast Asian countries to 6 %, Japan had fallen to 6 %, the USA accounted for 42 %, and Russia 3 %.

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on FDI inflows in the APR. This study covers the period from 1992 to 2023.

Theoretical Framework

Over the past two decades, structural gravity models have greatly advanced our understanding of the factors driving global trade and investment (Larch et al., 2023; Kleinert et al., 2010). Quantitative estimates of FDI flows, including for the Russian economy (Drapkin et al., 2023), highlight the influence of political and economic risks (Osabuohien-Irabor et al., 2022; Vasilyeva et al., 2021), gravity factors (Aiyar et al., 2024; Ben Belgacem et al., 2024), and trade and economic agreements. Research shows that bilateral investment agreements tend to have a neutral effect on FDI flows worldwide (Osnago et al., 2016; Larch et al., 2023), while advanced trade agreements have a positive, stimulating effect (Kox et al., 2019). Overall, these findings underscore the importance of comprehensive liberalization of trade and economic interactions and the reduction of risks to facilitate seamless global FDI flows.

The study of investment exchange dynamics revealed that a sustained decline in risks, together with broader economic freedoms, promoted FDI inflows into Asia-Pacific countries (Izotov, 2024). Trade growth in the region, driven by FDI and the openness of economies under relevant agreements, points to the link between capital flows and the movement of intermediate goods in "vertical" trade networks in East Asia and between the United States and Mexico (Fukao et al., 2003; Blair, 2017). Outward FDI flows from leading Asia-Pacific countries in East Asia were boosted by capital account liberalization and by higher levels of economic freedom in host economies (Le et al., 2021; Akhtaruzzaman, 2023; Pan et al., 2022). In East Asia, FDI primarily flowed from high-tech to medium-tech economies, consistent with the "flying geese" model, which suggests that technologies and capital move between economies at adjacent, rather than identical, levels of the technological ladder (Petri, 2012).

Research on the influence of trade and economic agreements on FDI inflows in the APR has so far been limited and usually focused on individual countries. For instance, gravity model estimates show that advanced trade and economic agreements with foreign partners increased FDI inflows into China (Yue et al., 2023) and Southeast Asia (Wahyuningsih, 2021; Duong et al., 2020) while bilateral investment treaties encouraged outward FDI from Japan (East…, 2019, p. 31).

A key limitation of these studies is that they overlook the impact of globalization. This omission is important because globalization can significantly distort assessments of how trade and economic agreements actually affect FDI inflows (Izotov, 2023). Another gap is the lack of attention to delayed or accumulated effects, which are particularly relevant in the long term. Given the diversity of APR economies, it remains unclear whether trade and economic agreements ultimately restrain, stimulate, or have little effect on long-term FDI inflows. What is missing is a comprehensive assessment that accounts for economic diversity, delayed effects of agreements, and the distorting role of globalization.

Evidence from the global economy (Larch, 2023) suggests that, over time, investment and advanced trade agreements have generally stimulated FDI inflows in the APR. In contrast, trade agreements without provisions to facilitate FDI tended either to have no effect or to restrain inflows. This study aims to provide a long-term assessment of both the direct and cumulative effects of different types of trade and economic agreements on FDI inflows in the region, taking into account the diversity of its economies and isolating the influence of globalization. The results of such assessments depend on the type of FDI data used — cumulative or flow values (Baltabaev, 2014)[6]. This study relies on cumulative FDI values, which are less volatile and contain far fewer zero or negative entries than flow values, making them more reliable for analysis (Kox et al., 2020; Larch et al., 2023).

FDI and Trade and Economic Agreements in the Asia-Pacific Region

On average over the period, the cumulative value of FDI inflows into Asia-Pacific countries grew 20.8 times in current prices — from USD 1,330 billion in 1992 to USD 27,719 billion in 2023. In the same period, these countries' share of global FDI increased from 53.3 % in 1992 to 56.4 % in 2023 (*Fig. 1*).

[6] FDI flows represent transactions recorded during the reporting period, which consist of equity acquisitions or disposals, reinvested earnings, and intercompany debt. Cumulative FDI refers to the total accumulated value of FDI recorded at the end of the reporting period.

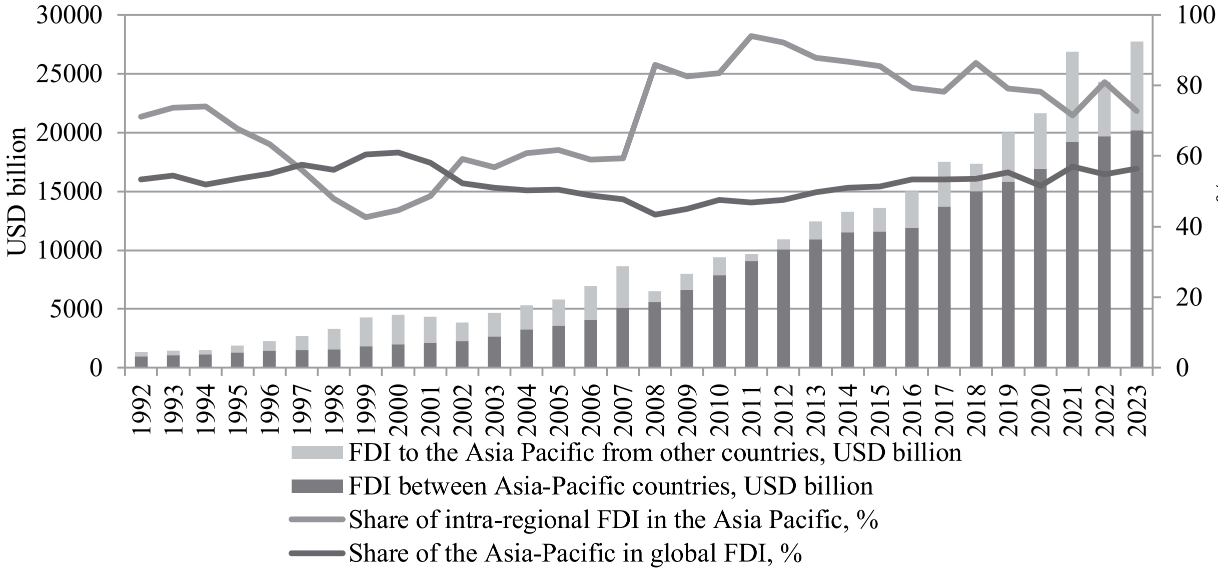

Figure 1. *Accumulated inflows of FDI in Asia-Pacific countries: Absolute and relative indicators*

Source: FDI Bilateral Statistics. UNCTAD. Retrieved from: https://unctad.org/en/Pages/DIAE/FDI%20 Statistics / FDI-Statistics-Bilateral.aspx (date of access: 14.06.2017); FDI database. UNCTAD. Retrieved from: https://unctad.org/fdistatistics (date of access: 01.02.2020); Foreign direct investment: Inward and outward flows and stock. Retrieved from: https://unctadstat.unctad.org/datacentre/dataviewer/US. FdiFlowsStock; OECD FDI Flows. Retrieved from: https://www.oecd.org/en/data/indicators/fdi-flows.html; Foreign Direct Investment Statistics: Data, Analysis and Forecasts. Retrieved from: https://mneguidelines.oecd.org/statistics.htm; OECD International Direct Investment Statistics. Retrieved from: https://www.oecd.org/en/publications/oecd-international-direct-investment-statistics_2307437x.html; IMF Coordinated Direct Investment Survey (CDIS). Retrieved from: http://data.imf.org/?sk=40313609-F037–48C1–84B1-E1F1CE54D6D5; Foreign Direct Investment Trends and Statistics. IMF. Retrieved from: https://www.imf.org/en/Publications/SPROLLs/direct-investment#sort=%40imfdate%20descending; CEIC Database. Retrieved from: https://www.ceicdata.com; Statistics of Foreign Direct Investment in ASEAN. Stocks of Inward Foreign Direct Investment (FDI) at year-end, by source country. Retrieved from: https://data.aseanstats.org/fdi-by-hosts-and-sources-stock (date of access: 01.03.2025).

Between 1992 and 2000, the APR's share of global FDI rose, reaching a peak of 61 percent. From 2001 to 2008, however, it declined, reflecting both the accumulation of foreign direct capital within the European Union and growing investment in other economies, including transit hubs. Afterward, the share of Asia-Pacific countries in global FDI tended to grow again, with the exception of episodes tied to the pandemic and heightened geopolitical risks in the early 2020s. The main Asia-Pacific economies accumulating FDI were the United States, China, ASEAN member states[7], Hong Kong, Canada, Australia, and Mexico, which together accounted for more than 90% of the region's inflows[8]. Inward FDI was driven primarily by intra-regional flows, that is, investment within the Asia-Pacific itself. The value of these FDI flows grew 21.3 times in current prices — from USD 946 billion in 1992 to USD 20,156 billion in 2023. On average, over 71% of FDI inflows into the region came from intra-regional sources, although since 2012 the share of extra-regional FDI in the Asia-Pacific has shown an upward trend.

It should be noted that since the early 1970s, the Asia-Pacific region, led by Japan, has pursued the "flying geese" strategy, which encouraged "vertical" trade by directing FDI toward East Asian countries with lower labor costs. From the second half of the 1980s onward, Korea, Taiwan, and Singapore also became important FDI donors in the region through production cooperation[9]. The strategy relied, among other things, on reducing various barriers that had constrained trade in intermediate goods and the

[7] Brunei, Vietnam, Indonesia, Cambodia, Laos, Malaysia, Myanmar, Singapore, Thailand and the Philippines.

[8] The United States and China accounted for more than 60% of the total FDI inflows into the Asia-Pacific.

[9] At the same time, the share of these countries in FDI inflows was small (less than 2%), since their economies relied on the capital of their own corporate sector.

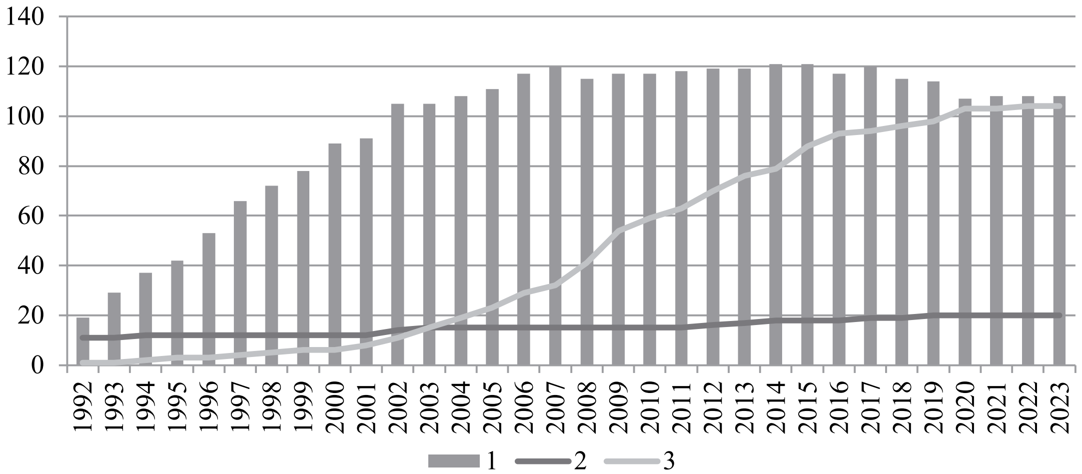

Figure 2. *Number of trade and economic agreements in the Asia-Pacific, cumulative total*

Note: 1 — Bilateral investment treaties; 2 — Trade agreements without provisions on facilitating FDI; 3 — Trade agreements with provisions on facilitating FDI.

Source: Regional trade agreements notified to the GATT/WTO and in force. Retrieved from: https://rtais.wto.org/UI/publicPreDefRepByCountry.aspx; Deep Trade Agreements database 2.0 (vertical depth). Retrieved from: https://datatopics.worldbank.org/dta/table.html; International Investment Agreements Navigator. Retrieved from: https://investmentpolicy.unctad.org/international-investment-agreements/by-economy (date of access: 01.02.2025).

exchange of direct investment between Asia-Pacific countries, often through trade and economic agreements. Other Asia-Pacific economies also entered into bilateral and multilateral agreements of this kind.

As a result, by the early 1990s, two types of trade and economic agreements were in practice in the region: bilateral investment treaties (hereafter investment agreements), and purely trade agreements without provisions facilitating FDI exchange — namely, partial-scope trade agreements (PSAs)[10], free trade areas (FTAs)[11], and customs unions (CUs)[12]. In effect, up to that point, liberalization of trade and investment in the Asia-Pacific region had not been synchronized. After most Asia-Pacific countries joined the WTO in 1995, trade liberalization experienced a brief period of stagnation, even as investment agreements continued to expand. From the early 2000s onward, extended free trade agreements (FTA+) became increasingly common. Alongside liberalizing goods and services, they also encouraged capital market integration, particularly in direct investment. In this respect, the Asia-Pacific saw a comprehensive reduction of barriers, both in trade in goods and services and in the exchange of FDI (*Fig. 2*).

In sum, the Asia-Pacific, like the global economy, featured three main types of trade and economic agreements: investment agreements and trade agreements that either lacked or contained provisions to support FDI exchange. In the second half of the 2010s, the operation of some investment agreements in the region was suspended, as participating countries signed FTA+ agreements that included FDI provisions. Nevertheless, investment agreements in the Asia-Pacific remained quite numerous and were usually concluded between countries that had not established trade agreements with each other.

It should be noted that, within the region, Russia has concluded an advanced trade agreement with FDI facilitation provisions only with Vietnam, which shows the lack of explicit Russian demand for integration with other Asia-Pacific countries. Before large-scale Western sanctions, and assuming interest in sub-global integration, such agreements could have helped maintain investment cooperation with countries the Russian government regards as “friendly”. Russia has also signed invest-

[10] Under partial-scope trade agreements (PSAs), countries reduce tariff barriers on specific groups of goods.

[11] Free trade areas (FTAs) involve reducing tariff and non-tariff barriers, while allowing countries to determine their own trade regimes with third countries.

[12] Customs unions (CUs) require member states to introduce a common external tariff and a unified system for regulating non-tariff measures toward third countries.

ment agreements with 12 Asia-Pacific countries[13], most of them friendly, though they mainly serve as recipients of Russian FDI, except for China.

Methods and Data

The general theoretical model of FDI exchange between countries can be presented as follows (Kox et al., 2020):

$$FDI_{ij} = \omega_{ij} \frac{\alpha Y_i}{P_i} \frac{\beta Y_j}{\Pi_j}, \tag{1}$$

where: *FDI* is the value of accumulated foreign direct investment; *i* is the host country of FDI inflows; *j* is the home country of FDI outflows; ω is a parameter reflecting the openness of *i* and *j* to bilateral capital exchange[14]; Y_i is the size of economy (GDP) of *i*; Y_j is the size of economy (GDP) of *j*; $\alpha > 0$ and $\beta > 0$ are proportionality factors of the gravity relationship; $P_{i \text{ and } \Pi j}$ are multilateral resistance terms.

The parameters P_i and Π_j aggregate all bilateral economic barriers (costs) faced by the FDI host and home countries, respectively. Thus, P_i reflects multilateral resistance for the host country *i*, while Π_j reflects multilateral resistance for the home country *j*. P_i and Π_j are expressed using a constant elasticity of substitution function to aggregate and average all costs hindering FDI inflows, after weighting them by the size of the economy. As a result, the multilateral resistance for the host country is represented as follows:

$$P_i = \left[\sum_{j=1}^{N} \left(\frac{z_{ij}}{\Pi_j} \right)^{(1-\sigma)} \frac{Y_j}{Y} \right]^{\frac{1}{1-\sigma}}, \tag{2}$$

where: z_{ij} signifies the costs arising from various barriers in country *i* that affect FDI inflows from country *j*; σ is the constant elasticity of substitution between domestic and foreign investments ($\sigma > 1$); *N* is the number of economic partners; and *Y* is the size of the world economy.

Thus, the multilateral resistance for the home country is represented by the following expression:

$$\Pi_j = \left[\sum_{i=1}^{N} \left(\frac{z_{ji}}{P_i} \right)^{(1-\sigma)} \frac{Y_i}{Y} \right]^{\frac{1}{1-\sigma}}, \tag{3}$$

where z_{ji} signifies the costs arising from various barriers that affect capital outflows from *j* to *i*. The costs reflected in the parameters z_{ij} and z_{ji} may be either symmetric (e. g., physical distance, language differences, etc.) or country-specific. All cost elements increase the expenses of cross-border capital exchange, with a key factor being the presence or absence of alternative options for FDI[15].

Other things being equal, the inflow of accumulated FDI into country *i* from country *j* is positively influenced by the size of the interacting economies. The larger the national economy, the more it invests abroad, and the greater the number of consumers, firms, and industries that generate demand for foreign capital and related technologies brought in through FDI. Free FDI inflows into the national economy are hindered by barriers. However, even when such barriers are relatively low, investors' decisions on whether to undertake FDI in a given country are determined by alternative costs, which are weighed when choosing the geographical direction of capital outflows. Relative costs of capital outflows also arise in the home country *j*, for example, through the introduction or abolition of special economic rules for firms undertaking FDI abroad.

It should be noted that in structural gravity models, which differ from traditional ones by explicitly incorporating unobservable indicators of multilateral resistance, the estimation of dummy variables reflecting countries' participation (or non-participation) in trade and economic agreements controls for inward and outward multilateral resistance through exporter/importer-time fixed effects, while all time-invariant bilateral costs are captured by country-pair fixed effects (Yotov et al., 2016). These provisions have greatly simplified estimating the effects of trade and investment

[13] Canada, Korea, Japan, Singapore, Vietnam, Mongolia, Laos, China, Indonesia, Nicaragua, Cambodia and North Korea

[14] If $\omega_{ij} = 1$, then market *i* is fully open to capital inflows from *j*; if $\omega_{ij} = 0$, then market *i* is completely closed to capital inflows from *j*. In theoretical model (1), this parameter is introduced for simplicity. It captures how national borders act as barriers to capital inflows, ranging from fully open to fully closed. The degree of this barrier can be assessed either through expert judgment or by analyzing the influence of both restrictive and supportive factors affecting FDI inflows.

[15] If, within the theoretical model, $\frac{z_{ji}}{P_i} < 1$ and $\frac{z_{ij}}{\Pi_j} < 1$, then the relative costs are below the global average and do not hinder bilateral capital flows; otherwise, they impede FDI. In the theoretical model, the combination of these costs and the sizes of the economies determines whether country *i* is a preferred destination for FDI inflows.

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agreements between countries (Larch et al., 2023), as they eliminate the need to include economic size as a dependent variable, thereby avoiding endogeneity issues. This approach also accounts for heterogeneity in the size of interacting economies, as well as multilateral resistance and other measures of symmetric and country-specific costs.

Since cross-country investment interactions often include a significant number of "zero" values, the relationship between accumulated FDI and the conclusion of trade and economic agreements was estimated using the Poisson pseudo-maximum likelihood (PPML) method. This approach allows inclusion of zero values in the dataset and avoids problems of heteroskedasticity and model misspecification due to an incorrectly chosen functional form (Kox et al., 2020). Empirical estimates for trade (Larch et al., 2025; Santos Silva et al., 2011) and investment (Kox et al., 2020; Larch et al., 2023) show that this method provides asymptotically unbiased estimates even when there are many zero observations, compared to the log-linear form.

It is essential to include each country's domestic accumulated investments in the panel to obtain accurate effect estimates. First, this allows us to control for the diversion of investment flows from partner countries toward their own domestic markets (Kox et al., 2020). Second, it helps eliminate the distorting influence of globalization on FDI inflows by incorporating dummy variables that capture the presence of barriers between countries for each year[16]—something that cannot be achieved by considering only bilateral interactions (Yotov, 2022).

Since the effects of trade and economic agreements on investment flows can be lagged, both the direct and cumulative impacts of these agreements on FDI inflows in the Asia-Pacific were estimated following the methodology used for trade flows (Yotov et al., 2016). The *direct effect* of trade and economic agreements on FDI inflows in the Asia-Pacific was estimated as follows:

$$FDI_{ijt} = \exp\,[\beta_0 + \beta_1 AGREEMENTj_{ijt} + \\ + \sum_{T=1}^{T=n} \beta_T INTL\,(T)_{ij} + \pi_{it} + \chi_{jt} + \mu_{ij} + \varepsilon_{ijt}], \qquad (4)$$

where: FDI_{ij} stands for accumulated FDI inflows into country i from country j (in USD); $AGREEMENT_{ijt}$ is the dummy variable indicating the presence (1) or absence (0) of a trade and economic agreement between countries i and j; $INTL(T)_{ij}$ is the dummy variable equal to 1 for FDI flows between countries in year T and 0 for domestic investments; β_0 is a constant; β_1 is the direct effect of the trade and economic agreement; β_T stands for the cumulative barriers in investment interactions between countries; t is the time period; π_i signifies fixed effects for the FDI home country, controlling for the year; χ_j, fixed effects for the FDI host country, controlling for the year; μ_{ij}, fixed effects for country pairs; and ε is the error term.

The *cumulative effect of trade and economic agreements* was evaluated using the following specification:

$$FDI_{ijt} = \exp\,[\beta_0 + \sum_{n=0}^{n=5} \beta_n AGREEMENTj_{ijt-n} + \\ \sum_{T=1}^{T=n} \beta_T INTL\,(T)_{ij} + \pi_{it} + \chi_{jt} + \mu_{ij} + \varepsilon_{ijt}], \qquad (5)$$

where: $\Sigma\beta_n$ is the value of the cumulative effect of trade and economic agreements and n is the time lag (5 years).

Variable $AGREEMENTj_{ij}$ represented the following types of trade and economic agreements among APEC countries: first, *PSAFTACU*, which included PSAs, FTAs, FTA+, and CUs. These were further divided into *INV_PSAFTACU*, i.e., trade agreements containing provisions that facilitate FDI exchange (FTA+), and *PSAFTACUsimple*, i.e., *BIT* — bilateral investment treaties.

Data

Compiling the dataset on mutual cumulative FDI among Asia-Pacific countries over the long term was a labor-intensive task. The main challenge in constructing the dependent variable was the lack of a unified statistical database showing the value of mutual cumulative FDI in current prices. Most sources were incomplete, both in terms of the time periods covered and the countries included. To address this, the dataset was assembled from multiple sources, primarily international databases such as the UN[17],

[16] The most recent of these was excluded from the set of variables, serving as the reference category for the others.

[17] FDI Bilateral Statistics. UNCTAD. Retrieved from: https://unctad.org/en/Pages/DIAE/FDI %20Statistics/FDI-Statistics-Bilateral.aspx (date of access: 14.06.2017); FDI database. UNCTAD. Retrieved from: https://unctad.

OECD[18], World Bank (Steenbergen et al., 2022), IMF[19], and CEIC[20]. When gaps in the data were identified, missing values were either filled using alternative sources (CEPII[21]; ASEAN[22]; central banks, statistical offices, relevant ministries, and investment agencies of Asia-Pacific countries and territories; as well as other international organizations and analytical agencies[23]) or, in some cases, estimated using a moving average. Occasional negative values in cumulative FDI were treated as zero (Kox et al., 2020).

To obtain unbiased estimates, it is necessary to account for the deviation of FDI flows in favor of domestic markets. Therefore, the dependent variable dataset included data on the value of accumulated fixed capital investments in APEC countries, net of accumulated FDI, following the methodological recommendations for estimating gravity models in trade (Yotov et al., 2016). For the period under review, statistics on domestic accumulated fixed capital investments were compiled both from specialized databases[24] and from the statistical agencies of APEC countries. Since data on domestic accumulated fixed capital investments were unavailable for several APEC countries[25], these economies were excluded from the estimated panel. This exclusion is not critical, as their share of total accumulated FDI inflows in APEC was only 0.05 % in 1992 and 0.07 % in 2023. As a result, consistent with an earlier study (Izotov, 2023), the panel comprised 36 APEC economies[26].

To construct the dataset of dummy variables for trade and economic agreements among APEC countries, information on the presence or absence of ratified PSAs, FTAs, FTA+, CUs, and investment agreements was drawn from the WTO[27], World Bank[28], and UN[29] databases. If an agreement entered into force in the first half of a given year, it was attributed to that year; if in the sec-

org/fdistatistics (date of access: 01.02.2020).

[18] OECD FDI Flows. Retrieved from: https://www.oecd.org/en/data/indicators/fdi-flows.html; Foreign Direct Investment Statistics: Data, Analysis and Forecasts. Retrieved from: https://mneguidelines.oecd.org/statistics.htm; OECD International Direct Investment Statistics. Retrieved from: https://www.oecd.org/en/publications/oecd-international-direct-investment-statistics_2307437x.html (date of access: 01.02.2025).

[19] IMF Coordinated Direct Investment Survey (CDIS). Retrieved from: http://data.imf.org/?sk=40313609-F037–48C1–84B1-E1F1CE54D6D5; Foreign Direct Investment Trends and Statistics. IMF. Retrieved from: https://www.imf.org/en/Publications/SPROLLs/direct-investment#sort= %40imfdate %20descending (date of access: 01.02.2025).

[20] CEIC Database. Retrieved from: https://www.ceicdata.com (date of access: 01.06.2012).

[21] FDI Map. CEPII. Retrieved from: https://www.cepii.fr/cepii/en/bdd_modele/bdd_modele_item.asp?id=4 (date of access: 01.02.2025).

[22] Statistics of Foreign Direct Investment in ASEAN. Stocks of Inward Foreign Direct Investment (FDI) at year-end, by source country. Retrieved from: https://data.aseanstats.org/fdi-by-hosts-and-sources-stock (date of access: 01.03.2025).

[23] Central Bank of Russia; Australian Bureau of Statistics; Brunei Darussalam Department of Economic Planning and Statistics; Vale Columbia Center on Sustainable International Investment; Foreign Investment Committee of Chile; Kingdom of Cambodia Ministry of Foreign Affairs and International Cooperation; Canada Department of Foreign Affairs and International Trade; Canada Department of Statistics; Singapore Department of Statistics; Central Bank of Malaysia; Malaysia Department of Statistics; Bank of Japan; JETRO; Japan Ministry of Finance; Central Bank of Ecuador; Ministry of Commerce People's Republic of China; Taiwan Ministry of Economic Affairs; Central Bank of Philippines; Bank of Thailand; Thailand Board of Investment; Bureau of Economic Analysis; Export-Import Bank of Korea; New Zealand Department of Statistics; Myanmar Directorate of Investment and Company Administration; National Statistical Office of Mongolia; Macau Statistics and Census Service; Laos Investment Promotion Department; Indonesia Investment Coordinated Board; Hong Kong Census and Statistics Department; Vietnam General Statistical Office; Statista; Institute for International Political Economy; Bank for International Settlements, etc.

[24] United States International Trade Commission (USITC). Retrieved from: https://www.usitc.gov/data/gravity/mreid.htm (date of access: 01.02.2025); CEIC Database. Retrieved from: https://www.ceicdata.com (date of access: 01.06.2012).

[25] Vanuatu, East Timor, Kiribati, North Korea, Marshall Islands, Nauru, New Caledonia, Palau, Cook Islands, Samoa, Solomon Islands, Tuvalu, Wallis and Futuna, Federated States of Micronesia, French Polynesia.

[26] Australia, Brunei, Vietnam, Guatemala, Honduras, Hong Kong, Indonesia, Cambodia, Canada, China, Colombia, Costa Rica, Laos, Macau, Malaysia, Mexico, Mongolia, Myanmar, Nicaragua, New Zealand, Panama, Papua New Guinea, Peru, Korea, Russia, El Salvador, Singapore, USA, Thailand, Taiwan, Tonga, Fiji, Philippines, Chile, Ecuador and Japan.

[27] Regional trade agreements notified to the GATT/WTO and in force. Retrieved from: https://rtais.wto.org/UI/publicPreDefRepByCountry.aspx (date of access: 01.02.2025).

[28] Deep Trade Agreements database 2.0 (vertical depth). Retrieved from: https://datatopics.worldbank.org/dta/table.html (date of access: 01.02.2025).

[29] International Investment Agreements Navigator. Retrieved from: https://investmentpolicy.unctad.org/international-investment-agreements/by-economy (date of access: 01.02.2025).

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Table 1

Evaluation results (4)

Variable	1	2	3	4	5	Δ, %
PSAFTACU	0,26*** (0,07)	–	–	–	–	30
INV_PSAFTACU	–	0,30*** (0,07)	–	–	0,30*** (0,07)	35
PSAFTACUsimple	–	–	−0.15 (0,14)	–	–	–
BIT	–	–	–	−0,18*** (0,06)	−0,17*** (0,06)	−17
$INTL_{1992}$	1,64*** (0,12)	1,67*** (0,12)	1,47*** (0,11)	1,42*** (0,11)	1,63*** (0,12)	–
$INTL_{1995}$	0,33*** (0,09)	0,36*** (0,08)	0,23** (0,09)	0,18* (0,09)	0,32*** (0,09)	–
$INTL_{1999}$	−0.08 (0,10)	−0.10 (0,10)	−0.04 (0,10)	−0.09 (0,10)	−0.06 (0,10)	–
$INTL_{2003}$	−0,15* (0,07)	−0,13* (0,07)	−0,20** (0,08)	−0,25** (0,08)	−0,17** (0,07)	–
$INTL_{2007}$	−0.06 (0,08)	−0.06 (0,08)	−0.03 (0,09)	−0.01 (0,08)	−0.02 (0,07)	–
$INTL_{2011}$	−0.05 (0,07)	−0.05 (0,07)	−0.02 (0,07)	−0.02 (0,06)	−0.01 (0,06)	–
$INTL_{2015}$	−0,13** (0,05)	−0,13** (0,05)	−0,14** (0,05)	−0,18*** (0,05)	−0,17*** (0,05)	–
$INTL_{2019}$	−0.03 (0,06)	−0.03 (0,06)	−0.03 (0,06)	−0.03 (0,05)	−0.03 (0,05)	–
Constant	12,50*** (0,33)	19,58*** (0,24)	21,99*** (0,19)	19,96*** (0,23)	22,92*** (0,22)	–
Pseudo log-likelihood	−3,05e+12	−3,02e+12	−3,09e+12	−3,06e+12	−2,99e+12	–
Pseudo R^2	0.99	0.99	0.99	0.99	0.99	–
RESET-test	0.01	0.01	0.01	0.01	0.02	–

Notes. 1–5 are different dependencies within Model (4). Here and below: *** — $p < 0.01$; ** — $p < 0.05$; * — $p < 0.10$; autocorrelation was accounted for using the Newey–West estimator; standard errors are reported in parentheses; *INTL* reflects border effect values, with 2023 as the baseline year; fixed effects estimates are not reported for brevity; $\Delta = (e^{\beta}-1)\times 100\,\%$ represents the impact of the independent variable on the dependent variable.

Source: calculated by the author.

ond half, it was assigned to the following year. As noted earlier, from the *PSAFTACU* dataset (PSAs, FTAs, FTA+, and CUs), two variables were distinguished: *INV_PSAFTACU* — trade agreements containing provisions facilitating FDI exchange[30], and *PSAFTACUsimple* — all other agreements[31]. Based on UN data, a separate dummy variable dataset was created for *BIT*[32].

To facilitate quantitative estimation, this study evaluated interval values of panel data with a five-year lag: 1992[33], 1995, 1999, 2003, 2007, 2011, 2015, 2019, and 2023. As a result, the study covered 11,502 observations.

Results

The calculations showed that the positive long-term direct effect of trade and economic agreements on FDI inflows into Asia-Pacific countries was achieved through agreements con-

[30] Appendix, Table 1A.

[31] Appendix, Table 2A.

[32] Appendix, Table 3A.

[33] *Note*: this is the only exception, since the interval between 1992 and 1995 is four years. This year was included to account for the impact of agreements concluded prior to the establishment of the WTO.

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taining provisions that facilitate the exchange of FDI (*INV_PSAFTACU*) (*Table 1*).

In the period under review, advanced trade agreements liberalizing investment between Asia-Pacific countries increased FDI inflows to the region by 35 %. In contrast, other trade agreements (*PSAFTACUsimple*) had no significant direct effect, indicating their focus solely on trade within the region. Investment agreements (*BITs*) were found to constrain FDI inflows.

Furthermore, the estimated cumulative effects suggested that the overall impact of trade agreements (*PSAFTACU*) on FDI inflows to APR countries was statistically insignificant, as other trade agreements (*PSAFTACUsimple*) had a long-term negative effect on the dependent variable, effectively offsetting the positive impact of advanced trade agreements that included the liberalization of investment interactions (*Table 2*).

Over the long term, Asia-Pacific countries that used trade agreements to lower investment barriers and promote FDI saw their inflows rise by an average of 37 %, whereas countries that concluded trade agreements without FDI-facilitating provisions experienced a 59 % decline in FDI inflows from the region relative to domestic investment. Additionally, the cumulative effect of bilateral investment treaties (*BITs*) on FDI inflows into APR countries was positive, contributing to an average increase of 16 %, in contrast to the estimates for their direct effect.

By using the *INTL* variable to control for the distorting effects of global economic conditions,

Table 2

Evaluation results (5)

Variable	1	2	3	4	5	Δ, %
PSAFTACU	0.08 (0,10)	–	–	–	–	–
INV_PSAFTACU	–	0,32*** (0,09)	–	–	0,32*** (0,05)	37
PSAFTACUsimple	–	–	–0,89*** (0,16)	–	–	–59
BIT	–	–	–	0,16** (0,04)	0,15** (0,06)	16
$INTL_{1992}$	1,50*** (0,12)	1,68*** (0,12)	1,44*** (0,11)	1,46*** (0,11)	1,67*** (0,11)	–
$INTL_{1995}$	0,19* (0,10)	0,37*** (0,09)	0,19* (0,09)	0,22** (0,09)	0,39*** (0,08)	–
$INTL_{1999}$	–0.03 (0,10)	–0.12 (0,11)	–0.03 (0,10)	–0.04 (0,09)	–0.12 (0,08)	–
$INTL_{2003}$	–0,26*** (0,08)	–0,12* (0,06)	–0,18** (0,07)	–0,22*** (0,07)	–0,11* (0,06)	–
$INTL_{2007}$	–0.05 (0,06)	–0.07 (0,07)	–0.06 (0,08)	–0.01 (0,08)	–0.08 (0,08)	–
$INTL_{2011}$	–0.01 (0,06)	–0.06 (0,06)	–0.05 (0,06)	–0.01 (0,06)	–0.05 (0,06)	–
$INTL_{2015}$	–0,17*** (0,05)	–0,13** (0,05)	–0,12** (0,05)	–0,16*** (0,05)	–0,15*** (0,05)	–
$INTL_{2019}$	–0.04 (0,06)	–0.03 (0,06)	–0.01 (0,06)	–0.02 (0,06)	–0.02 (0,05)	–
Constant	20,01*** (0,22)	19,58*** (0,24)	21,81*** (0,30)	12,77*** (0,31)	12,11*** (0,17)	–
Pseudo log-likelihood	–3,03e+12	–3,02e+12	–3,95e+12	–3,02e+12	–2,99e+12	–
Pseudo R^2	0.99	0.99	0.99	0.99	0.99	–
RESET-test	0.01	0.02	0.05	0.01	0.02	–

Note. 1–5 are different dependencies within Model (5). Given the large number of semi-elasticity estimates with a 5-year lag over the 32-year period, their values are presented in aggregated form for brevity.

Source: calculated by the author.

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the study identified cumulative barriers affecting investment interactions between APR countries relative to their domestic capital markets. The assessment of these barriers indicated an increase compared to the early 1990s, reflecting that the size of most Asia-Pacific economies, which determines the scale of domestic investments, was not comparable to current levels at that time.

Discussion

The assessment of direct effects has shown that FDI inflows into Asia-Pacific countries were driven primarily by extended trade agreements that included provisions on liberalizing investment relations among member states. This finding is consistent with results reported for the global economy (Kox et al., 2020; Larch et al., 2023).

The evaluation of cumulative effects showed that reducing barriers to trade in goods, including intermediates, is only part of the solution. Sustaining production cooperation through FDI depends primarily on further development of integration frameworks. Otherwise, when Asia-Pacific countries conclude trade and economic agreements focused solely on trade liberalization, such a strategy may actually hinder FDI inflows. A closer look revealed that the positive impact of BITs on FDI became visible only about a decade after they came into force. This delay can be explained by the fact that countries signing such treaties later developed other integration frameworks relying on the mechanisms established in the BITs, which generated positive outcomes. Another factor may have been the long adjustment period that businesses required to adapt to the new opportunities, especially since these treaties were typically signed in the absence of deeper integration formats between economies.

Estimates of overall barriers to investment showed that, for most Asia-Pacific countries, greater trade and investment openness encouraged domestic capital investment in fixed assets. Over time, these domestic investments came to far exceed accumulated FDI compared to the early 1990s. By 2023, FDI barriers had eased somewhat relative to the early 2000s and mid-2010s, indicating a gradual convergence of Asia-Pacific economies in investment relations, despite ongoing trade, economic, and foreign policy challenges.

In this study, the Asia-Pacific is viewed as a sub-global economic space that is not homogeneous, yet is assumed to operate under common "rules of the game." By following these rules, national economies either facilitated or restricted FDI inflows, thus shaping their own strategies of investment interaction. Given the uneven development of Asia-Pacific countries, the varying impacts of different trade and economic agreements reveal general patterns in FDI attraction across the region.

Overall, the estimates of the impact of trade and economic agreements on FDI inflows into Asia-Pacific countries indicated the effectiveness of FTA+ in attracting foreign direct capital, a finding also confirmed in global assessments (Larch et al., 2023). However, in recent years, large-scale FDI inflows into Russia have become virtually impossible due to restrictions on capital account operations, increased risks associated with secondary sanctions, and the loss of opportunities for cooperation with Western countries, which had been the main investors in the Russian economy before the sanctions[34].

Under current conditions, only selective and largely non-public FDI enters the Russian economy, coming exclusively from countries considered friendly by the Russian government, including some Asia-Pacific states. Integration frameworks could be developed with these countries, primarily China, as well as with several Southeast Asian and Latin American nations. FDI inflows from Asia-Pacific countries are particularly important for supporting both traditional and emerging sectors of the Russian economy, especially in macro-regions such as the Far East, which is geographically part of the Asia-Pacific.

Despite strict sanctions, FDI has continued to enter the Russian Far East from "unfriendly" countries such as Japan, alongside a notable increase in capital linked to Chinese businesses, partly facilitated by existing investment agreements. Easing sanctions and expanding integration frameworks with selected Asia-Pacific countries could stimulate renewed FDI flows into Russia, particularly into the Far East. At the same time, the composition of foreign investors is likely to shift toward countries considered friendly by the Russian government, which could then engage in advanced FTA+ trade agreements with Russia.

[34] This also includes FDI into Russia from Western countries routed through offshore jurisdictions. A significant portion of these investments was undoubtedly fictitious, that is, funds moved out of the national economy to offshore accounts and then returned under the appearance of capital.

Conclusion

The exchange of FDI has been a central aspect of economic interactions among Asia-Pacific countries. Accounting for over 60 % of the global economy, the region received, on average, more than half of the world's accumulated FDI between 1992 and 2023, with over 70 % of these flows occurring within the region. Until the mid-1990s, the liberalization of trade and investment interactions was largely unsynchronized, particularly in the expansion of bilateral investment agreements. From the early 2000s onward, the region saw a rapid growth in advanced FTA+ trade agreements, which reduced barriers to both the trade of goods and services and the exchange of FDI within this sub-global region. Thus, three main types of trade and economic agreements have facilitated regional integration in the Asia-Pacific: bilateral investment agreements, trade agreements with provisions easing FDI flows, and trade agreements without such provisions.

This study contributes to the field by providing a long-term assessment of how trade and economic agreements influence FDI inflows within the Asia-Pacific region, distinguishing between direct and accumulated effects of regional integration. Because the impact of such agreements on investment flows may be delayed, both the immediate and long-term accumulated effects on FDI inflows were estimated using a structural gravity model. The results show that the long-term positive direct effect was achieved exclusively through advanced FTA+ agreements, which increased FDI inflows by 35 % relative to domestic investment. Other trade agreements in the region had no statistically significant direct effect, indicating their focus on promoting trade rather than investment, while bilateral investment agreements actually restrained FDI inflows.

Estimates of the accumulated effects reveal a similar pattern: FTA+ agreements and investment agreements contributed to average increases in FDI inflows of 37 % and 16 %, respectively, whereas trade agreements without FDI-facilitating provisions led to a 59 % decline.

The study also found that countries in the Asia-Pacific pursued various long-term strategies when interacting with the sub-global economy. Some countries sought to stimulate FDI inflows through the conclusion of advanced FTA+ agreements as well as investment agreements. The delayed positive impact of investment agreements on FDI inflows into Asia-Pacific countries can be explained both by the long adaptation period required for national businesses in the absence of deeper integration formats and by the simultaneous development of advanced FTA+ agreements. Yet other countries sought to restrain the attraction of foreign direct capital by implementing trade agreements without provisions to reduce barriers to FDI.

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Appendix

Table 1A

List of trade agreements containing provisions to facilitate FDI flows between Asia-Pacific countries (*INV_PSAFTACU*)[35]

INV_PSAFTACU	Year
Australia and New Zealand	1989
North American Free Trade Agreement (NAFTA) (USA, Mexico, Canada)	1994–2020
Colombia — Mexico	1995
Canada — Chile	1997
ASEAN Free Trade Zone (AFTA)	1998
Chile — Mexico	1999

[35] In the FTA+ format, unless another format is specified.

INV_PSAFTACU	Year
Central America (Honduras, Costa Rica, Nicaragua, El Salvador, Panama); New Zealand — Singapore	2001
Chile — Costa Rica; Chile — El Salvador; Japan — Singapore	2002
China — Hong Kong; China — Macau; Panama — El Salvador; Singapore — Australia	2003
Panama — Taiwan; Korea — Chile; USA — Chile; USA — Singapore	2004
USA — Australia; Thailand — Australia; Thailand — New Zealand; Japan — Mexico	2005
Central America — USA; Guatemala — Taiwan; Japan — Malaysia; Panama — Singapore; Korea — Singapore; Trans-Pacific Strategic Economic Partnership (Brunei, New Zealand, Singapore, Chile)	2006
Japan — Thailand; ASEAN — China; Chile — Japan	2007
Brunei — Japan; Chile — Honduras; China — New Zealand; El Salvador — Honduras — Taiwan; Japan — Indonesia; Japan — Philippines; Nicaragua — Taiwan; Panama — Costa Rica; Panama — Chile	2008
Peru — Chile; Peru — Singapore; Panama — Guatemala; Panama — Honduras; Panama — Nicaragua; Japan — Vietnam; USA — Peru; China — Singapore; Colombia — Northern Triangle countries (El Salvador, Guatemala, Honduras); ASEAN — Korea; Australia — Chile; Canada — Peru; Chile — Colombia	2009
ASEAN — Australia — New Zealand; Chile — China; Chile — Guatemala; New Zealand — Malaysia; Peru — China	2010
Peru — Korea; Canada — Colombia; China — Costa Rica; Hong Kong — New Zealand	2011
Japan — Peru; Chile — Nicaragua; Panama — Peru; Peru — Mexico; Korea — USA; USA — Colombia; USA — Panama	2012
Malaysia — Australia; Mexico — Central America; New Zealand — Taiwan; Canada — Panama; Costa Rica — Peru; Costa Rica — Singapore	2013
Canada — Honduras; Korea — Australia; Singapore — Taiwan	2014
Korea — New Zealand; Korea — Vietnam; Mexico — Panama; Australia — China; Canada — Korea; Chile — Thailand; China — Korea; Hong Kong — Chile; Japan — Australia	2015
Costa Rica — Colombia; Russia[36] — Vietnam; Japan — Mongolia; Korea — Colombia; Pacific Alliance (Colombia, Mexico, Peru, Chile)	2016
Peru — Honduras	2017
Comprehensive and Progressive Trans-Pacific Partnership (Australia, Brunei, Vietnam, Canada, Malaysia, Mexico, New Zealand, Peru, Singapore, Chile, Japan); Hong Kong — Macau	2018
ASEAN — Hong Kong; Korea — Central America	2019
Peru — Australia; ASEAN — Japan; Hong Kong — Australia; Indonesia — Australia; Pacific Agreement on Close Economic Relations (Australia, New Zealand, Tonga); USA — Mexico — Canada (USMCA)	2020
Comprehensive Regional Economic Partnership (Australia, Brunei, Vietnam, Indonesia, Cambodia, China, Korea, Laos, Malaysia, Myanmar, New Zealand, Singapore, Thailand, Philippines, Japan)	2022

Source: compiled by the author based on: Deep Trade Agreements database 2.0 (vertical depth). Retrieved from: https://datatopics.worldbank.org/dta/table.html; Regional trade agreements notified to the GATT/WTO and in force. Retrieved from: https://rtais.wto.org/UI/publicPreDefRepByCountry.aspx (date of access: 01.02.2025).

Table 2A

List of other trade agreements between Asia-Pacific countries (*PSAFTACUsimple*)

PSAFTACUsimple	Year
CU — Central American Common Market (Guatemala, Honduras, Nicaragua, El Salvador)	1961
PSA Trade Negotiation Protocol (Korea, Mexico, Peru, Chile, Philippines)	1973
PSA Asia-Pacific Trade Agreement (Korea, Laos)	1976
FTA Australia– Papua New Guinea	1977
PSA Latin American Integration Association (Colombia, Mexico, Peru, Chile, Ecuador); PSA South Pacific Agreement on Regional Trade and Economic Cooperation (Australia, New Zealand, Papua New Guinea, Tonga, Fiji)	1981
PSA Ecuador — Mexico	1983
CU — The Andean Community of Nations (Colombia, Peru, Ecuador).	1988

[36] As a member state of the Eurasian Economic Union.

PSAFTACUsimple	Year
PSA Global System of Trade Preferences (Vietnam, Indonesia, Colombia, Korea, Malaysia, Mexico, Nicaragua, Peru, Singapore, Thailand, Philippines, Chile, Ecuador)	1989
PSA Laos — Thailand	1991
FTA ASEAN	1992–1998
PSA Melanesian Initiative Group (Papua New Guinea, Fiji)	1994
PSA Asia-Pacific Trade Agreement — China; Canada–Costa Rica FTA	2002
FTA Trade agreement between Pacific Island countries (Papua New Guinea, Tonga, Fiji)	2003
FTA Chile — Malaysia	2012
CU Central America — Panama	2013
FTA Chile — Vietnam	2014
PSA El Salvador — Ecuador	2017
FTA Chile — Indonesia	2019

Source: compiled by the author based on: Deep Trade Agreements database 2.0 (vertical depth). Note: FTA — Free Trade Area; PSA — Partial-Scope Trade Agreement; CU — Customs Union. Retrieved from: https://datatopics.worldbank.org/dta/table.html; Regional trade agreements notified to the GATT/WTO and in force. Retrieved from: https://rtais.wto.org/UI/publicPreDefRepByCountry.aspx (date of access: 01.02.2025)

Table 3A

List of BITs between Asia-Pacific countries

BIT	Year
China — Singapore	1985–2019
Indonesia — Singapore	1990–2006
China — Russia	1990–2009
Indonesia — Vietnam	1991–2016
Australia — Vietnam	1991–2019
Panama — Taiwan	1992–2004
China — Korea	1992–2007
Nicaragua — Taiwan	1992–2010
Australia — Indonesia	1992–2020
Korea — Vietnam	1993–2004
Korea — Peru	1993–2011
Ecuador — USA; Chile — Ecuador	1993–2018
Australia — Hong Kong	1993–2020
Ecuador — El Salvador	1994–2008
Colombia — Peru	1994–2010
Chile — China	1994–2014
China — Indonesia; Indonesia — Malaysia; Indonesia — Laos	1994–2015
China — Ecuador	1994–2018
Australia — Peru	1995–2020
Chile — Korea	1996–2004
El Salvador — Taiwan; Honduras — Taiwan	1996–2008
Australia — Chile	1996–2009
Canada — Ecuador	1996–2018
El Salvador — Korea	1998–2020
El Salvador — Nicaragua	1999–2008
Cambodia — Indonesia	1999–2016
Ecuador — Peru	1999–2017

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BIT	Year
Ecuador — Honduras; Ecuador — Nicaragua	2000–2008
Chile — Peru	2000–2009
Costa Rica — Korea; Honduras — Korea; Guatemala — Korea; Korea — Nicaragua	2000–2019
Japan — Mongolia	2001–2016
Korea — Panama	2001–2021
Ecuador — Guatemala	2002–2008
Peru — Singapore	2003–2009
Mexico — Panama	2005–2015
Indonesia — Singapore	2005–2016
Australia — Mexico	2005–2018
Panama — USA	1982
China — Thailand	1985
Australia — China; China — New Zealand; Korea — Malaysia; China — Japan; China — Malaysia	1988
Korea — Thailand; Canada — Russia	1989
Laos — Thailand; Korea — Russia; Australia — Papua New Guinea	1990
Korea — Mongolia; Peru — Thailand; Thailand — Vietnam; China — Papua New Guinea; China — Mongolia; Indonesia — Korea	1991
Malaysia — Vietnam; Singapore — Vietnam; Philippines — Vietnam; Laos — Malaysia; China — Vietnam; Chile — Malaysia; China — Philippines	1992
Taiwan — Vietnam; China — Laos	1993
Laos — Mongolia; China — Peru; Australia — Laos; Russia — Vietnam; Korea — Philippines; Mongolia — USA	1994
Hong Kong — New Zealand; Australia — Philippines; Mongolia — Singapore; Malaysia — Mongolia; Philippines — Thailand; Canada — Philippines; Cambodia — Thailand; Chile — Philippines; Malaysia — Peru; Honduras — USA; Mongolia — Russia	1995
Korea — Laos; Laos — Vietnam; El Salvador — Peru; Canada — Panama; Chile — El Salvador; Chile — Panama; Cambodia — China; Cambodia — Singapore; Chile — Costa Rica; Chile — Nicaragua; Laos — Russia; Chile — Guatemala	1996
Cambodia — Korea; Hong Kong — Japan; Hong Kong — Korea; Laos — Singapore; Canada — Thailand; Indonesia — Mongolia	1997
Myanmar — Philippines; Indonesia — Thailand; Canada — Costa Rica; Japan — Russia	1998
Guatemala — Taiwan; Costa Rica — Taiwan	1999
Korea — Mexico; Mongolia — Vietnam; Mongolia — Philippines; Brunei — Korea	2000
Cambodia — Vietnam; China — Myanmar	2001
Japan — Korea	2002
Japan — Vietnam; Korea — Vietnam; Laos — Myanmar	2003
Hong Kong — Thailand	2005
Canada — Peru; China — Russia	2006
Indonesia — Russia; Colombia — Peru; China — Costa Rica; China — Korea; Cambodia — Japan	2007
China — Mexico; Japan — Laos; China — Colombia; Myanmar — Thailand; Japan — Peru	2008
Mexico — Singapore	2009
Russia — Singapore	2010
Japan — Papua New Guinea; Colombia — Japan	2011
Canada — China; Nicaragua — Russia	2012
Japan — Myanmar	2013
Korea — Myanmar	2014
Cambodia — Russia	2015
Canada — Hong Kong; Chile — Hong Kong; Canada — Mongolia	2016
Indonesia — Singapore	2018

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BIT	Year
Myanmar — Singapore	2019
Hong Kong — Mexico	2020

Source: compiled by the author based on: International Investment Agreements Navigator. Retrieved from: https://investmentpolicy.unctad.org/international-investment-agreements/by-economy (date of access: 01.02.2025)

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Navigating sustainability: understanding the linkages between inclusive economic growth, institutional quality, and environmental degradation in BRICS Plus countries

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ABSTRACT

Relevance: Global economic growth has intensified concerns about environmental degradation, particularly in rapidly expanding economies such as the BRICS Plus countries. These countries contribute significantly to global GDP and trade, yet face rising challenges involving carbon emissions, resource scarcity, and socio-economic inequality. Understanding how inclusive growth affects the environment and how institutional quality shapes this relationship is essential for advancing sustainable development goals.

Research Objective: This study examines how inclusive economic growth affects environmental degradation, measured through CO_2 emissions, and assesses how institutional quality, specifically regulatory quality and government effectiveness, moderates this relationship in BRICS Plus countries.

Data and Method: This study uses macro panel data for BRICS countries from 2000 to 2023 and applies a quantitative design using several analytical techniques. Panel Ordinary Least Squares (OLS) provides the baseline estimates, while the Dynamic Generalized Method of Moments (GMM) is used to address endogeneity, with static OLS informing instrument selection. Inclusive growth is measured using the Social Mobility Curve (SMC) and a PCA-constructed index. The Environmental Inclusive-Growth Kuznets Curve (EIKC) framework is applied to examine the relationship between inclusive growth and environmental degradation, focusing on CO_2 emissions.

Results: The findings support the Environmental Inclusive-Growth Kuznets Curve (EIKC) hypothesis. At early development stages, inclusive growth increases CO_2 emissions due to industrial expansion and energy-intensive activity. After reaching a threshold, however, greater inclusiveness leads to environmental improvement. Institutional factors such as government effectiveness and regulatory quality strengthen the link between inclusive growth and environmental outcomes. This suggests that in BRICS Plus countries, institutional efficiency still tends to favor economic gains over environmental protection, which can amplify ecological pressures when incentives are oriented toward growth.

Conclusions: To ensure sustainable development in BRICS Plus countries, it is necessary to align institutional performance with environmental goals. Stronger environmental regulations, integrating sustainability metrics into governance evaluations, and improving policy coherence between social inclusion and environmental management are essential for ensuring that inclusive growth supports sustainability rather than contributing to additional environmental costs. Future work could examine subnational or sectoral patterns, broaden the set of environmental indicators, and analyze how formal and informal institutions differently influence sustainable inclusiveness.

KEYWORDS

inclusive economic growth, economic and environmental nexus, institutional quality, environmental inclusive-growth Kuznets curve, BRICS plus

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Управление устойчивым развитием: понимание взаимосвязи между инклюзивным экономическим ростом, качеством институтов и ухудшением состояния окружающей среды в странах БРИКС+

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АННОТАЦИЯ
Актуальность: Глобальный экономический рост усилил обеспокоенность по поводу ухудшения состояния окружающей среды, особенно в таких быстрорастущих экономиках, как страны БРИКС+. Эти страны вносят значительный вклад в мировой ВВП и торговлю, но при этом сталкиваются с растущими проблемами, связанными с выбросами углерода, дефицитом ресурсов и социально-экономическим неравенством. Понимание того, как инклюзивный рост влияет на окружающую среду и как качество институтов формирует эту взаимосвязь, имеет решающее значение для достижения целей устойчивого развития.
Цель исследования: В данном исследовании изучается влияние инклюзивного экономического роста на ухудшение состояния окружающей среды, измеряемое через выбросы CO_2, и оценивается, как качество институтов, в частности качество регулирования и эффективность государственного управления, смягчает эту взаимосвязь в странах БРИКС+.
Данные и методы: В данном исследовании используются панельные макроэкономические данные по странам БРИКС за период с 2000 по 2023 год, а также применяется количественный дизайн с использованием нескольких аналитических методов. Панельный метод наименьших квадратов (OLS) обеспечивает базовые оценки, в то время как динамический обобщенный метод моментов (GMM) используется для анализа эндогенности, а статический OLS используется для выбора инструментов. Инклюзивный рост измеряется с помощью кривой социальной мобильности (SMC) и индекса, построенного на основе PCA. Для изучения взаимосвязи между инклюзивным ростом и ухудшением состояния окружающей среды с акцентом на выбросы CO_2 применяется модель кривой Кузнеца «Экологический инклюзивный рост» (EIKC).
Результаты: Полученные данные подтверждают гипотезу кривой Кузнеца «Экологический инклюзивный рост» (EIKC). На ранних этапах развития инклюзивный рост увеличивает выбросы CO_2 в результате промышленного расширения и энергоёмкой деятельности. Однако после достижения определённого порогового значения более высокий уровень инклюзивности приводит к улучшению состояния окружающей среды. Институциональные факторы, такие как эффективность государственного управления и качество регулирования, усиливают связь между инклюзивным ростом и экологическими результатами. Это говорит о том, что в странах БРИКС+ институциональная эффективность по-прежнему, как правило, благоприятствует экономическим выгодам, а не охране окружающей среды, что может усиливать экологическую нагрузку, когда стимулы ориентированы на рост.
Выводы: Для обеспечения устойчивого развития в странах БРИКС+ необходимо согласовывать эффективность институтов с экологическими целями. Более строгое экологическое регулирование, интеграция показателей устойчивости в оценки государственного управления и повышение согласованности политики между социальной инклюзивностью и экологическим менеджментом имеют решающее значение для обеспечения того, чтобы инклюзивный рост способствовал устойчивому развитию, а не приводил к дополнительным экологическим издержкам. В дальней-

КЛЮЧЕВЫЕ СЛОВА
инклюзивный экономический рост, экономико-экологическая взаимосвязь, качество институтов, кривая Кузнеца для инклюзивного роста в сфере экологии, БРИКС+

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ДЛЯ ЦИТИРОВАНИЯ
Zulfia, B., I. Dwiputri, N., Soesilowati, E., De Silva, S. (2025). Navigating sustainability: understanding the linkages between inclusive economic growth, institutional quality, and environmental degradation in BRICS Plus countries. *R-Economy*, 11(4), 463–487. doi: 10.15826/recon.2025.11.4.025

шем можно было бы изучить субнациональные или отраслевые модели, расширить набор экологических показателей и проанализировать, как формальные и неформальные институты по-разному влияют на устойчивую инклюзивность.

可持续发展管理：理解金砖国家+包容性经济增长、制度质量与环境退化之间的关系

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摘要
现实性：全球经济增长加剧了人们对环境恶化的担忧，尤其是在金砖国家+等快速增长的经济体中。这些国家对全球GDP和贸易贡献巨大，但同时面临着碳排放、资源短缺和社会经济不平等加剧等问题。了解包容性增长如何影响环境，以及制度质量如何塑造这种关系，对于实现可持续发展目标至关重要。
研究目标：本研究考察了包容性经济增长对环境恶化（以二氧化碳排放量为标准）的影响，并评估了制度质量（特别是监管质量和治理效率）如何调节金砖国家及其他国家之间的关系。
数据与方法：本研究采用2000年至2023年期间金砖国家面板宏观经济数据，并运用多种分析方法进行定量设计。面板最小二乘法（OLS）提供基础估计值，动态广义矩方法（GMM）用于分析内生性，静态OLS用于工具变量选择。包容性增长的衡量指标包括社会流动曲线（SMC）和基于主成分分析（PCA）构建的指数。环境包容性增长库兹涅茨曲线（EIKC）模型用于考察包容性增长与环境恶化之间的关系，重点则关注二氧化碳排放。
研究结果：研究结果支持生态包容性增长库兹涅茨曲线（EIKC）假说。在发展初期，包容性增长会因产业扩张和能源密集型活动而导致二氧化碳排放增加。然而，达到一定阈值后，更高的包容性水平会带来更好的环境效益。治理效能和监管质量等制度因素强化了包容性增长与环境效益之间的联系。这表明，在金砖国家及地区，制度效能仍然倾向于优先考虑经济收益而非环境保护，当政策激励以增长为导向时，这可能会加剧环境负担。
结论：为确保金砖国家+集团的可持续发展，必须使制度效能与环境保护目标相协调。加强环境监管、将可持续性指标纳入政府效能评估，以及提高社会包容性政策与环境管理政策的协同性，对于确保包容性增长能够促进可持续发展、而非带来额外的环境成本至关重要。未来的研究可以探讨国家内部或行业层面的模式，扩展环境指标体系，并分析正式与非正式制度如何对可持续包容性产生差异化影响。

关键词
包容性经济增长、经济生态关系、制度质量、环境领域包容性增长的库兹涅茨曲线、金砖国家+

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Introduction

Sustainable growth and development have become a global strategic priority, built on three main dimensions: economic, social, and environmental. One of the key challenges is achieving economic growth while reducing resource intensity and safeguarding the quality of life for future generations. Yet the escalating threats of global warming and climate change remain a major concern, requiring policies that can anticipate how environmental quality will evolve alongside rising economic activity (Onafowora & Owoye, 2014).

A growing body of research shows that energy use, environmental resources, and economic growth are closely interconnected (Ali et al., 2019; Ibrahim & Abbas, 2022; Kamah et al., 2021; Khan et al., 2021; Kwilinski et al., 2023; Lau et al., 2018; Onafowora & Owoye, 2014; Zahid et al., 2023). However, unsustainable energy consumption can lead to climate change, natural resource depletion, and environmental degradation (Kamah et al., 2021).

According to the World Bank, global carbon emissions rose from 22.51 billion tons in 1990 to 38.52 billion tons in 2022, while global GDP increased from 36.05 trillion USD to 93.35 trillion USD by 2023. Economic growth fuels demand for energy, such as electricity and oil, across production processes, which in turn generates large volumes of carbon dioxide (Wang et al., 2023).

BRICS Plus countries play an influential role in global population trends, politics, environmental outcomes, the world economy, and domestic inequality. In 2017, BRICS nations contributed 18.82 trillion USD, or around 23.31 % of global GDP (Awosusi et al., 2022). They held more than 4 trillion USD in foreign exchange reserves, accounted for nearly 40 % of the global population, and were responsible for up to 17 % of world trade (Voumik & Sultana, 2022). The main driving forces behind the economic growth of BRICS countries are the increased use of production factors, large population scale, and abundant resources, which have led to economic performance that far exceeds that of other countries. (Awosusi et al., 2022; Voumik & Sultana, 2022; Zahid et al., 2023). In addition to their influence in the global economy, BRICS countries have proven themselves to be role models in choosing rapid economic transformation. At the same time, this rapid transformation intensifies energy demand and heightens environmental pressures (Zahid et al., 2023). Amidst increasing global pressures, managing sustainable economic growth in BRICS countries is crucial for achieving global development goals.

Literature on the relationship between economic growth and the environment has expanded in recent decades. Conventional growth, typically measured by GDP, is often viewed as a marker of development, but it has clear limitations, particularly in terms of how benefits are distributed. Ravallion (2014) argues that conventional economic growth has contributed to the eradication of absolute poverty. However, its impact is uneven, especially in countries with high income inequality, and tends to neglect environmental sustainability. Other studies highlight the need for growth that not only reduces poverty but also addresses the distribution of income, wealth, and opportunities to create a more inclusive and sustainable economic structure (De Haan, 2015). Unequal growth can influence GDP and carbon emissions through varying consumption patterns and environmental behaviors. Low-income groups may rely on less sustainable practices to meet basic needs, increasing environmental pressure (Liu et al., 2018; Wang et al., 2023). As a result, conventional growth models are often criticized for their excessive exploitation of natural resources and increased carbon emissions, which exacerbate climate change and ecosystem degradation.

In response to these criticisms, the concept of inclusive economic growth has emerged as an alternative paradigm that emphasizes the balance between economic efficiency and equitable social welfare. Inclusive growth refers to broad-based growth that creates equal opportunities for all (Bappenas, 2019). According to the Asian Development Bank (ADB), inclusiveness not only encompasses broad participation in the growth process, but also requires the active involvement of all levels of society in the creation and distribution of its benefits. This approach emphasizes social dimensions such as gender equality, ethnic and racial inclusion (Ngepah, 2017; Rauniyar & Kanbur, 2010; Zulfia et al., 2024), and adds environmental sustainability as a key element. Growth that neglects environmental considerations cannot be regarded as fully inclusive (Asian Development Bank, 2014a)[1].

Within this broader discussion, the Environmental Kuznets Curve (EKC) offers a relevant framework. Originally proposed by Kuznets (1955) to explain the nonlinear relationship between income inequality and per capita income, it was later adapted by Grossman & Krueger (1991) to environmental outcomes (Environmental Kuznets Curve (EKC)). The EKC suggests an inverted U-shaped relationship between environmental quality and economic growth. In the early stages of development, industrialization and urbanization intensify resource extraction and pollution. After income reaches a certain threshold, however, priorities shift toward sustainability, and cleaner technologies begin to improve environmental outcomes.

Empirical research also points to a strong link between institutional quality and environmental performance. Lau et al. (2018) find that institutional quality is central to CO_2 mitigation, espe-

[1] Asian Development Bank. (2014a). *Framework of Inclusive Growth Indicators 2014: Key Indicators for Asia and the Pacific Special Supplement* [4th Edition].

cially in developed countries, while the rule of law strengthens environmental governance in most contexts except low-income settings. Ibrahim & Law (2016) add that political instruments help balance economic development, environmental degradation, and social justice by enabling effective environmental policies. Strong institutions can accelerate the EKC turning point, allowing countries to reach peak environmental degradation earlier and transition sooner toward sustainability (Ali et al., 2019).

Building on the distinction between conventional and inclusive growth, this study develops the Environmental Inclusive-Growth Kuznets Curve (EIKC) to examine the relationship between inclusive growth and environmental degradation. Adapting the EKC turning point estimation method, the analysis incorporates the Social Mobility Curve (SMC) from Anand et al. (2013) to capture the pace and distribution of inclusive growth. This approach allows for a more precise assessment of inclusiveness in BRICS Plus countries and evaluates the interactive role of institutional quality in supporting environmental sustainability. BRICS Plus is selected due to its rapid growth dynamics and significant influence on global economic patterns, although unequal outcomes and weak institutional capacity remain key challenges.

The rest of the study is presented as follows: Section 2 reviews the theoretical framework. Section 3 outlines the methodology and model construction. Section 4 presents the empirical analysis and findings. Section 5 summarizes key results, discusses policy implications, and identifies limitations and avenues for future research.

Theoretical Framework

Inclusive Economic Growth and the Environment

After the 2000s, developing countries, including BRICS Plus, experienced rapid economic growth, often accompanied by rising income inequality and uneven development. The focus of economic growth has shifted from the goal of merely reducing poverty to promoting equity, a change increasingly emphasized in recent reports (OECD, 2015)[2].

The Commission on Growth and Development (2008) wrote that systematic inequality of opportunity can be "poisonous." Without equal opportunities and protection in market and labor transitions, achieving inclusiveness will be challenging and could potentially jeopardize political stability[3]. Kakwani & Pernia (2000) explain that pro-poor growth is a growth procedure whereby the poor benefit proportionally more. Meanwhile, Klasen (2010) emphasizes that pro-poor growth results in relative growth and inequality between people with low incomes and the non-poor, whereas inclusive growth reflects changes in inequality for all parties. This approach was later expanded by the Asian Development Bank (2014) by linking issues of gender, ethnicity, race, and the environment as integral components of inclusiveness[4].

Within an empirical framework, a number of studies define inclusive growth as a process based on expansion with social participation — through the provision of public facilities in the form of workplaces, public security, and social infrastructure (Angulo-Bustinza et al., 2022; Mitra & Das, 2018), and environmental sustainability (Rini & Hamonangan Tambunan, 2021). Efforts to measure inclusiveness have been made through multidimensional composite indices such as the index developed by Vellala et al. (2016) for India and the Regional Opportunity Analysis Tool employed by Kitagawa & Vidmar (2023) to reduce disparities between rural, semi-rural, and urban areas in the UK. Social approaches, including the Social Mobility Curve and the Poverty Equivalent Growth Rate, also highlight the importance of equal employment opportunities and the manufacturing sector's contribution to achieving inclusive economic growth (Zulfia et al., 2024).

There is evidence confirming the relationship between inclusive growth and the environment (Ali et al., 2019; Annor et al., 2023; Ibrahim & Abbas, 2022; Kamah et al., 2021; Khan et al., 2021; Kwilinski et al., 2023; Lau et al., 2018; M. Lee et al., 2014; Onafowora & Owoye, 2014; Phung et al., 2023; Vidyarthi, 2015; Zahid et al., 2023). Ka-

[2] OECD. (2015). *Inclusive Growth: The OECD Measurement Framework* (OECD Statistics Working Papers No. 2015/06; OECD Statistics Working Papers, Vol. 2015/06). https://doi.org/10.1787/5jrqppxjqhg4-en

[3] Commission on Growth and Development. (2008). *The Growth Report: Strategies for Sustained Growth and Inclusive Development*. https://elibrary.worldbank.org/doi/abs/10.1596/978–0-8213–7491–7

[4] Asian Development Bank. (2014a). *Framework of Inclusive Growth Indicators 2014: Key Indicators for Asia and the Pacific Special Supplement* [4th Edition].

mah et al. (2021) introduced the concept of the environmental inclusive-growth Kuznets curve (EIKC), which explains that in the early stages of inclusive growth, there is an increase in environmental degradation. However, in the later stages, environmental degradation actually decreases. Annor et al. (2023) explore this further by reconceptualizing the Environmental Kuznets Curve into the Financial Development Environmental Kuznets Curve (FDEKC), which explains the financial-environmental relationship in various strata of economic development in Sub-Saharan Africa. Meanwhile, Vidyarthi (2015) and Phung et al. (2023) confirm that restructuring the renewable balance sheet can promote economic inclusiveness.

Thus, inclusive growth can be understood as a multidimensional concept that combines economic equality, social protection, and ecological sustainability. Various studies confirm that achieving this kind of growth is highly dependent on the quality of institutions, income distribution, and human resource capacity in supporting the transition to fair and sustainable development.

Institutions and the Environment

Institutions are conceptualized as a composition of rights, rules, and decision-making processes through levels of social organization, with an emphasis on the environment and resources (Ali et al., 2019). Romer (1990) asserts that an economy without regulatory institutions is not an optimal system; institutions are necessary to reduce transaction costs, encourage innovation, and ensure the diffusion of knowledge (North, 1991). Strong institutions can play a role in promoting economic growth (Mahran, 2023), ensuring inclusiveness (Kwilinski et al., 2023), influencing household and corporate behavior (Dwiputri et al., 2019), and explaining inequality through government effectiveness (Dwiputri et al., 2018). In addition, strong institutions can reduce the influence of ethnicity in the political process (Kalu & Aniche, 2024) and curb environmental degradation (Khan et al., 2021; Lau et al., 2018) by ensuring that potentially polluting industries comply with environmental regulations (Ali et al., 2019).

The Transaction Cost Economics and Endogenous Growth Theory frameworks provide tools for understanding how institutional efficiency can reduce information asymmetry, enhance innovation incentives, and strengthen adaptive capacity for green growth policies (North, 1991; Romer, 1990). Such efficiency supports inclusive and sustainable growth. In the case of China, Wu & Ling (2023) write that the institutional system of environmental accountability, which emphasizes government oversight and effectively influences stakeholder strategies, encourages the government to implement stricter environmental regulations through political incentives and reputation mechanisms. This motivates polluting companies to comply with emission standards through sanction mechanisms and encourages local communities to channel their protests institutionally through responsive mechanisms.

Cross-country empirical literature shows a complex relationship between institutional quality and the environment (Abid, 2016, 2017; Ali et al., 2019; Carlsson & Lundström, 2003; Halkos & Tzeremes, 2013; Hassan et al., 2020; Ibrahim & Law, 2016; Kamah et al., 2021; Kerekes, 2011; Lau et al., 2014, 2018; Zakaria & Bibi, 2019). Carlsson & Lundström (2003) found that countries with higher levels of political freedom allow their citizens to voice their views on environmental issues, and therefore tend to have better environmental quality. Furthermore, sustainable agribusiness and environmentally friendly agribusiness require institutional support and governance oriented towards job creation, poverty alleviation, economic growth, and a pro-environment core-plasma system (Damelia & Soesilowati, 2016; Soesilowati & DWP, 2015).

Political stability, law enforcement, and corruption control reduce CO_2 emissions (Abid, 2016, 2017; M. H. Ibrahim & Law, 2016; Khan et al., 2021; Lau et al., 2014, 2018; Zakaria & Bibi, 2019). Meanwhile, according to Hassan et al. (2020), high levels of corruption limit government officials in designing and implementing efficient environmental policies. Weak institutions create opportunities for domestic and multinational firms to engage in polluting industries and facilitate the transfer of outdated, environmentally harmful technologies. As a result, low institutional quality is linked to slower development and greater environmental degradation (Shahzad, 2020; Shahzad et al., 2020).

However, some studies suggest a more complex picture. Halkos & Tzeremes (2013) state that improvements in institutional factors, including legal rules and corruption control, do not always have a positive impact on the environment. Improved institutions actually worsen pollution due to the effects of "growth bias" and production orientation (Kerekes, 2011; Le & Ozturk, 2020). This difference shows that the role of institutions is not linear, but depends on incentive structures and the domestic political-economic context.

Linking Inclusive Growth, Institutions, and Environment: The EIKC Framework

Conceptually, inclusive growth changes the environmental pressure turning point through three main mechanisms: income redistribution, clean technology diffusion, and equitable human capital investment. In endogenous growth theory, human capital investment triggers learning by doing, which encourages the creation of environmentally friendly technologies. This dynamic shifts people's preferences toward the environment, thereby promoting equitable social demand for environmental protection, which effectively moves the EKC curve downward earlier. Furthermore, institutional integration in the Environmental Inclusive-Growth Kuznets Curve (EIKC) model positions institutions as a transmission mechanism between inclusive growth and environmental outcomes. Adaptive institutions have the potential to accelerate the turning point through policies that balance economic expansion and ecological efficiency, while weak institutions may slow down or even delay the transition to sustainability (see Figure 1).

This study broadens the EKC literature by integrating the dimensions of inclusive and institutional growth into the EIKC framework and empirically testing it in the BRICS Plus countries. This method provides a clearer understanding of how inclusive growth interacts with environmental degradation within the BRICS Plus, which is a new economic bloc with varied governance and environmental policies. Two inclusive growth indices are employed: the PCA composite main index and the Social Mobility Curve (SMC)-based index, to illustrate social mobility across income deciles. This research offers both theoretical and empirical insights into the mechanisms driving sustainable transition in large developing nations.

Research Method

This study uses panel data from nine BRICS Plus member countries — Brazil, Russia, India, China, South Africa, Iran, Egypt, Ethiopia, and the United Arab Emirates — during the period 2000–2023. This time frame reflects the emergence of rapid economic growth in emerging countries. The BRICS Plus countries were selected as the focus of this study for several key reasons.

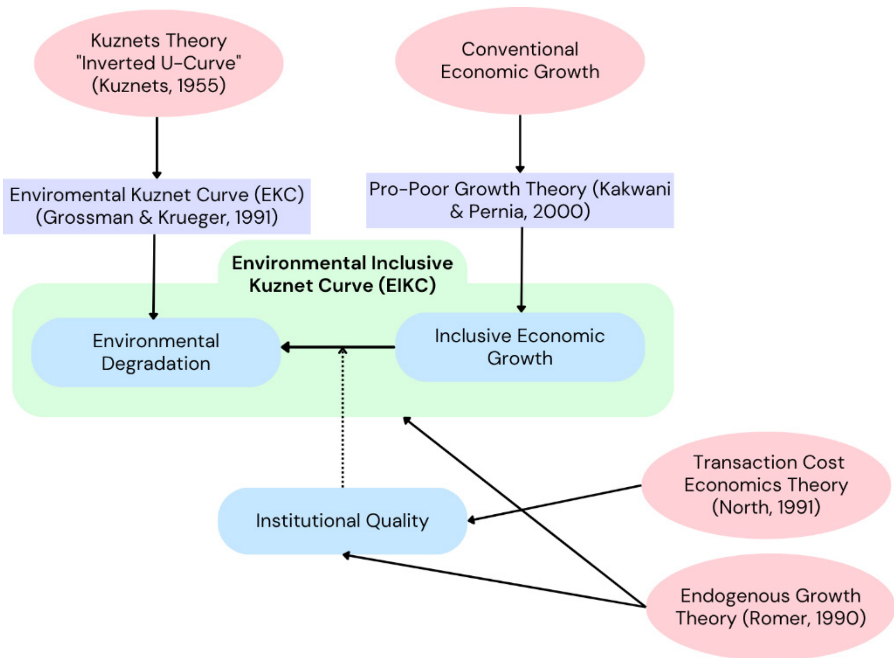

Figure 1. *Conceptual Framework*
Source: Developed by the authors (2025)

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First, they account for a substantial share of global GDP, trade, and population, while facing significant challenges such as inequality, carbon emissions, and natural resource scarcity. Their rapid economic transformation has also resulted in considerable environmental costs. Second, the expansion of BRICS Plus enhances their collective economic and geopolitical influence and highlights the diversity of their institutional frameworks.

Due to missing data points, unbalanced panel data are used in the study. Observations with more than two consecutive years of missing data are removed to ensure consistent estimates. Data sources include the World Development Indicators (WDI) for economic and social indicators and the Worldwide Governance Index (WGI) for institutional quality, government effectiveness, and regulatory quality. Carbon emissions represent environmental degradation variables. However, ecological footprint, air quality, and biodiversity cannot be included in the analysis due to limitations in consistent data across BRICS Plus countries.

The analysis was carried out in the following stages: (1) constructing an inclusive growth index using Principal Component Analysis (PCA) and the Social Mobility Curve (SMC); (2) formulating a theoretical model based on the Environmental Inclusive-Growth Kuznets Curve (EIKC) and incorporating institutional variables; (3) estimating the baseline model using OLS; (4) addressing potential endogeneity with a dynamic GMM model; and (5) validating and interpreting key results for policy implications (see Figure 2).

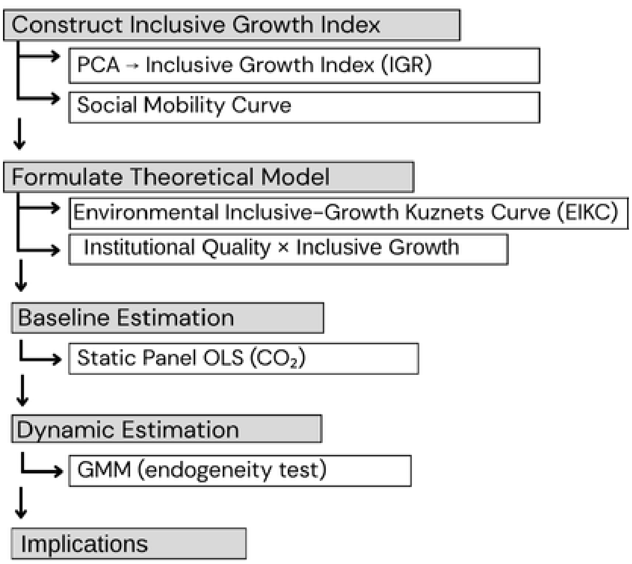

Figure 2. *Methodological Flowchart*
Source: Developed by the authors (2025)

Initial estimation was performed using Panel Ordinary Least Squares (OLS) to analyze the fundamental relationship between the dependent variable, environmental degradation, and independent variables such as inclusive economic growth, institutional quality, and control variables. Classical assumptions of normality, heteroscedasticity, and multicollinearity were tested to ensure the model's validity. Robustness tests were also conducted to identify the most appropriate model through the Hausman test, Chow test, and Lagrange Multiplier test. Additionally, inter-individual dependence was examined using standard fixed effects (FE) and random effects (RE) models, as proposed by Driscoll & Kraay (1998) that these estimates can be valid under the assumption that inter-spread dependence is caused by unobserved common factors (with effects felt through disturbances) but are not correlated with the explanatory variables. The model can be expressed as follows:

$$ENV_{it} = \gamma_1 IGR_{it} + \gamma_2 IQ_{it} + \gamma_3 IGR^2_{it} + \\ + \gamma_4 (IGR_{it} \cdot IQ_{it}) + \gamma_6 Z_{it} + \eta_t + \lambda_i + \varepsilon_{it}. \quad (1)$$

To address potential endogeneity issues arising from the reciprocal relationship between variables, the Dynamic Panel Generalized Method of Moments (GMM) method was used (Ali et al., 2019; Gyamfi et al., 2022; Ibrahim & Law, 2016; Kamah et al., 2021; Lau et al., 2014; Ofori et al., 2023). This method uses lags of the dependent variable as instruments, with the validity of the instruments tested through the Sargan Test, while the model specification is tested through AR (1) and AR (2) (Kripfganz & Schwarz, 2019).

The following is the empirical model for the dynamic panel that will be used in this study:

$$ENV_{it} = \gamma_1 ENV_{it-1} + \gamma_2 IGR_{it} + \gamma_3 IQ_{it} + \\ + \gamma_4 IGR^2_{it} + \gamma_5 (IGR_{it} \cdot IQ_{it}) + \gamma_6 Z_{it} + \\ + \eta_t + \lambda_i + \varepsilon_{it}. \quad (2)$$

The ENV variable represents environmental degradation, measured through carbon emissions. The variable ENV_{it-1} is a lag of the dependent variable that captures the dynamics of environmental change over time. Meanwhile, the IGR variable measures inclusive economic growth, and IGR2 is used to evaluate the non-linear relationship between environmental degradation and inclusive economic growth in accordance with the Environmental Kuznets Curve hypothesis. Institutional quality IQ_{it} is represented by two main indicators, namely government effectiveness and regulatory quality, which reflect the effectiveness of governance in controlling environmental degradation.

The control variables include education, trade, foreign direct investment (FDI), population growth, and urbanization, as supported by previous studies. Specifically, education is referenced by Anand et al. (2013); Dwiputri et al. (2018); Gyamfi et al. (2022); Kamah et al. (2021); trade by Ali et al. (2019); Annor et al. (2023); Kamah et al. (2021); FDI by Annor et al. (2023); Lau et al. (2014); Ofori et al. (2023); population by Gyamfi et al. (2022); Khan et al. (2021), and urbanization by Ali et al. (2019); Kamah et al. (2021).

Measuring Inclusive Economic Growth

Social Mobility Function Framework

This study assumes the concept of inclusive growth by following the Asian Development Bank (ADB) Framework and the study by Anand et al. (2013), which states that inclusive growth depends on income growth and income distribution. This concept defines the measure of inclusiveness in a general concentration curve called the Social Mobility Curve. SMC can be explained as follows

$$S^c \approx \left(x_i \frac{x_1 + x_2}{2} \ldots \frac{x_1 + x_2 \ldots + x_n}{n} \right). \tag{3}$$

In Equation (3), the number of people in the population with income $x_1, x_2, \ldots, x_n$ is represented by n. x_1 represents the poorest person in the population, while x_n represents the wealthiest person in the population. According to Anand et al. (2013), the general concentration curve is essentially the cumulative distribution of the social mobility vector $S \approx (x_1, x_2, \ldots, x_n)$ with the underlined function $m = m\ (x_1, x_2, \ldots, x_n)$. This concept must satisfy two properties of the social welfare function. First, it requires a dimension of growth, and second, a dimension of distribution through income transfer. Redistribution of income among individuals in a more equitable manner will flatten the curve of the function. A higher concentration curve indicates higher income in the population. In this case, the two curves can be ranked based on which curve provides higher social benefits, considering the area under the curve.

To measure the magnitude of changes in income distribution, a simple form of the following equation can be used to calculate the area under the social mobility curve

$$\bar{x}^* = \int_0^{100} \bar{x}_i d_i. \tag{4}$$

The income in the population is greater the higher the value of $\bar{x}^*$. Equity is achieved -values of $\bar{x}^*$ and $\bar{x}_i$ when the incomes of all individuals are equal. However, if the value of $\bar{x}^*$ is smaller than the value of $\bar{x}_i$, income distribution is unequal or inequality occurs. Based on this, Ali & Son (2007) came up with the Income Equity Index (IEI), which is as follows:

$$m = \frac{\bar{x}^*}{\bar{x}_i}. \tag{5}$$

Perfect social equality occurs when $m = 1$. The closer the value of m is to 1, the more equal the income of the society and vice versa. Thus, Equation (5) can be rearranged as follows:

$$\bar{x}^* = m\bar{x}_i. \tag{6}$$

Since there are two dimensions to fulfill in the SMC approach, $\bar{x}^*$ needs to be increased to achieve inclusive growth. An increase in $\bar{x}^*$ can be realized by an increase in average income $\bar{x}_i$ through economic growth. Then, the income equity index m must be increased through increased equity. Thus, to determine the change in the magnitude of inclusive growth, Equation (6) is differentiated as follows:

$$\partial\bar{x}^* = m \cdot \partial\bar{x}_i + \bar{x}_i \cdot \partial m. \tag{7}$$

Economic growth is considered inclusive if the social mobility index, $\partial\bar{x}^*$, has a positive change. Therefore, the right-hand side of Equation (7) represents the direction and intensity of inclusive growth. The results of the Social Mobility Curve (SMC) measurement will be one of the inclusive economic growth indexes in this study and combined with the inclusive growth index referring to the ADB's Inclusive Growth Framework formed through Principal Component Analysis (PCA) as an independent variable (see Table 1). Both indices are used to test the robustness of the effect of the independent variable IGR in the model.

Principal Component Analysis (PCA)

PCA is an approach that allows the projection of observations from a dimension of p variables to a space of k smaller dimensions, where $k < p$, so that maximum information is preserved. This approach transforms many interrelated indicators into unrelated variables called PCs (Senna et al., 2019). The first component captures the largest variance among the other indicators, while the second component captures the second largest variance from the set of indicators and so on (Mahran, 2023). More simply, Principal Component Analysis (PCA) serves to reduce the dimensions of independent variables that have high correlation and produce principal components that retain the main information of the original data (Gyamfi et al., 2022).

Table 1

Variable used in constructing IGR index

	Variables
1	Voice and accountability
2	GDP per capita growth (annual %)
3	Employment to population ratio, ages 15–24, total (%) (modeled ILO estimate)
4	Access to electricity (% of population)
5	Ratio of female to male labour force participation rate (%) (modeled ILO estimate)
6	Government expenditure on Health, total (% of government expenditure)
7	Percentage of seats held by women in national parliament
8	Government expenditure on education as a percentage of total government expenditure
9	Immunization (% of children ages 12–23 months)
10	Mobile cellular subscriptions (per 100 people)

Source: Authors' computation using WGI and WDI data

The algorithm for deriving PCs depends on analyzing the data matrix X_{ij}. The covariance matrix Σ can be decomposed into an eigenstructure as follows (Mahran, 2023);

$$\Sigma = V \Lambda V^{t}. \quad (8)$$

With Λ being the diagonal matrix of eigenvalues; V being the corresponding load matrix and t for the transpose. The eigenvalues in Λ give the variance of PC_r which is written as follows:

$$PC_r = XV_r. \quad (9)$$

Where V_r represents the contribution of each variable X in the r-th PC. The extracted components are ordered by the amount of total variance explained by the indicators that make up the variable. This study calculates the inclusive growth index by retaining the first three principal components, which cumulatively explain approximately 71.79 % of the variation in all indicators used (see Table 2). The index values have been standardized (z-score) to enable comparison between countries and over time, following the approach of Gyamfi et al. (2022); Kamah et al. (2021); and Ofori et al. (2023).

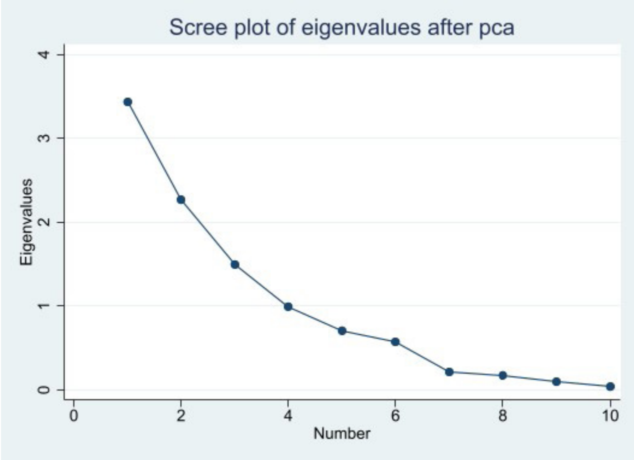

Figure 3. *Scree plot of Eigenvalues After PCA*

Source: Calculated by the authors using WGI and WDI data

Environmental Inclusive-Growth Kuznets Curve (EIKC)

This study refers to the turning point calculation method in the Environmental Kuznets Curve (EKC) (Kamah et al., 2021; Khan et al., 2021; and Lau et al., 2018). In the EKC hypothesis, the relationship between inclusive economic growth and environmental degradation depends on the coefficient values of γ_{IGR} and inclusive growth squared γ_{IGR^2}. In general, under the EKC hypothesis, a monotonically increasing linear relationship (no turning point) is obtained if the inclusive growth coefficient $\gamma_{IGR} > 0$ and $\gamma_{IGR^2} = 0$. This implies that an increase in inclusive growth is associated with an increase in the rate of environmental degradation. Conversely, if $\gamma_{IGR} < 0$ and $\gamma_{IGR^2} > 0$, then the relationship formed is U-shape, where in the early stages inclusive growth decreases environmental degradation, but after reaching a certain point it increases environmental degradation. As for the relationship that validates EKC, there is an inverted U-shaped nonlinear relationship if

Table 2

PCA results

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	3.433	1.167	0.3433	0.3433
Comp2	2.266	.7691	0.2266	0.5700
Comp3	1.497	.5022	0.1497	0.7197
Comp4	.9949	.2864	0.0995	0.8192
Comp5	.7085	.1359	0.0709	0.8900
Comp6	.5726	.3582	0.0573	0.9473
Comp7	.2144	.0383	0.0214	0.9688
Comp8	. 1760	.0781	0.0176	0.9864
Comp9	.0979	.0595	0.0098	0.9962
Comp10	.0384		0.0038	1.0000

Source: Calculated by the authors

the inclusive growth coefficient is $\gamma_{IGR} > 0$ and the squared inclusive growth coefficient $\gamma_{IGR^2} < 0$. This pattern shows that in the early stages, inclusive economic growth harms the environment, but after reaching a certain point, there is an improvement in environmental quality.

To calculate the turning point of inclusive economic growth, the following equation is used:

$$\frac{\partial^2 ENV}{\partial IGR^2} = \gamma_2 + 2\gamma_4 IGR. \quad (10)$$

This expression represents the second derivative of Equation (10)

$$\frac{\partial^2 ENV}{\partial IGR^2} = 2\gamma_4, \quad (11)$$

when $\gamma_4 < 0$, it implies the existence of local maxima which means the existence of an inverted U-curve. $\gamma_4 > 0$ implies local minima or the existence of a U-shaped relationship. The turning point of the EKC is obtained by setting the first derivative — as in Equation (11) — equal to 0 — Equation (12) — and solving using *IGR*.

$$\gamma_2 + 2\gamma_4 IGR = 0. \quad (12)$$

Using Equation (12), the expression is rearranged into Equation (13) to compute the corresponding *IGR* value

$$IGR^* = \frac{-\gamma_2}{2\gamma_4}. \quad (13)$$

Here *IGR** indicates the threshold (turning) point of inclusive economic growth.

Variable and Measurement

There is insufficient convergence in how environmental sustainability indicators are defined, even though the existing literature describes the concept in explicit terms. Nonetheless, environmental degradation, most commonly proxied by CO_2 emissions, has often been used as an inverse measure of sustainability. This study adopts a set of environmental degradation indicators, including CO_2 emissions, to represent environmental sustainability in the opposite direction. The variables used in this study are summarized in Table 3 below.

Result and Discussion

The discussion of the analysis results begins by presenting the descriptive statistics of the variables used in the model estimation, as shown in Table 4. The table summarizes the core indicators: environmental degradation (measured by CO_2 emissions per capita); inclusive economic growth (calculated in two ways — IGR following the ADB framework and IGR_SMC using the Social Mobility Curve); and institutional quality (government effectiveness and regulatory quality). The control variables include tertiary school enrollment, trade openness, foreign direct investment (FDI), population growth, and the urban population.

Presenting data distribution is essential to essential for understanding the nature and characteristics of the dataset that underpins this study's conclusions. The average per capita CO_2 emissions for the BRICS Plus countries stand at 7.135 metric tons, with the highest level reaching

Table 3

Variable and Measurement

Variable	Measurement	Scale	Data Source
IGR	Inclusive growth generated using the PCA	standardized PCA score	Authors
IGR_SMC	Inclusive growth is measured by Social Mobility Curve	Index 0 to 1	Authors
CO_2	Carbon dioxide emission per capita	Ratio	WDI
Gov	Government effectiveness evaluates the efficiency of public and administrative services, as well as the authority's ability to develop and implement policies efficiently.	(estimated value, —2.5 weak; 2.5 strong)	WGI
Reg	Regulatory quality measures the authority's capability to encourage and develop the private sector by formulating and implementing effective policies and sound regulations.	(estimated value, —2.5 weak; 2.5 strong)	WGI
Education	School enrollment, tertiary	total	WDI
Trade	Merchandise trade	% of GDP	WDI
FDI	Foreign direct investment, net inflows	% of GDP	WDI
Population	Population growth	annual %	WDI
Urban	Urban population	% of total population	WDI

Source: Authors' computation using WGI and WDI data

Table 4

Descriptive Statistics

Variable	Obs.	Mean	Std. dev.	Min	Max
Environment					
CO2	207	7.135	7.175	.0574	27.17
Inclusive Growth					
IGR	144	–8.67e	.9238	–1.889	1.834
IGR_SMC	100	.3021	.0610	.1806	.4882
Institution					
GOV	207	–.084	.5793	–1.21	1.6
REG	207	–.324	.6697	–1.71	1.1
Control					
EDUC	153	37.28	22.78	1.166	84.51
TRADE	216	46.92	35.68	13.13	186.2
FDI	211	2.162	1.772	–1.756	9.660
POP	216	1.614	2.250	–.4600	18.12
URBAN	216	57.86	22.51	14.74	87.78

Source: Calculated by the authors

27.17 metric tons in the United Arab Emirates — a figure that significantly exceeds the BRICS average. The Inclusive Growth Rate (IGR) variable was constructed using the PCA method applied to a set of socio-economic indicators derived from the Asian Development Bank (ADB) framework. While the original indicators all carry positive values, the PCA-generated IGR score may appear as either positive or negative. This results from the standardization process applied prior to PCA, where each indicator is normalized using a z-score transformation to produce a mean of zero and a standard deviation of one. PCA then forms a composite score by generating a linear combination of these normalized variables. As a result, countries with relatively lower values in some indicators — or imbalances across components — may obtain negative PCA scores. A negative IGR score signals that a country exhibits comparatively lower inclusive growth. Within this dataset, IGR values range from — 1.385 to 2.179.

Meanwhile, IGR_SMC, measured using the Social Mobility Curve (SMC) approach, has an average value of 0.3021, with a minimum of

Table 5

Correlation Matrix

	CO2	IGR	IGR_SMC	GOV	REG	EDUC	TRADE	FDI	POP	URB
CO2	1.00									
IGR	–0.091	1.00								
IGR_SMC	0.216	–0.115	1.00							
GOV	–0.131	0.290	0.062	1.00						
REG	–0.153	0.424	–0.358	0.467	1.00					
EDUC	0.737	–0.132	0.137	–0.242	–0.169	1.00				
TRADE	0.531	0.104	0.168	–0.049	0.102	–0.017	1.00			
FDI	–0.211	0.552	–0.353	0.145	0.669	–0.115	0.089	1.00		
POP	–0.642	–0.263	–0.028	–0.109	–0.377	–0.576	–0.343	–0.276	1.00	
URBAN	0.456	–0.052	–0.359	–0.415	–0.138	0.698	–0.171	–0.002	–0.404	1.00

Source: Calculated by the authors

0.1806 and a maximum of 0.4882. The standard deviation of 0.0610 reflects relatively low variation but provides enough insight to distinguish the level of social mobility between countries. The average institutional quality suggests relatively low institutional standards across the region. Meanwhile, the average trade value indicates a fairly high level of openness. The FDI values, however, show a relatively low level of FDI.

Table 5 displays the correlation matrix illustrating the relationships among all the variables used. The correlation results indicate a relatively weak relationship — below 0.8 — so there is no issue with multicollinearity in the model. The negative correlations of IGR, GOV, and REG variables with CO_2 align with the initial hypothesis that inclusive growth and improved institutional quality can help reduce environmental degradation.

The above indifference curves serve as a tool to analyze the evolution of inclusive growth in BRICS Plus countries over time (appendix 2). In all cases, during both the initial and final years of observation, the indifference curves tend to shift upward, generally reflecting the overall increase in society's income. However, the magnitude of the relative shift and the curvature of the indifference curve are crucial in evaluating the nature of the growth. A steeper curve indicates greater income inequality between deciles, especially between the highest and lowest income groups. Most BRICS countries have a particularly steep indifference curve in the tenth decile, that is, the top 10 percent of the income group earns significantly more than the group below. China's inclusive growth, for instance, has benefited the wealthiest, obscuring inequality while still producing high growth. The same pattern applies to India, Brazil, and Ethiopia, where growth has decreased levels of equality. Another example is South Africa, which did not experience a significant shift in its income growth curve. However, sharp increases in the 9th and 10th deciles have reinforced inequality.

The empirical analysis results are presented in Table 6, with carbon dioxide (CO2) as the dependent variable. It can be seen that all Hausman tests reject the initial hypothesis regarding the development of a random effects regression model. Therefore, in this section, a fixed effects regression model is used to explore the nonlinear relationship between inclusive growth and environmental sustainability.

Dynamic panel GMM estimation was performed to assess the potential persistence of CO_2 emissions and control for endogeneity. Since fixed effects OLS (OLS-FE) may be biased when an AR(1) autoregressive process exists, lagged values of the dependent variable are necessary to address this. If an AR (1) process is present, it can lead to endogeneity issues that fixed effects models cannot resolve (Kripfganz & Schwarz, 2019).

The results showed no evidence of AR (1), and the AR (2) p-value indicated no consistent second-order serial correlation, suggesting no first- or second-order serial correlation in the first-differenced residuals. The lagged dependent variable ($CO_2(-1)$) was consistently insignificant across all specifications, indicating a lack of strong dynamic effects. Moreover, the Sargan–Hansen test supported the overall validity of the instruments.

Table 6

Result of Fixed Effect Regression Estimation (Dependent variable: CO_2)

Variable	1	2	3	4
IGR	.869*** (.151)	.461** (.193)	.352* (.182)	.438 (.291)
IGR^2	–.320*** (.079)	–.543*** (.083)	–.450*** (.084)	–.424*** (.137)
IGR_SMC				–4.56 (18.4)
IGR_SMC^2				.119 (29.3)
Gov	.863*** (.244)	.089 (.260)		–.553 (1.54)
Gov*IGR	.901*** (.256)	.956*** (.317)		.281 (.418)
Gov*IGR_SMC				2.71 (4.48)
Reg	.190 (.328)		.345 (.260)	.916 (1.07)
Reg *IGR	–.031 (.243)		.416** (.193)	.187 (.327)
Reg*IGR_SMC				–4.56 (3.28)
Educ		–.006 (.007)	–.008 (.007)	–.017* (.008)
Trade		–.014* (.007)	–.013* (.007)	–.012 (.010)
FDI		–.004 (.024)	–.015 (.025)	.057 (.049)
Population		.542*** (.159)	.556*** (.165)	.535** (.251)
Urban		.125*** (.030)	.167*** (.028)	.179*** (.041)
Constant	6.01*** (.114)	–.576 (1.77)	–2.86* (1.64)	–2.47 (3.68)
Turning point (IGR*) %	0.139	0.125	0.08	0.09
No. of Obs.	144	114	114	72
F-test	17.78	33.71	30.98	15.05
Cross-section	Yes	Yes	Yes	Yes
HausmanTest	20.64***	99.19***	98.60***	53.26***

Standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$
All models have met the OLS assumption of passing the test of normality, non-heteroskedasticity, and non-multicollinearity.

Source: Calculated by the authors

Additionally, the Portmanteau test confirmed no serial correlation ($p \approx 0.43$), suggesting that the instrument set did not overfit the data. Therefore, although the GMM estimation was statistically valid, the model appeared better suited for static estimation methods like OLS.

The analysis shows that inclusive growth has a positive and significant relationship with CO_2 emissions, while the quadratic term of inclusive growth is associated with a significant negative impact on environmental degradation. This indicates an inverted U-shaped nonlinear relationship, where the linear coefficient is positive ($\gamma_{IGR} > 0$) and the quadratic coefficient ($\gamma_{IGR^2} < 0$) is negative (see Table 6). Furthermore, this study confirms that the pattern holds even when the economic growth used is based on inclusive measures instead of conventional growth. The estimated turning point (IGR) for the four EIKC model specifications ranges from 0.08 to 0.14, based on the standardized inclusive growth index generated from PCA. Since this index is normalized, these values should be interpreted in relative rather than absolute terms. The results suggest that when the level of inclusive growth rate improves by approximately 0.1 standard deviations above its mean, the trend of environmental degradation begins to decline. In other words, moderate improvements in inclusive growth — characterized by equitable access to economic opportunities, social inclusion, and environmental participation — are enough to trigger a phase of EIKC decline in the BRICS Plus economies. These findings reinforce the argument that inclusivity accelerates environmental turning points by promoting wider technology diffusion, better regulatory compliance, and collective environmental awareness, in line with the endogenous growth and institutional quality frameworks (see Figure 1). In the early stages of inclusive growth, the focus is on balancing differences in societal in-

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Table 7

GMM Estimation (Dependent Variable: CO_2)

	GMM			
Variable	**5**	**6**	**7**	**8**
$LagCO_{2\,(-1)}$	0.447 (0.736)	0.154 (0.906)	0.066 (0.928)	−2.21 (2.20)
IGR	−1.39 (2.00)	4.49*** (1.68)	1.05 (.765)	−1.47 (1.65)
IGR^2	−0.244 (0.971)	0.445 (0.997)	−2.00 (1.53)	2.12* (1.13)
Gov	−10.1* (5.96)			
Gov*IGR		−4.85* (2.88)		
Reg			3.32 (1.91)	
Reg *IGR				−4.97* (2.95)
Educ	−0.11 (0.082)	2.88** (0.047)	0.011 (0.020)	0.050*** (0.019)
Trade	−0.003 (0.006)	0.028** (0.013)	0.004 (0.003)	0.016** (0.006)
FDI	−0.260 (0.197)	−0.030 (0.088)	0.151 (0.096)	−0.099 (0.073)
Population	−0.312 (0.907)	−5.24* (2.90)	−1.51 (1.03)	−0.351 (0.644)
Urban	0.123 (0.124)	0.116 (0.124)	0.167 (0.144)	0.276 (0.211)
Constant	–	–	–	–
Turning point (IGR*) %	−0,16958	−0,99903	1,05	1,5582
No. of Obs.	111	111	111	111
No. of Countries	9	9	9	9
No of Instruments	24	24	24	24
AR (2): P-value	0.657	0.009	0.469	0.711
Sargan-Hansen test	0.877	0.877	0.877	0.877
Portmanteau test	0.438	0.437	0.427	0.437

Standard errors in parentheses; *** and ** indicate significance at 0.01 and 0.05 levels, respectively.
Note: The variable *IGR_SMC* is not included in the GMM models due to a limited number of observations, which resulted in its omission during estimation. As such, the effects of *SMC* are analysed solely within the OLS framework.

Source: Calculated by the authors

equality, thus paying less attention to the environmental impact (especially CO2 tends to be overlooked) (Kamah et al., 2021).

This finding supports the three main foundations proposed by Grossman & Krueger (1991) regarding the existence of EKC, where the shape of the inverted U-curve between income and environmental quality can be explained through by three effects namely: scale effect, composition effect, and technique effect. The scale effect appears in the early phase of industrialization, where increased economic activity drives environmental degradation. The composition effect, on the other hand, occurs when the structure of the economy changes towards industry and resource extraction, often without adequate environmental regulation, in which case natural resource consumption is based on comparative advantage and environmental policies/laws are less stringent. The quality of institutions implementing environmental policies has a positive impact on inclusive growth and consequently on environmental sustainability. Finally, the engineering effect reflects increased awareness and adoption of environmentally friendly technologies as incomes and public pressure rise.

This finding is also in line with previous studies (Ahmed et al., 2019; Annor et al., 2023; M. D. Ibrahim & Abbas, 2022; Kamah et al., 2021; Mu'min et al., 2024; Sarkodie & Strezov, 2018; Wang et al., 2023; Yan et al., 2022). The significant positive effect on CO_2 emissions can be attributed to economic progress and development — in BRICS Plus countries — which goes hand in hand with large resource extraction, industrial activity, and trade that can potentially increase CO2 emissions. In this case, inclusive growth that includes economic improvement, addressing inequality, education, health, and other social protections may have a negative impact through CO_2 emissions.

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For example, Ibrahim & Abbas (2022) found that in the short run, an increase in per capita income exacerbates environmental damage. They identified the EKC pattern in the Indonesian province of Java and detected an N-shape EKC with two turning points. Using threshold effect regression approach, Wang et al. (2023) examined the relationship between income inequality and carbon emissions. Along with rapid economic growth, the constraining effect of income inequality on carbon emission efficiency increases so that there is an inverted U-shaped relationship between income inequality and carbon emission efficiency. The ASEAN study by Mu'min et al. (2024) emphasizes the need for an inclusive approach in combating the negative impacts of energy transition on social dimensions. Similarly, Ahmed et al. (2019) concluded that the shift from labour-intensive to capital-intensive technologies also worsens environmental quality if not accompanied by institutional reforms.

Institutional quality in this study is measured through two main indicators: government effectiveness and regulatory quality. Regulatory quality reflects the government's capacity to design and implement effective policies, especially in encouraging private sector growth without compromising good governance. The positive and significant coefficient of government effectiveness and its interaction with inclusive growth (IGR × GE), including the quality of regulation interacting with inclusive growth, indicates that, in the BRICS Plus economy, institutional effectiveness can actually exacerbate environmental degradation. This suggests that although institutions operate efficiently in promoting economic activity, their governance structures tend to prioritize facilitating growth over ecological preservation. In practical terms, a one-unit increase in government effectiveness — when combined with inclusive growth — corresponds to a proportional increase in CO_2 emissions, implying that institutional efficiency has been directed toward speeding up industrialization and investment rather than supporting environmental protection (Kerekes, 2011; Le & Ozturk, 2020).

This paradox highlights a widespread 'growth-biased policy' in BRICS Plus countries, where the development agenda focuses on infrastructure growth, energy security, and maximizing output to sustain rapid economic change. In this context, effective institutions can streamline bureaucratic processes, reduce investment barriers, and mobilize resources, yet they can also weaken environmental oversight due to political and fiscal trade-offs. These outcomes align with the concept of regulatory capture, where powerful industrial and extractive sectors sway policy enforcement, and with governance trade-offs, where environmental protection is overlooked during economic expansion (Hassan et al., 2020; Le & Ozturk, 2020).

A crucial component of regulatory quality lies in the protection and enforcement of property rights, as emphasised by Kerekes (2011). Stronger property rights institutions can encourage private investment and capital formation, but without strong environmental regulations, such institutional improvements can indirectly worsen pollution through more intensive production. While clear property rights can reduce deforestation and improve access to clean water, they are also correlated with higher air pollution due to industrial expansion. Similarly, geopolitical instability and governance vulnerabilities — challenges that are common in some BRICS Plus member countries — can exacerbate emissions by disrupting regulatory consistency and encouraging reliance on environmentally damaging sectors (Halkos & Tzeremes, 2013).

Furthermore, among BRICS Plus members, institutional heterogeneity, ranging from democratic to state-led governance, creates uneven environmental accountability. For example, state capitalist systems (China, Russia) often demonstrate high administrative efficiency but limited transparency, while democratic systems (Brazil, South Africa) face political fragmentation that hinders consistent law enforcement. As a result, increased institutional effectiveness does not necessarily lead to ecological sustainability unless environmental mandates are embedded in institutional performance metrics.

In this study, the control variables include education, trade, foreign direct investment (FDI), population growth, and urbanization because of their potential impact on inclusive growth and the environment as described by previous studies (Ali et al., 2019; Anand et al., 2013; Annor et al., 2023; Dwiputri et al., 2018; Gyamfi et al., 2022; Kamah et al., 2021, 2021; Khan et al., 2021; Lau et al., 2014; Ofori et al., 2023). Based on the estimation results in Table 6, some important findings are obtained.

Population growth and urbanization have a significant positive impact on environmental degradation, consistent with empirical evidence reported by Alam et al. (2016); Ali et al. (2019); Khan et al. (2021). This influence emphasizes the role of demographic dynamics as a catalyst for ecological pressure in BRICS Plus countries. Rapid population growth boosts demand for resources, especially energy, housing, transportation, and industrial goods, thereby worsening fossil fuel use and waste production. Likewise, faster urbanization, often paired with poor infrastructure planning and weak regulatory enforcement, leads to increased air pollution, land conversion, and ecological footprint growth.

Conclusion and Policy Implications

This study uses macroeconomic data from the nine BRICS countries (2000–2023) to examine how inclusive economic growth affects environmental degradation, particularly CO_2 emissions. While earlier research generally shows that economic growth produces harmful environmental externalities, this study expands the debate by incorporating inclusive growth into the Environmental Inclusive-Growth Kuznets Curve (EIKC) framework. This shift reflects a broader understanding of growth — one that evaluates not only its scale but also how widely its benefits are distributed.

From this perspective, the EIKC suggests an inverted U-shaped relationship between environmental quality and inclusive growth. As with the traditional EKC, early-stage inclusive growth raises emissions because of industrial and energy-intensive development. Once a certain level of inclusiveness is achieved, however, income redistribution, technological advancement, and human capital investments strengthen environmental preferences and help reduce emissions. These mechanisms effectively lower the EIKC curve.

Empirical evidence from a static panel Fixed Effects Model supports the EIKC hypothesis for BRICS Plus economies. This finding signals the importance of prioritizing inclusive growth in emerging economies; sacrificing inclusiveness for short-term expansion may undermine long-term sustainability.

Institutional quality also plays a crucial moderating role. Yet the study identifies a paradox: government effectiveness and regulatory quality, while essential for economic coordination, can intensify environmental degradation when growth-oriented institutions lack ecological safeguards. Rapid population growth and urbanization further strain the environment by increasing demand for resources and fossil fuel consumption, especially where regulatory capacity is weak.

The central policy challenge for BRICS Plus governments, therefore, is to align inclusive growth strategies with environmental objectives so that economic inclusion becomes a driver of ecological sustainability rather than a trade-off. Strengthening environmental laws, improving transparency in environmental spending, and integrating ecological accountability into bureaucratic performance evaluations can enhance institutional credibility and ensure that governance efficiency supports sustainability. Informal mechanisms, such as policy cohesion, decentralization, cultural norms, and public participation, can also reinforce long-term resilience, especially in countries with complex social structures like India and Ethiopia.

The study has several limitations. Aggregate indicators such as CO_2 do not capture the full extent of environmental pressures, including biodiversity loss or localized air quality issues. Future research could expand the analysis by using subnational datasets, alternative environmental indicators, or distinctions between formal and informal institutional arrangements to better understand non-linear interactions. Examining policy experiments, such as green industry incentives, environmental taxation, or just-transition programs, would also provide deeper insights into how inclusive growth can be aligned with environmental sustainability.

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Appendix 1

Estimation Results

Variable	CEM–OLS				REM				GMM			
	1	2	3	4	5	6	7	8	9	10	11	12
$LagCO_{2\,(-1)}$									0.447 (0.736)	0.154 (0.906)	0.066 (0.928)	−2.21 (2.20)
IGR	4.23*** (0.371)	1.35*** (0.461)	1.51*** (0.536)	3.15*** (1.06)	.959*** (.158)	1.35*** (.480)	1.51*** (.517)	3.15*** (.956)	−1.39 (2.00)	4.49*** (1.68)	1.05 (.765)	−1.47 (1.65)
IGR^2	−1.26*** (0.382)	−0.141 (0.241)	0.075 (0.250)	−0.285 (0.452)	−.319*** (.084)	−.141 (.246)	.075 (.246)	−.285 (.366)	−0.244 (0.971)	0.445 (0.997)	−2.00 (1.53)	2.12* (1.13)
IGR_SMC				64.6 (61.1)				64.6 (66.9)				
IGR_SMC^2				−110.2 (94.3)				−110.2 (108.2)				
Gov	2.16* (1.22)	−1.67** (0.700)		8.80 (6.94)	.902*** (.259)	−1.67** (.720)		8.80 (6.07)	−10.1* (5.96)			
Gov*IGR	4.75*** (1.39)	2.48*** (0.884)		0.856 (1.21)	.969*** (.271)	2.48*** (.945)		.856 (1.25)		−4.85* (2.88)		
Gov*IGR_SMC				−26.2 (20.3)				−26.2 (17.7)				
Reg	−2.65*** (0.683)		−1.74*** (0.533)	−1.74 (3.51)	.352 (.341)		−1.74*** (.496)	−1.74 (3.73)			3.32 (1.91)	
Reg *IGR	−.438 (0.986)		0.608 (0.639)	3.14** (1.34)	.025 (.257)		.608 (.681)	3.14** (1.25)				−4.97* (2.95)
Reg*IGR_SMC				0.321 (10.2)				.321 (11.6)				
Educ		0.081*** (0.009)	0.076*** (0.009)	0.107*** (0.018)		.081*** (.010)	.076*** (.012)	.107*** (.016)	−0.11 (0.082)	2.88** (0.047)	0.011 (0.020)	0.050*** (0.019)
Trade		0.110*** (0.012)	0.132*** (0.011)	0.187*** (0.023)		.110*** (.013)	.132*** (.011)	.187*** (.021)	−0.003 (0.006)	0.028** (0.013)	0.004 (0.003)	0.016** (0.006)
FDI		−0.48*** (0.098)	−0.40*** (0.095)	−0.33*** (0.188)		−.487*** (.084)	−.401*** (.088)	−.332** (.164)	−0.260 (0.197)	−0.030 (0.088)	0.151 (0.096)	−0.099 (0.073)
Population		−1.60*** (0.264)	−1.54 (0.205)	−1.43*** (0.380)		−1.60*** (.316)	−1.54*** (.295)	−1.43*** (.424)	−0.312 (0.907)	−5.24* (2.90)	−1.51 (1.03)	−0.351 (0.644)
Urban		−0.009 (0.019)	−0.015 (0.020)	−0.041 (0.031)		−.009 (.017)	−.015 (.018)	−.041 (.030)	0.123 (0.124)	0.116 (0.124)	0.167 (0.144)	0.276 (0.211)
Constant	5.31*** (.455)	1.23 (1.47)	.086 (1.26)	−11.2 (10.3)	6.90*** (1.07)	1.23 (1.34)	.086 (1.17)	−11.2 (10.6)	–	–	–	–

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Variable	CEM-OLS				REM				GMM			
	1	2	3	4	5	6	7	8	9	10	11	12
Turning point (IGR*) %	2,6649	0,095175	–0,05663	0,448875					–0,16958	–0,99903	1,05	1,5582
No. of Obs.	144	114	114	72	114	114	114	72	111	111	111	111
No. of Countries					9	9	9		9	9	9	9
No of Instruments									24	24	24	24
Adjusted R^2	0.52***	0.88***	0.89***	0.93***								
F-test	43.82	134.47	145.37	105.3	107.60***	825.94***	874.61****	745.39***				
AR (2): P-value									0.657	0.009	0.469	0.711
Sargan-Hansen test									0.877	0.877	0.877	0.877
portmanteau test									0.438	0.437	0.427	0.437

Standard errors in parentheses; *** and ** indicate significance at 0.01 and 0.05 levels, respectively.
Note: The variable *IGR_SMC* is not included in the GMM models due to a limited number of observations, which resulted in its omission during estimation. As such, the effects of *SMC* are analyzed solely within the OLS framework.

Source: Calculated by the authors

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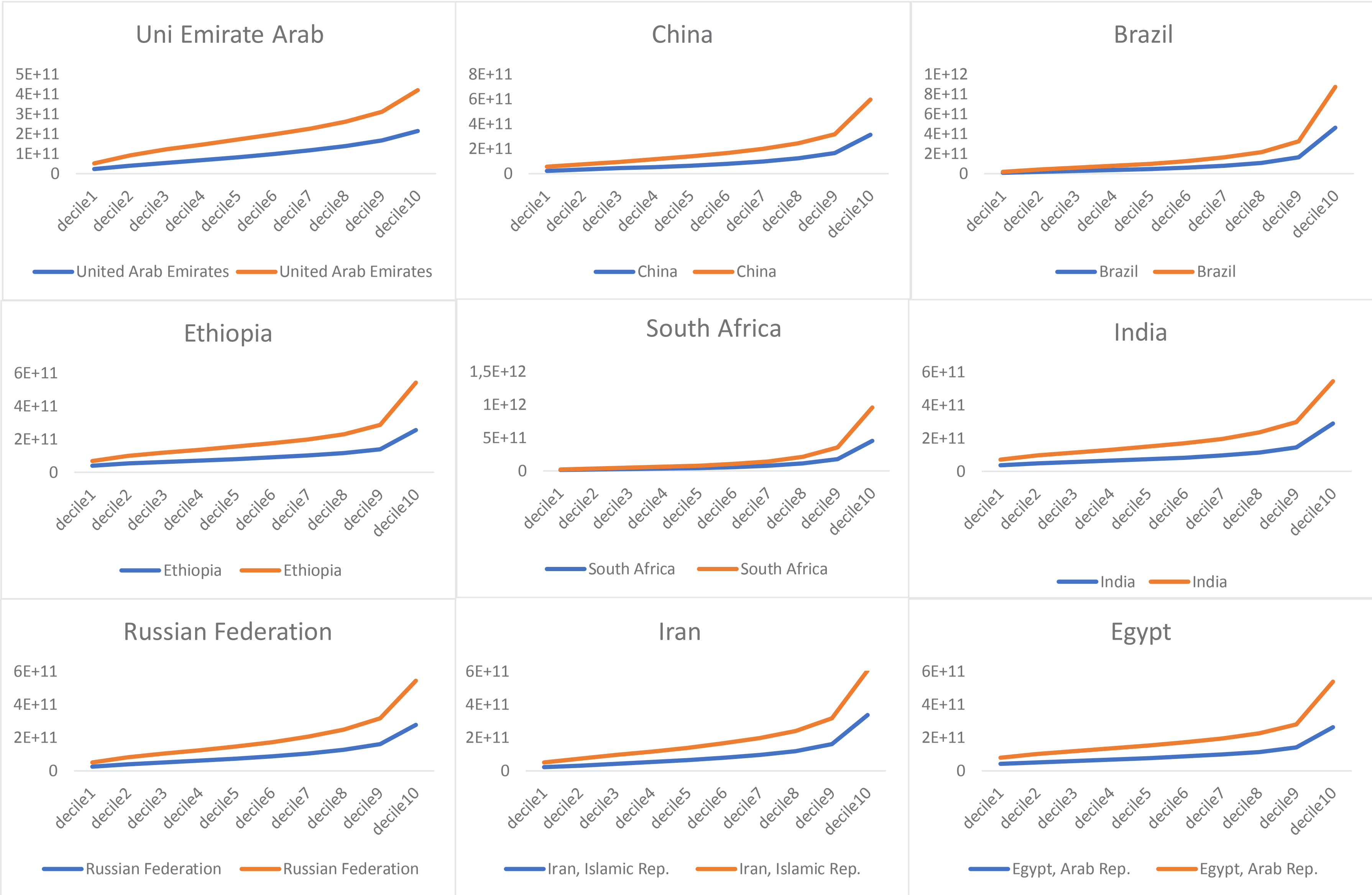
Appendix 2

Distribution of BRICS on the inclusiveness matrix



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Assessing the impact of export development institutions on regional economic growth in Russia

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ABSTRACT
Relevance. Increasing national export support is becoming increasingly important for regional economic development. To enhance the effectiveness of such support, it is crucial to understand the relationship between financial export support and regional economic growth.
Research Objective. The study aims to assess the impact of the state financial export support on regional economic growth, focusing on the national project "International Cooperation and Export".
Data and Methods. The analysis covers 81 subjects of the Russian Federation from 2019 to 2024, totaling 486 observations. Quantile regression is employed to examine how explanatory variables affect different points of the dependent variable's distribution (lower, median, and upper quantiles), which is particularly useful for analyzing heterogeneous regional systems.
Results. Using the proposed methodological approach, asymmetric effects of economic policy and project support on regional development were investigated. Regions were divided into three quantile groups based on financial export support: low (up to 0.33), medium (0.5), and high (0.667). The quantile regression model confirmed its statistical reliability. The analysis revealed significant heterogeneity in the impact of financial support for regional projects: stable positive effects were observed only in regions with the highest funding (upper quantile). The findings highlight the need to shift from universal support measures toward differentiated strategies tailored to regional typologies.
Conclusion. The effectiveness of export support depends on adopting targeted strategies that reflect regional characteristics. The study provides evidence-based recommendations to improve the impact of state export support on regional development.

KEYWORDS
export, state support, international cooperation, export regulation, Russian Export Center, export promotion, Russian regions, national project

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Оценка влияния институтов развития экспорта на экономический рост российских регионов

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АННОТАЦИЯ
Актуальность. В целях наращивания национального экспорта в региональных экономиках все большее значение приобретает государственная поддержка экспорта. Для повышения эффективности такой поддержки необходимо лучше понимать связь между показателями экспортной финансовой поддержки и экономическим развитием региона.

КЛЮЧЕВЫЕ СЛОВА
экспорт, государственная поддержка, международная кооперация, регулирование

Цель исследования. Целью исследования является оценка влияния государственной финансовой поддержки экспорта с фокусом на национальный проект «Международная кооперация и экспорт» на экономический рост российских регионов.
Данные и методы. Исследование охватывает 81 субъект Российской Федерации за период с 2019 по 2024 годы, что составляет 486 наблюдений. Для реализации цели исследования использовался метод квантильной регрессии. В отличие от модели обыкновенных наименьших квадратов (OLS), квантильная регрессия позволяет изучить, как объясняющие переменные влияют на различные уровни распределения зависимой переменной (на нижние, средние и верхние значения), что особенно важно при анализе неоднородных региональных систем.
Результаты. На основе авторского подхода исследованы асимметричные эффекты, возникающие при анализе влияния экономической политики и поддержки проектов на региональное развитие, выделены 3 квантильные группы, в соответствии с которыми произведено распределение регионов по показателю «финансовая экспортная поддержка»: нижняя (до 0,33), средняя (0,5) и верхняя (0,667). Построена модель квантильной регрессии, статистические характеристики которой подтвердили ее значимость и корректность. Проведённый анализ выявил значительную неоднородность воздействия финансовой поддержки региональных проектов в рамках федерального проекта «Международная кооперация и экспорт» на социально-экономическое развитие субъектов Российской Федерации. Только в регионах с наибольшим объёмом финансирования (верхний квантиль) наблюдаются стабильные положительные эффекты. Результаты расчетов подтверждают необходимость перехода от универсальных мер поддержки к дифференцированным стратегиям, соответствующим типологии регионов.
Заключение. Дальнейшая эффективность экспортной поддержки напрямую связана с переходом от универсальных мер поддержки к дифференцированным стратегиям, соответствующим типологии регионов. В исследовании предлагаются рекомендации по повышению результативности государственной поддержки экспорта.

экспорта, Российский экспортный центр, стимулирование экспорта, российские регионы, национальный проект

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评估出口发展机构对俄罗斯地区经济增长的影响

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摘要
摘要：为促进区域经济体的出口，政府对出口支持的重要性日益凸显。为提高此类支持的有效性，有必要更好地了解出口金融支持指标与区域经济发展之间的关系。
研究目标：本研究旨在评估国家对出口的财政支持（以“国际合作与出口”国家项目为重点）对俄罗斯各地区经济增长的影响。
数据与方法：本研究涵盖俄罗斯联邦81个主体，时间跨度为2019年至2024年，共包含486个观测值。为实现研究目标，本研究采用了分位数回归方法。与普通最小二乘法（OLS）模型不同，分位数回归能够考察解释变量如何影响因变量分布的不同水平（低值、中值和高值），这在分析异质性区域系统时尤为重要。
研究结果：基于作者的研究方法，文章探讨了在分析经济政策和项目支持对区域发展影响时产生的不对称效应，并划分出三个分位数组，据此按“金融出口支持”指标对各区域进行划分： 低分组（低于0.33）、中分组（0.5）和高分组（0.667）。研究构建了分位数回归模型，其统计特征证实了该模型的有效性和正确性。分析表明，在联邦项目“国际合作与出口”框架内，区域项目金融支持对俄罗斯联邦各主体社会经济

关键词
出口、国家支持、国际合作、出口管制、俄罗斯出口中心、促进出口、俄罗斯各地区、国家项目

发展的影响存在显著的异质性。只有在获得最高资金支持的地区（高分组），才能观察到稳定的积极效果。计算结果证实，有必要从通用支持措施转向符合地区类型的差异化战略。
结论：出口支持的持续有效性与从普惠性支持措施向针对区域特点量身定制的差异化战略的转变直接相关。本研究就如何提高国家出口支持的有效性提出了建议。

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Introduction

Despite the resilience of Russia's foreign economic activity system, the sanctions have impacted the national economy, including export performance metrics. Under these conditions, state export regulation aims to stimulate economic growth primarily by enhancing exporter business activity.

Export promotion instruments are commonly divided into several groups, with the most frequent classification distinguishing between financial and non-financial instruments (Naryshkin, 2021). These tools are implemented by various development institutions, which function within a framework of norms and rules in a specific policy domain and include specialized organizations whose activities support economic development and entrepreneurship through targeted problem-solving (Tatarkin & Kotlyarova, 2013). Following this definition, export development institutions as a form of state support (EDI) include:

– Eximbank of Russia (for concessional financing of export operations), Russian Agency for Export Credit and Investment Insurance (EXIAR) (for export credit insurance), and Russian Export Center (support and promotion of non-primary exports, primarily of high-tech products);

– Other development institutions, e. g., Industrial Development Fund: financial and non-financial support for import substitution, including advisory and informational services;

– State development corporation VEB.RF: national economic development institution

– The national project "International Cooperation and Export"[1]: key export development instrument, extended to 31.12.2030; includes measures by all export development institutions and their financial support

The relationship between development institutions and instruments for export development is presented in Table 1.

The activities of these institutions certainly make it possible to stimulate new participants' access to external markets and support active exporters, in the face of sanctions restrictions, however, as emphasized by Minakov (2023), pointed out, it is impossible to achieve the strategic goals of developing commodity exports before the end of a turbulent period in the world economy and trade.

Notwithstanding the government's substantial efforts and support measures, there are still issues with export development. For example, during the IV Big Open Dialogue Investment Forum in February 2025 in the Urals, it was announced that in 2024 there would be more than 1.3 thousand SMEs have benefited from support measures when entering foreign markets, and about one and a half hundred companies have signed export contracts with partners from 45 countries[2], but the results could have been better.

Despite extensive researches one important aspect remains unclear, particularly at the regional level, but rather how export support measures to exporting enterprises affect the social and economic development of Russian regions. Update of the list of state aid is accompanied by evaluation of performance for foreign market entrants.

These considerations shaped the research focus of this study, which aims to analyze how funding levels for regional projects under the International Cooperation and Export federal project[3] affect key indicators of socioeconomic and industrial development across Russia's constituent entities.

[1] The International Cooperation and Export national project URL: http://government.ru/rugovclassifier/922/events/ (Date of access: 22.04.2025)

[2] Ural in the "Big Open Dialogue"//Kommersant Yekaterinburg. 04.03.2025. URL: https://www.kommersant.ru/doc/7551612 (Date of access: 22.04.2025)

[3] Government support measures. URL: https://www.exportcenter.ru/services/spetsialnye-programmy-po-podderzhke-eksporta/ (Date of access: 22.04.2025)

Table 1

Key Russian export support institutions

Institution/Program	Financial Support	Non-Financial Support	Role in the national project
National project "International Cooperation and Export"	Coordinates the allocation of: – subsidies (via the Ministry of Industry and Trade); – export grants (via the Russian Export Center); – preferential loans (via *Roseximbank*)	Coordinates: – export training (Russian Export Center, Federal Corporation for the Development of Small and Medium Enterprises); – exhibition organization (Roscongress Foundation); – infrastructure programs (*VEB.RF*)	Consolidates support measures from other institutions
Russian Export Center JSC (REC)	– Subsidies for cost reimbursement; – Preferential lending	– Foreign trade training; – Marketing and promotion; – digital platform "My Export"	Key implementing body for the national project
EXIMBANK OF RUSSIA	– Export loans; – Pre-export financing	Consultations on currency operations	Participant in the national project
The Russian Agency for Export Credit and Investment Insurance (EXIAR)	Export credit insurance	Risk assessment	Participant in national project's insurance programs
National economic development institution *VEB.RF*	Infrastructure project financing	– Strategic analytics; – ESG initiative support	Oversees systemic projects under the national project
Industrial Development Fund	– Subsidized loans (1–5 %); – Project co-financing	– Technical expertise; – Import substitution assistance	Key national project implementer for industry

Source: National Project "International Cooperation and Export". URL: http://government.ru/rugovclassifier/922/events/ (Date of access: 22.04.2025)

This federal project, which includes Russian export support institutions, has had a positive impact on regional socio-economic development by providing financial support, as the hypothesis states.

To achieve this objective and test the hypothesis, the study addresses the following key questions:

– to acquire fundamental concepts to comprehend the activities of institutions that support export development and their effect on the social and economic development of regions of the country;

– suggest a methodical approach to evaluate their impact on the socio-economic development of Russian regions;

– conduct econometric modeling.

The novelty of the research is the quantile regression analysis to identify distinct regional clusters and quantify the differential effects of export support institutions (through the federal export promotion program) across these groups.

These findings can be of interest to policy-makers seeking to refine regional export policies. The study also offers evidence-based recommendations tailored to the government support processes in Russian regions.

Theoretical Framework

The development of foreign economic activity in Russian regions has long been a focus of scholarly research, with the Ural scientific school standing out in particular (Andreeva & Ratner, 2011). The topic is especially relevant today given ongoing global changes. While scholars may emphasize different aspects, they generally agree that goods exports, as a key form of international economic relations, both sustain the country's global competitiveness and drive national economic growth.

In recent years, growing attention has been given to the role of government support through development institutions. Research on the impact of these institutions in international activity can be grouped into several conceptual areas (see Table 2 below):

1) Analysis of international activity in general, including the effects of sanctions;

2) Examination of government export support and regulation;

3) Study of export development institutions themselves;

4) Regional-level (meso-level) studies.

Import substitution is also crucial for export development, as it shifts the economy from raw-material dependence toward high-tech production, creating competitive advantages in global markets (Glazyev, 2010). By fostering domestic innovation and industrial capacity, import substitution becomes a strategic tool for sustainable export growth and technological sovereignty.

These studies have been conducted at different times and in varying contexts: non-commodity export development (2005–2006), economic sanc-

Table 2

Main approaches to improving the effectiveness of state export support

Area of research	Publications	Description and relevant findings
Export government regulation (support)	Sidorov A. A. (2023)	Strengthening the country's position in the global high-tech market requires supporting not only exports but also domestic industries. Export promotion can only function as a supplement to broader tax and financial reforms, including R&D funding, multilingual websites, and language training for personnel.
	Minakov A. V. (2024)	This approach focuses on transforming the structure of the national economy through the expansion of high value-added and non-resource exports.
	Gavrilov N., Belyakov I. (2007)	The system of state support for industrial exports, combining financial, infrastructural, and social-educational measures, plays a central role in the country's economic growth. Effective support requires balancing Russia's export policies with those of its trading partners and combining financial tools (such as ECAs) with institutional assistance from EPAs.
	Koshman, V. V., Zimovets, A. V., & Khanina, A. V. (2024)	Russian export (and import) dynamics depend heavily on external factors, making long-term forecasting difficult, though some "safety margin" remains. The most effective support tools include programs for high-tech exports, entrepreneurship support, logistics development in the Asian part of the country and the "new territories," and the involvement of regional chambers of commerce in market research.
	Ushkalova D. I. (2023)	Under the current sanctions regime, state support measures remain important for exporters, but policymakers must consider the "big country trap": when a large exporter exits a market, global prices may rise.
Export development institutions	Hairov B. G., Berdov A. A., Kunichkin A. M. (2020)	The Russian Export Center serves as a key platform for cooperation between the state and exporters. Priorities for improvement include expanding the one-stop-shop model, developing a "Register of Exporters," building a network of foreign offices, and promoting the "Made in Russia" brand through international exhibitions and congress events.
	Minakov A. V. (2024)	The activities of the Russian Export Center and other export development institutions primarily aim to stimulate the business activity of exporting enterprises.
Research on national foreign economic activity	Sazonov S. P., Fedotova G. V., Sibagatulina L. M. (2016)	Support for import substitution programs within the framework of the state program includes support for domestic producers in the form of R&D subsidies, grants for public procurement, the creation of a state automated information system in the field of food security, etc.
Research on the regional level of foreign economic activity	Knobel A. Yu., Loshenkova A. N. (2018)	Regional export support, especially within SME support programs, can stimulate export volumes, but typically only in the short term.
	Berkovich M. I., Zakrevskaya (Khakhina) E. S. (2024)	Export support must consider both individual enterprises and entire regions. Effective regional systems include development institutions, exporting firms, credit, leasing, and insurance organizations, and local authorities. Analysis of the Regional Export Standard 2.0 shows weak correlation with the effectiveness of the Russian Export Center, largely due to underdeveloped regional institutional infrastructure and the lack of transparent public financing mechanisms.
Support for the export value chain	Okello, J. J., Narrod, C. A., Roy, D. (2011)	Support for smallholder farmers enabling their participation in global value chains may involve public–private partnerships for standardized processes and network credit agreements that allow the final exporter to settle interconnected loans within the chain.

tions (Balyuk, 2016), import substitution (recent years), and now diversification and technological sovereignty. Despite these differences, common challenges persist. These include the need for regular monitoring and analysis of state export support relative to the country's position in global markets (Gavrilov & Belyakov, 2007), development of institutional forms appropriate to the current stage of economic development, and improvement of methodological evaluation tools.

Export Promotion Agencies (EPAs) are widely used internationally to support exports. Researchers identify several key challenges to export efficiency, including limited access to distribution channels, high transport costs, and low brand awareness (Fernandes, 2018). These findings suggest that export support is most effective when it combines marketing, informational, transport, and other measures. In parallel, Lederman, Olarreaga, and Payton (2006) use econometric models to assess how EPAs' export budgets influence regional GDP. Overall, the main research focus is on evaluating the effectiveness of export development institutions and their impact on regional economic performance.

Data and Methods

While the academic literature offers several approaches for evaluating the influence of export development institutions on regional economic growth, the effectiveness of regional measures for export support remains a relatively unexplored problem in the Russian context (Berkovich & Zakrevskaya [Khakhina], 2024). In light of this, several approaches can be outlined:

– Evaluation of the relationship between the implementation of the regional export standard and the effectiveness of the regional export center using the Pearson correlation coefficient (Berkovich & Zakrevskaya [Khakhina], 2024).

– Assessment of the impact of exports on economic growth (GDP per capita), including employment growth, support for small and medium-sized enterprises, and indicators of scientific and technological development (Gavrilov & Belyakov, 2007).

– Analysis of import substitution programs using counterfactual methods, such as propensity score matching and the synthetic control method, which compare outcomes under current policies with hypothetical scenarios without such interventions (Kotyrlo & Zaytsev, 2021).

– Evaluation of the effectiveness of all types of support measures (financial and non-financial) and the work of export support institutions, including econometric modeling of the impact of financial expenditures on industrial, agricultural, and services exports (Sudakov, 2022).

– Assessment of export support costs within regional entrepreneurship development programs and their effect on regional export volumes, to identify priority regions for export support (Knobel & Loshenkova, 2018).

– Expert assessment through surveys of participants in foreign economic activity using structured questionnaires (Sokolov et al., 2019).

– Analysis of the impact of existing export promotion agencies (EPAs) and their strategies using a dataset covering 104 developing and developed countries, which shows a strong and statistically significant effect on exports (Lederman, Olarreaga & Payton, 2006).

Analysis of these proposals shows that the regional level itself is not fully examined, with most studies relying on country-wide indicators, even when some aspects of regional programs are described.

To address this gap, the study employs quantile regression, as proposed by Koenker and Bassett (1978), an extension of linear regression for modeling conditional quantiles of a dependent variable. Unlike ordinary least squares (OLS) regression, quantile regression allows for the analysis of how explanatory variables influence different segments of the dependent variable's distribution, particularly the lower, median, and upper quantiles. This approach is especially valuable for examining heterogeneous regional systems, where factor effects may differ substantially across regions' positions in the outcome distribution (Hao & Naiman, 2007). Moreover, quantile regression enables the investigation of asymmetric effects, which frequently occur when analyzing the impact of economic policies and project support on regional development, as confirmed by multiple empirical studies (Buchinsky, 1998; Koenker & Hallock, 2021).

The dependent variables considered are the gross regional product (*GDP*), the region's share in the country's gross domestic product (*ShareGDP*), investment in fixed capital (*Invest*), exports in roubles (*ExportRUB*) and US dollars (*ExportUSD*), high-tech exports (*HiTechExport*), the volumes of the mining (*Mining*) and manufacturing (*Manufacture*) industries, the production and distribution of electricity (*Electricity*), water supply (*Water*), and the total volume of industrial production (*IndProd*).

In addition to dependent variables, the model includes the following explanatory variable: *FinSupport* — total amount of financial support for export promotion in the region under the project "International Cooperation and Export" (aggregated from sub-programs: "Systemic Development Measures", "Industrial Export", and "Agricultural Export"). All variables, except for the region's share in the gross domestic product, are measured in billion rubles (USD)

The source of information is data from state statistics[4], and for the last year (2024) we used data from analytical agencies[5]. The study is based on economic and export data for Russian regions from 2019 to 2024, published by the Federal State Statistics Service (Rosstat[6]). There is no unified statistical database reporting the volume of export support across Russian regions. Instead, the available information is dispersed between the official portals of regional governments and the websites of regional Departments of Industry or Committees for Economic Development and Investment. For this study, a consolidated information base was compiled by aggregating data on the volume of export support for each region. All raw data were adjusted for inflation and normalized using a logarithmic transformation. This procedure addressed variance heterogeneity, normalized variable distributions, and reduced the influence of potential outliers.

The study includes 81 subjects of the Russian Federation from 2019 to 2024, totaling 486 observations. Due to limited data, the following regions were excluded: the federal cities of Moscow, Saint Petersburg, and Sevastopol; Crimea; and the Donetsk and Luhansk People's Republics, as well as Zaporozhye and Kherson regions.

To achieve the study's objective, the quantile regression method proposed by Koenker and Bassett (1978) was used. This method extends linear regression to model conditional quantiles of a dependent variable. Unlike ordinary least squares (OLS) regression, quantile regression allows for the analysis of how explanatory variables affect different points of the dependent variable's distribution, such as the lower, median, and upper quantiles. This feature is particularly valuable when studying heterogeneous regional systems, where the impact of factors may vary significantly depending on a region's position within the distribution of the outcome variable.

The general model of quantile regression is defined as follows (1):

$$Q_Y(\tau|X) = X\beta_{(\tau)}, \tag{1}$$

where $Q_Y(\tau|X)$ is a conditional τ — quantile of the dependent variable Y with given values of the regression X; $\beta_{(\tau)}$ is a vector of coefficients evaluated for each quantile group.

The study distinguishes three quantiles based on the median values of the "funding" indicator — 0.33, 0.50, and 0.67 — allowing the analysis of the effects of variable financing on the lower, middle, and upper parts of the indicator distribution. This approach is standard for identifying heterogeneous effects in regional data (Koenker & Hallock, 2001) and is particularly important in the context of the spatial and sectoral heterogeneity of Russian regions, where the impact of the same factor can vary significantly depending on a region's level of economic development.

Using logarithmic values enables the interpretation of model coefficients as elasticities, i. e., the percentage change in the outcome resulting from a one-percent change in a factor, enhancing comparability across regions and time periods. The data were normalized and inflation-adjusted using Rosstat deflators, expressed in constant 2019 prices.

The panel data structure captures both temporal dynamics and inter-regional differences while minimizing bias associated with limited observations or sample instability. Quantile regression results were interpreted with regard to regional differences in response to state support measures, allowing identification not only of the average effects but also of the groups where the impact is strongest, neutral, or even negative.

[4] Regions of Russia. Socio-economic indicators. 2025. URL: https://www.rosstat.gov.ru/folder/210/document/13204 (Date of access: 23.04.2025)

[5] GRP of Russian regions. URL: https://www.tadviser.ru/index.php/Статья:_ВРП_регионов_России (Date of access: 23.04.2025)

[6] Socio-economic indicators for the subjects of the Russian Federation. Appendix to the statistical yearbook "Regions of Russia. Socio-Economic Indicators" [Electronic resource]. URL: https://rosstat.gov.ru/folder/210/document/47652 (date of access 16.04.2025)

The research followed a step-by-step algorithm:

1. Preparation of data for modeling and analysis of the dynamics of financial export support.

2. Formation of quantile groups based on the level of regional participation in the export support mechanism, using the indicator "financial support for export" under the federal project "International Cooperation and Export".

3. Construction of the quantile regression model, compilation of its characteristics, and testing of variables.

4. Interpretation of the modeling results.

Results and Discussion

Stage 1. Data preparation for modeling and analysis of the dynamics of financial export support.

The source data for the study (Table 3) are drawn from regional portals of the project "International Cooperation and Expor", considering the total funding of its three sub-projects, and accumulated financial investments are used to construct the economic and mathematical model, reflecting resource accumulation at the regional level.

The descriptive statistics, adjusted for inflation using the consumer price index, are presented in Table 4.

The high values of skewness (up to 21.8) and excess reflect the natural heterogeneity of Russia's regional data, where a few highly developed entities dominate. This confirms the need to use quantile regression to account for heterogeneity, while logarithmic normalization minimizes the impact of outliers on the model.

Stage 2. Definition of quantile groups. Three quantiles of regions were identified depending on the level of financial export support they received under the federal project (see Table 5).

We deliberately ignored the level of economic development when grouping the regions by the amount of financial support (*FinSupport*) to isolate the net effect of funding. This results in both developed regions (e.g., Leningrad region in the lower quantile) and less developed regions appearing in the same quantiles, emphasizing that the effectiveness of support depends on funding amounts rather than the region's initial economic status.

Stage 3. Construction of a quantile regression model and its characteristics. Let us consider the characteristics of the obtained quantile regression model (Table 6). A preliminary GLS model was constructed to check for multicollinearity among the variables. Based on this analysis, the following indicators were removed: the region's share of national GDP, export volume (in rubles), manufacturing industry output, and electricity production and distribution. Since the data structure and the set of regressors in the quantile regression models are fully consistent with those in the

Table 3

Raw data (fragment using the example of Saratov region)

Region	Year	Indicators of financing regional projects of the International cooperation and export federal project (mln. rub.)				
		Systemic Development Measures for International Cooperation and Export	Industrial export	Export of agricultural products	Total for all sources	Total cumulative
Saratov region	2019	58,680	0,485	0,416	59,580	59,580
	2020	15,415	0,382	0,478	16,276	75,856
	2021	24,340	0,485	0,120	24,944	100,800
	2022	29,208	0,485	1,940	31,632	132,432
	2023	32,453	0,485	1,939	34,877	167,309
	2024	32,453	0,485	1,939	34,877	202,186

Source: the full table was calculated by the authors based on Rosstat data URL: https://rosstat.gov.ru/and official portals of regional governments, including the following: Regional project "Systemic Measures for the Development of International Cooperation and Export" of Saratov region. URL: https://saratov.gov.ru/gov/auth/mininf/ancicorrupcia/npa_corrupcia/Экспорт%20услуг. pdf (Date of access: 23.04.2025); Regional project "Systemic Measures for the Development of International Cooperation and Export" of Rostov region. URL: https://www.donland.ru/activity/2556/(Date of access: 23.04.2025); Regional project "Export of Agricultural Products" of Tumen region. URL: https://admtyumen.ru/ogv_ru/gov/ProjectOffice/National_projects/Export/Export_APK.htm etc. (Date of access: 23.04.2025).

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Table 4

Descriptive statistics

Variable	Average	Median	Min	Max
(Inf)FinSupport	0,13228	0,0074405	0,00000	11,139
(Inf)ShareGDP	0,74497	0,45456	0,00000	5,2504
(Inf)GDP	891,06	563,06	0,00000	6728,0
(Inf)Invest	295,24	83,941	0,00000	1593,5
(Inf)ExportUSD	1,2258	0,00043219	0,00000	18,764
(Inf)ExportRUB	83,792	0,031809	0,00000	1212,2
(Inf)HiTechExport	1170,6	0,00000	0,00000	158,3
(Inf)Mining	178,40	7,2016	0,00000	5561,1
(Inf)Manufacture	406,79	213,53	0,00000	3839,2
(Inf)Electricity	46,032	26,414	0,00000	293,02
(Inf)Water	11,733	6,3358	0,00000	141,59
(Inf)IndProd	642,95	319,27	0,00000	6511,0
Variable	**SD**	**Variation**	**Asymmetry**	**Excess**
(Inf)FinSupport	0,56783	4,2926	15,482	289,92
(Inf)ShareGDP	0,84231	1,1307	2,5534	7,6470
(Inf)GDP	1002,0	1,1245	2,7303	9,1990
(Inf)Invest	3171,0	10,740	21,849	477,23
(Inf)ExportUSD	2,6096	2,1288	3,1905	11,952
(Inf)ExportRUB	178,09	2,1254	3,1909	11,689
(Inf)HiTechExport	11793,	10,074	11,564	137,50
(Inf)Mining	551,57	3,0918	5,8923	40,747
(Inf)Manufacture	559,47	1,3753	2,5765	8,7801
(Inf)Electricity	53,842	1,1697	1,8840	3,8038
(Inf)Water	18,280	1,5580	3,5829	16,277
(Inf)IndProd	891,32	1,3863	2,6920	9,2487
Variable	**5 per cent**	**95 per cent**	**IQR**	**Miss obs.**
(Inf)FinSupport	0,00000	0,54696	0,099798	0
(Inf)ShareGDP	0,072778	2,6275	0,72345	0
(Inf)GDP	86,355	2826,3	810,48	0
(Inf)Invest	0,00000	543,68	178,32	0
(Inf)ExportUSD	0,00000	6,8256	1,0232	0
(Inf)ExportRUB	0,00000	458,87	72,493	0
(Inf)HiTechExport	0,00000	52,279	0,00000	0
(Inf)Mining	0,00000	814,46	98,018	0
(Inf)Manufacture	0,00000	1408,9	567,06	0
(Inf)Electricity	0,00000	160,21	50,341	0
(Inf)Water	0,00000	42,143	11,998	0
(Inf)IndProd	0,00000	2509,2	818,77	0

Source: calculated by the authors based on Table 3

OLS model, the VIF values calculated from the GLS model remain valid across all quantiles, and re-testing for multicollinearity is unnecessary.

The following characteristics of the model were obtained:

– *Standard error of the regression* = 2.5205, reflecting the average deviation of observed values from the quantile regression line.

– *Quantile dependent variable* (value at the median) = –4.992, representing the central ten-

Table 5

Quantiles of regions by financial export support

Lower quantile group (0.33)	Middle quantile group (0.500)	Upper quantile group (0.667)
Low inclusion can be achieved in regions with very low or no export support	Balanced regions (not flagship, but also not lagging behind), that is in the "golden mean" by the level of inclusion in the export support mechanism	Leading regions by funding volume, that is, with a high level of support, and actively involved in the implementation of priority areas.
Arkhangelsk region, Vladimir region, Vologda region, Jewish Autonomous District, Zabaykalsky Krai, Ivanovo region, Kamchatka Krai, Kostroma region, Kurgan region, Leningrad region, Murmansk region, Nenets Autonomous District, Nizhny Novgorod region, Omsk region, Oryol region, Perm Krai, Pskov region, Republic of Adygea, Republic of Altai, Republic of Buryatia, Republic of Karelia, Republic of Mari El, Republic of Sakha (Yakutia), Republic of North Ossetia-Alania, Chelyabinsk region, Chukotka Autonomous District, Yaroslavl region	Belgorod region, Kabardino-Balkar Republic, Kaluga region, Karachay-Cherkess Republic, Kemerovo region-Kuzbass, Krasnoyarsk Krai, Lipetsk region, Novgorod region, Penza region, Republic of Bashkortostan, Republic of Dagestan, Republic of Kalmykia, Republic of Komi, Republic of Tuva, Saratov region, Sverdlovsk region, Smolensk region, Tambov region, Tver region, Tomsk region, Tula region, Tyumen region, Udmurt Republic, Khanty-Mansi Autonomous District-Yugra, Khabarovsk Krai, Chuvash Republic, Yamalo-Nenets Autonomous District	Altai Krai, Amur region, Astrakhan region, Bryansk region, Volgograd region, Voronezh region, Irkutsk region, Kaliningrad region, Kirov region, Krasnodar Krai, Kursk region, Magadan region, Moscow region, Novosibirsk region, Orenburg region, Primorsky Krai, Republic of Ingushetia, Republic of Mordovia, Republic of Tatarstan, Republic of Khakassia, Rostov region, Ryazan region, Samara region, Sakhalin region, Stavropol Krai, Ulyanovsk region, Chechen Republic

Table 6

Key parameters determining the model's overall relevance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Ln (GDP)	0.212671	0.180534	1.178006	0.2394
Ln (Invest)	–0.181034	0.102332	–1.769089	0.0775**
Ln (ExportUSD)	–0.229135	0.142220	–1.611132	0.1078
Ln (HiTechExport)	0.077512	0.110384	0.702204	0.4829
Ln (Mining)	0.019540	0.145562	0.134236	0.8933
Ln (Water)	–0.212185	0.107194	–1.979462	0.483*
Ln (IndProd)	0.747158	0.135054	5.532301	0.0000***
C	–11.26350	1.961282	–5.742928	0.0000
S. E. of regression	2.520484	S. D. dependent var		4.453135
Quantile dependent var	–4.991969	Objective		913.6172
Sparsity	14.05789	Restr. objective		974.7212
Prob (Quasi-LR stat)	0.000012	Quasi-LR statistic		34.77276

Coefficient significance level at which zero causality test hypothesis is rejected: * — $p < 0{,}1$; ** — $p < 0{,}05$; *** — $p < 0{,}01$.
Source: calculated by the authors based on Table 3

dency of the dependent variable in logarithmic form.

– *Sparsity* = 14.058, which measures the density of data around the selected quantile. Lower values indicate denser observations; this value suggests a moderate level of sparsity, typical for regional economic data.

– *Quasi-LR statistic* = 34.773 with a corresponding p-value (Prob (Quasi-LR stat)) = 0.000012, indicating the overall statistical significance of the model.

Overall, these statistics confirm that the quantile regression model is both statistically significant and valid.

Stage 4. Interpreting the modeling results. The results obtained in the modeling process (Table 4) showed differences in the impact of financial support for regional projects of the "International Cooperation and Export" project on the economic indicators of regions grouped by quantiles (Table 7).

The stability of the parameters of the quintile models was tested by comparing the esti-

Table 7

Results of quantile regression

	Quantile	Coefficient	Std. Error	t-Statistic	Prob.
Ln (GDP)	0.333	0.182687	0.160593	1.137578	0.2559
	0.500	0.212671	0.180534	1.178006	0.2394
	0.667	0.337847	0.072006	4.691938	0.0000***
Ln (Invest)	0.333	–0.301042	0.068321	–4.406260	0.0000***
	0.500	–0.181034	0.102332	–1.769089	0.0775*
	0.667	–0.011938	0.058137	–0.205340	0.8374
Ln (ExportUSD)	0.333	–0.306866	0.061088	–5.023328	0.0000***
	0.500	–0.229135	0.142220	–1.611132	0.1078
	0.667	–0.018723	0.039391	–0.475305	0.6348
Ln (HiTechExport)	0.333	–0.018797	0.035728	–0.526108	0.5991
	0.500	0.077512	0.110384	0.702204	0.4829
	0.667	–0.016326	0.042229	–0.386606	0.6992
Ln (Mining)	0.333	0.060001	0.077908	0.770147	0.4416
	0.500	0.019540	0.145562	0.134236	0.8933
	0.667	–0.096165	0.063111	–1.523750	0.1282
Ln (Water)	0.333	–0.183029	0.128680	–1.422354	0.1556
	0.500	–0.212185	0.107194	–1.979462	0.4832
	0.667	–0.078628	0.055404	–1.419168	0.1565
Ln (IndProd)	0.333	0.684896	0.132087	5.185200	0.0000***
	0.500	0.747158	0.135054	5.532301	0.0000***
	0.667	0.303149	0.097955	3.094771	0.0021***
C	0.333	–15.31106	1.219848	–12.55161	0.0000
	0.500	–11.26350	1.961282	–5.742928	0.0000
	0.667	–7.095004	0.706732	–10.03917	0.0000

The significance level of the coefficients at which the null hypothesis of the test of absence of causality is rejected:
* — $p < 0,1$; ** — $p < 0,05$; *** — $p < 0,01$.
Source: calculated by the authors based on Rosstat data (URL: https://rosstat.gov.ru/, date of access: 23.04.2025) and Table 3

mates of the coefficients between the quintiles τ = 0.33, 0.50 and 0.67. The analysis showed that for the key variables Ln (GDP) and Ln (IndProd) the positive sign of the coefficients is preserved in all quintiles, while for Ln (IndProd) the significance remains at a high level ($p < 0.01$) in all cases, and for Ln (GDP) there is an increase in the effect towards the upper quintile, where the coefficient becomes statistically significant ($p < 0.01$). The variables Ln (Invest) and Ln (ExportUSD) also demonstrate the stability of the sign (negative at all quantiles), however, the magnitude of the coefficients and their significance decrease when moving from the lower to the upper quintile, which may reflect the heterogeneity of the influence of these factors in the distribution of the dependent variable. Thus, the directions of the effects of the key variables are preserved over the entire interval of the distribution, which confirms their stability within the framework of the model specification. The joint significance of the model is confirmed by the Quasi-LR = 34.773 ($p < 0.01$) statistic. Endogeneity was not identified, since funding is determined by federal mechanisms and is exogenous for the regions.

The main results can be interpreted as follows:

– The most significant and stable effects of financial support for exports on regional development indicators were observed in the upper and lower quantile groups, while the middle group showed moderate effects with lower statistical significance.

– The upper quantile group (leading regions with high export support) exhibited a strong and statistically significant positive impact on gross regional product (Ln (GDP), $p < 0.01$), demonstrating the high effectiveness of support in the most developed regions. However, the impact on investment in fixed capital and exports in dollars was not significant, suggesting the influence of additional factors on these indicators.

– The middle quantile group (balanced regions) showed a moderate effect of financial support. In certain regions, such as Belgorod, Sverdlovsk, Tyumen, and the Republic of Bashkortostan, the investment coefficient was negative (Ln (Invest), $p < 0.1$), indicating a weak or partially negative impact. For most other variables in this group, no statistically significant effects were identified.

– The lower quantile group (regions with minimal or no export support) presented the most notable results, showing a contradictory picture: investment in fixed capital and exports (Ln (Invest) and Ln (ExportUSD), $p < 0.01$) were statistically negative. This suggests that current support measures are ineffective or insufficient for these regions, highlighting the need for more careful allocation and management of funds.

Inferences are drawn only from statistically significant coefficients ($p < 0.1$); non-significant variables are excluded, emphasizing the heterogeneity of effects.

Additionally, farm enterprises play an important role in national economic development, but only 2% of peasant (farm) enterprises currently export their products. Greater involvement of farmers in export activities is necessary. Non-financial support institutions, such as demonstration farms in partnership with foreign entities, inter-farm associations and unions, agricultural service centers, and training centers, can enhance the effectiveness of state financial support (Voytyok, Marinchenko, Kuznetsova & Sypok, 2021).

Conclusions

The analysis confirmed the research hypothesis but revealed substantial heterogeneity in the impact of financial support for regional projects under the federal project "International Cooperation and Export" on the socio-economic development of Russian regions. This finding aligns with those of Lederman, Olarreaga, and Payton (2006), who also noted significant differences across regions, levels of development, and types of instruments.

Quantile regression results indicate that only regions receiving the largest volumes of financing exhibit stable positive effects on gross regional product (Ln (GDP), $p < 0.01$) and total industrial production (Ln (IndProd), $p < 0.01$). Effects on other indicators, such as investment and exports in dollars, were not statistically significant, suggesting that a threshold of accumulated financial support may be necessary to produce measurable impacts. In these regions, investment and exports may also reflect a high level of institutional maturity, where additional financing does not immediately stimulate growth.

Conversely, regions in the lower quantiles show statistically significant negative effects on investment and exports. This likely reflects limited institutional capacity, inefficient use of funds, or insufficient infrastructure to convert support into economic growth.

Drawing on these findings, a more flexible and targeted approach to regional export support is advisable:

– Lower-quantile regions: Strengthen institutional support, develop export infrastructure, and stimulate local production chains oriented toward foreign markets.

– Regions with average inclusion: Update goals and financing mechanisms to reflect regional economic structures and the maturity of export competencies.

– Leading regions: Focus on maintaining achievements and promoting more complex forms of export, including high value-added products.

Overall, the future effectiveness of the federal project depends on shifting from uniform support measures to differentiated strategies that align with regional typologies and their responses to export promotion.

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The problem of definition and calculation of the social discount rate for government financing of social projects at the regional level

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ABSTRACT
Relevance. The study's relevance stems from the need to resolve a fundamental contradiction in spatially distributed state financing to prevent inefficient resource allocation and reduce inequality.
Research Objective. The study seeks to examine specialized theories and present a practical approach to estimating the social discount rate for the effective implementation of state social policy and public financing.
Data and Methods. The study relies on mathematical modeling in combination with comparative and statistical analysis of empirical data, while theoretical and interpretive approaches provide the basis for justifying the chosen calculation model (intertemporal preferences) and critically evaluating the results. This integrated approach was used to calculate and assess the social discount rate for 85 Russian regions.
Results. The study highlights the theoretical and heuristic differences among approaches to estimating the social discount rate, explaining why the intertemporal preference method is most appropriate and distinguishing between stationary and non-stationary economic assessments. It provides an objective interpretation of the Ramsey formula parameters, grounded in primary sources and mathematical constructs. Social discount rate values were calculated for Russian regions, revealing spatial variation and a notable discrepancy between the calculated mean rate (4.26 %) and the Central Bank's key rate (18 %).
Conclusions. The proposed methodology for calculating a differentiated social discount rate for each Russian region enables a shift from a uniform approach to a targeted evaluation of social investment effectiveness. In other words, it provides a practical tool to support more informed and equitable budget policy decisions under present economic conditions.

KEYWORDS
spatial economy, social time preferences, elasticity of marginal utility, social financing, opportunity cost of capital, consumption utility, savings, income

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Проблема определения и расчёта социальной ставки дисконтирования для государственного финансирования социальных проектов на региональном уровне

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АННОТАЦИЯ
Актуальность. Актуальность исследования обусловлена насущной необходимостью решения фундаментального противоречия в государственном финансировании проектов по пространственному признаку, во избежание неэффективного распределения ресурсов и минимизации неравенства.
Цель исследования. Рассмотреть специальные теории и представить наглядную практику оценки социальной ставки дисконтирования для це-

КЛЮЧЕВЫЕ СЛОВА
пространственная экономика, социальные межвременные предпочтения, эластичность предельной полезности,

лей эффективной реализации социальной политики государства и государственного финансирования.
Данные и методы. В исследовании применен метод математического моделирования в сочетании со сравнительным и статистическим анализом эмпирических данных. Теоретические и интерпретационные методы служат основой для обоснования выбранной модели расчёта (межвременные предпочтения) и критического осмысления результатов. Проведён расчёт и оценка социальной ставки дисконтирования по 85 регионам России.
Результаты. Представлен теоретико-эвристическое различие подходов к оценке социальной ставке дисконтирования. Объяснено, почему приоритетным подходом к оценке социальной ставки дисконтирования является подход межвременных предпочтений, а также разница между стационарной и нестационарной экономической оценкой. Продемонстрирована объективная, основанная на первоисточниках и математических конструктивных выражениях интерпретация показателей формулы Рамсея. Произведен расчет социальной ставки дисконтирования по регионам России. Объяснена вариация значений социальной ставки дисконтирования по пространственному признаку. Выявлено расхождение между рассчитанной средней ставкой дисконтирования (4,26 %) и ключевой ставкой ЦБ (18 %).
Выводы. Расчет дифференцированной социальной ставки дисконтирования для каждого региона России позволяет перейти от унифицированного подхода к адресному оцениванию эффективности социальных инвестиций, то есть представляет практический инструмент для повышения обоснованности и справедливости бюджетной политики в текущих экономических условиях хозяйствования.

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区域层面社会项目国家融资的社会贴现率的确定和计算问题

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摘要
现实性：本研究的现实意义在于，亟需解决基于地域特征的国家项目融资中存在的根本性矛盾，以避免资源配置失效并最大限度地减少不平等现象。
研究目标：探讨特殊理论，并提出评估社会贴现率的明确方法，以便有效实施国家社会政策和公共融资。
数据与方法：本研究采用数学建模方法，并结合实证数据的比较和统计分析。理论和解释方法为所选计算模型（跨期偏好）的论证和结果的批判性评估奠定了基础。本研究计算并评估了俄罗斯85个地区的社会贴现率。
研究结果：本文阐述了社会贴现率评估方法的理论与启发式差异。文中解释了为何跨期偏好法应作为评估社会贴现率的优先方法，并区分了稳态与非稳态经济评估之间的区别。同时，基于原始文献与数学推导表达式，文章对拉姆齐公式的指标进行了客观阐释。研究计算了俄罗斯各地区的社会贴现率，并解释了社会贴现率在空间分布上的差异。结果发现，计算得出的平均贴现率（4.26%）与中央银行的基准利率（18%）之间存在显著偏差。
结论：针对俄罗斯各区域计算差异化的社会贴现率，有助于从统一方法转向精准评估社会投资效益，从而为在当前经济运营条件下提升预算政策的合理性与公平性提供实用工具。

关键词
空间经济学、社会时间偏好、边际效用弹性、社会融资、资本替代成本、消费效用、储蓄、收入

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Introduction

The social discount rate (SDR) has remained a controversial indicator since its inception, both in terms of value interpretation and assessment. The challenge of evaluating social discount rates is especially relevant today, as the effectiveness of public funding for social projects has become a critical factor for the sustainable development of regional and national economies. Standard discount rate practices do not reflect the substantial differences in the socioeconomic conditions of regional development, resulting in suboptimal and inefficient resource allocation and contributing to greater spatial inequality.

For the first time in complete form and with a specific mathematical description, the social discount rate appeared in Frank Plumpton Ramsey's well-known 1928 work *A Mathematical Theory of Saving*. From the moment this piece was published, which, as will later be shown, serves as a factual supplement to and a logical continuation of Evgenii Slutsky's (also known as Eugene, Eugen, or Yevgeni Slutsky) 1915 work *On the Theory of the Budget of the Consumer* (Slutsky, 2010), there has consistently been a real difficulty in interpreting and evaluating this indicator. As already noted, there are numerous interpretations of both the calculation formula and the evaluation of the SDR. There are two reasons for this:

The first reason is the actual complexity of the mathematical apparatus in the work, primarily in Slutsky's contributions that informed Ramsey's assessments in 1928. In 1963, V.A. Volkonsky and A.A. Konyus criticized Slutsky's article for presenting the main calculations in a cumbersome and unclear manner (Slutsky, 2016). This criticism, however, is not entirely justified. It is true that Ramsey presented his calculations in a more elegant and accessible form. However, Slutsky's 1915 work *On the Theory of the Budget of the Consumer* serves as a factual supplement to his earlier piece, one of the foundational works in the entire field of macroeconomics, *The Theory of Marginal Utility*, published in 1910. In that work, Slutsky developed argumentation and proofs while frequently omitting detailed explanations. This approach was understandable given the nearly 400-page volume of the text and the assumption that a thoughtful reader would be capable of analyzing causal relationships as well as performing logical and heuristic analysis. As subsequent development of the subject field demonstrated, this assumption proved correct, which is confirmed by Ramsey's 1928 work. The same applies to J.R. Hicks's 1939 book *Value and Capital*, where he discusses Slutsky's 1915 work across three chapters, and indeed the entire book reflects theory belonging to the subject field introduced by Slutsky: "The present work represents the first systematic investigation of the 'territory' first opened by Slutsky" (Hicks, 1988). Even so, the complexity of the mathematical apparatus continues to make it difficult to compare this theory with real-world phenomena, especially for economists with a predominantly humanitarian orientation.

The second reason arises directly from the first. The complexity of the mathematical expressions in Ramsey's work prompted numerous studies that offered varying interpretations, some of which diverge significantly from the original meaning of his contribution.

The objective of the study is to examine specialized theories and present a demonstrable practice for estimating the social discount rate for the effective implementation of state social policy and public financing. To accomplish this, the study pursues the following tasks:

1. To conduct a comparative analysis of theoretical approaches to determining the social discount rate and, on objective grounds, assign priority to the intertemporal preference (STP) approach;
2. To examine the methodological aspects of economic assessment related to stationary and non-stationary models and provide a clear interpretation of the Ramsey formula parameters;
3. To implement a practical procedure for calculating social discount rate values for Russian regions;
4. To analyze and explain the spatial variation in the calculated values of social discount rates.

All stated tasks were successfully completed. The first task involved a theoretical and heuristic analysis, confirming the suitability of the STP approach. The second task established a methodological foundation and an applied framework for calculating the social discount rate. Completion of the third task produced an empirical set of social discount rate values for each oblast. Finally, the fourth task revealed a key pattern: significant spatial variation in the social discount rate, reflecting differences in the socio-economic development of Russia's regions.

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Theoretical Framework

The discussion concerning the definition of the social discount rate begins with the differences in how it is understood. While standard evaluation practice typically distinguishes between two approaches, a closer historical examination reveals three:

1. *The social time preferences approach (STP).* This direction includes the contributions of E. E. Slutsky, F. Ramsey, A. C. Pigou, J. R. Hicks, J. von Neumann, O. Morgenstern, J. Broome, W. Baumol, N. Stern, M. F. G. Scott, M. Spackman, D. Ackland, A. Matthew, and others.

2. *The social opportunity cost approach (SOC).* Related terms include social opportunity cost, social alternative cost, and the marginal productivity of capital (SMP). This approach is associated with J. Hirshleifer, K. J. Arrow, R. C. Lind, D. W. Milliman, R. H. Strotz, J. A. Stockfisch, M. Eden, H. Gravelle, T. Sterner, and others.

3. The third approach combines political and economic judgments, or the views of society as a whole, to define the social discount rate. Its main representatives are S. A. Marglin and A. K. Sen, but it has not gained wide adoption.

The fundamental methodological problem in all three approaches lies in the assumption that government financing of public and social activities arises from insufficient development of markets and private capital. Practically all foundational work in this subject field was written under the influence of economic liberalism, Friedman's monetarism, and related ideas. The dominance of concepts associated with J. Locke (1632–1704), A. Smith (1723–1790), J.-B. Say[1] (1767–1832), and others remains characteristic of modern Western economic thought. However, it was during the early and mid-twentieth century that these ideas reached their peak.

For example, Hollis B. Chenery in his 1953 work[2] observes "the gap between theory and practice in the analysis of investments in underdeveloped regions". O. Eckstein's 1957 study, authored by one of the leading theorists of the STP approach, states that "criteria are necessary for project selection, considering certain specific market imperfections characteristic of underdeveloped countries". The central idea behind applying the SDR was its intended use for financing projects in "underdeveloped" countries, in line with the prevailing belief that the market serves as the primary solution to economic problems.

A notable exception is the 1970 work by K. J. Arrow and R. C. Lind, *Uncertainty and the Evaluation of Public Investment Decisions*. This study is one of the few that, following the contributions of Slutsky and Ramsey, can also be regarded as genuinely fundamental in this subject area.

The Social Time Preferences Approach

The essence of this approach lies in the idea that market or commercial interest rates reflect private interests and individual preferences regarding income, risk-taking, and related factors. In contrast, in society or a social group, collective preferences in consumption, income distribution, and similar matters become important. As a result, individual preferences expressed through market or commercial interest rates may conflict with collective preferences concerning consumption, income distribution, and risk-taking at different points in time. This distinction becomes especially important in government policy-making for financing public and social projects, activities in the budget sector, and state social programs. A practical example is the system of national projects in Russia, which are financed at preferential rates that differ from commercial or market rates.

There is a deeper issue concerning temporal preference. The commercial sector seeks to obtain benefits as quickly as possible, while the state is expected to think long-term and consider the interests of future generations. Given the finite nature of natural resources, an intertemporal consumption problem emerges: whether to consume more in the current generation or to restrain current consumption in light of future needs. Until the 1970s, the prevailing view held that the government financing rate should include a premium over the market interest rate. K. J. Arrow and R. C. Lind, particularly Lind, challenged this position by raising the issue of the fundamental distinction between market or commercial interest rates and social interest rates. These authors can be regarded as the principal theorists of the social opportunity cost (SOC) approach.

[1] Say's famous law states that supply creates its own demand, meaning that equilibrium is achieved automatically, without government intervention.

[2] Chenery introduced the indicator (within the SOC approach) of marginal productivity of capital (SMP).

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The Approach of Social Opportunity Cost (SOC)

According to this approach, a single generation can use available resources in different ways and with varying levels of benefit. The social discount rate therefore reflects the alternative uses of resources in government financing and expresses the effectiveness of those alternatives in generating public benefits.

The 1970 article by K. J. Arrow and R. C. Lind, *Uncertainty and the Evaluation of Public Investment Decisions*, became the starting point for the development of the entire SOC framework. In this work, they argue that it is necessary to distinguish not only between the benefits and costs accruing to society and those accruing to individuals, but also between individuals who experience net losses and those who experience net gains. They further argue that expected benefits should be discounted at a rate higher than the certainty rate, and costs at a rate lower than the certainty rate, even when social totals are already determined (Arrow, Lind, 1970).

At present, when the aim is to calculate the SDR with a level of credibility comparable to its explanatory value, the first approach is typically used, as it rests on a well-developed theoretical foundation and, importantly, provides a clearly articulated methodology for calculation and assessment (V. Pareto, E. E. Slutsky, F. Ramsey, J. von Neumann, O. Morgenstern, N. Stern, M. F. G. Scott, M. Spackman, D. Pearce, D. Ulph, and others). In the second approach, the theory is articulated, yet mathematical expressions with genuine explanatory power are lacking.

It should also be noted that the publications by K. J. Arrow and R. C. Lind sparked active debate and substantial criticism from supporters of economic liberalism. In fact, the subsequent influence of their work can be attributed largely to the considerable authority of these two scholars, particularly Arrow. Nevertheless, the theory of the second approach is formulated in a sufficiently complete manner, and it led to the formulation of the well-known Arrow–Lind principle (Arrow–Lind theorem): the social cost of risk tends toward zero as the population size approaches infinity (Arrow, Lind, 1970).

Arrow and Lind present equation number 23 on page 372:

$$\lim_{n\to\infty} nk(n) = 0,$$

and explain that as the number of taxpayers increases, the total cost required to cover risks approaches zero. In other words, the individual risks borne by taxpayers in connection with government investments are distributed across a very large population. Since the share of each taxpayer in the total population is extremely small ($n \to \infty$), the individual cost of covering individual risk tends toward zero as the number of participants rises, which corresponds to the scale of a national government project. This concerns primarily the individual risks associated with instability of social payments (social welfare, salaries of public employees, and other benefits), fluctuations in well-being due to reductions in government financing (social subsidies, grants, subventions), and unsystematic risks specific to a national project. The Arrow–Lind principle later found applications beyond this subject field.

The Approach to Defining the Social Discount Rate Through Consensus of Political and Economic Assessments (or of Society as a Whole)

The approach formulates a theoretical framework, but unlike the second approach, where at least some calculation procedures exist, this one offers none. Its core idea is that the social discount rate should reflect a rate emerging from the consensus of politicians, economists, and society as a whole. However, the heavy reliance on theory and the complete absence of applied assessment methods have prevented this approach from moving beyond a conceptual level.

S. A. Marglin illustrates one of the key difficulties, noting that the marginal time preference of individuals in the context of collective decisions on savings and consumption can differ markedly from their marginal time preference when they act independently (Marglin, 1968). The challenge here is that decisions about government financing are collective decisions made by those entrusted with state authority. Such decisions are not equivalent to collective decisions taken within a particular group of consumers. Marglin also observes that the rate of interest formed in an atomistic competitive market does not automatically acquire normative significance for planning collective investments (Marglin, 1963). Another problematic assumption lies in treating government financing of public and social sectors as identical to collective investment. Even within the logic of radical economic liberalism, such an identity appears doubtful.

To summarize, given the nature of the required assessments and the availability of established methods for practical evaluation, the most workable option is the social time preference (STP) approach. This view is widely shared; for example, M. Spackman (2004) notes that the standard STP rate is generally better suited for comparing government expenditures across time. In the practical section of this article, we likewise rely on the social time preference approach.

Method and Data

The Formula for Calculating SDR Within the STP Approach

The formula for calculating SDR, which is considered the main one (the so-called Ramsey formula or equation), usually looks like the following way (Ramsey, 1928):

$$s = \rho + \mu \cdot g. \quad (1)$$

Where *s* (STPR) is the social rate of intertemporal preferences (social discount rate, SDR), percent; ρ is the rate (norm) of temporal preference, percent; μ is the elasticity of marginal utility with respect to consumption, percent; *g* is the rate of growth of consumption per capita, percent.

Formula (1) represents a simplified special case. As noted earlier, Khairullin et al. (2021) argue that treating the parameters ρ and μ as constant is untenable in light of the empirical and theoretical evidence, a point that stems directly from Ramsey's own work. Despite this, the simplified formula continues to be widely used in applied evaluations.

When SDR is calculated dynamically, the formula's parameters must be understood as time-dependent. Moore and Vining (2018) acknowledge that ρ, *g*, and η may vary over time, yet they begin their analysis by treating them as constant. In the next section, we show how strongly this simplifying assumption can distort actual calculations.

A more general expression — one that better reflects real conditions — takes the following form (Khairullin et al., 2021; Khairullin, 2012):

$$STPR_t = \rho_t + t\Delta\rho_t + \mu_t g + \ln(C_t)\Delta\mu_t. \quad (2)$$

If consumption growth is treated as conditionally constant and the SDR is evaluated for a single time interval, then Formula (1) becomes equivalent to real conditions.

Stationary and Non-Stationary Model for Assessing SDR

The most important methodological issue in economic assessment lies in identifying the axiomatic assumptions that underlie any evaluation of economic events. This is crucial because many researchers, without reflecting on the nature of the initial model or assessment approach, such as Ramsey's model, apply it directly to specific projects. If the assessment model does not correspond to the actual conditions of project implementation, for example, if the model assumes stationarity while the project operates under non-stationary conditions, errors arise that can severely distort the empirical evaluation of the project's effectiveness.

But what do stationarity and non-stationarity mean? In economics, and more broadly in the analysis of time series, stationary and non-stationary models differ in the statistical properties of their indicators, specifically how the mean, variance, and covariance of a time series change over time. A model or time series is considered stationary if these statistical properties, including the mathematical expectation, variance, and covariance, do not depend on time. Importantly, this does not mean that the values are empirically constant; rather, they are conditionally constant within the model.

To make this clearer, let's consider a simple analogy. Imagine a person who visits a doctor once a year for a check-up. The examination itself involves certain controlled conditions, such as fasting before a blood test, and the person is in a rested state during the visit. The doctor's conclusions are valid at that specific moment, reflecting the accumulated "wear" on the body, but they do not account for future changes in lifestyle, exposure to new external factors, or shifts in emotional state. In this analogy, the doctor's assessment is stationary. If nothing significant changes, the conclusions and prognosis remain valid.

The problem, however, is that the world is not stationary. Both the environment and the individual's circumstances are constantly changing. To address this in practice, two general strategies are possible. First, the frequency of assessments can be increased, for example, from yearly to monthly. Second, conditions can be created to minimize the influence of external changes, such as through isolation. While a rough analogy, this example illustrates the fundamental distinction

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between stationary and non-stationary assessments and why recognizing it is critical in economic evaluation.

Let us return to economics. The overwhelming majority of existing economic and econometric models are stationary, which represents a significant empirical challenge for the discipline. As early as 1944, John von Neumann noted that the empirical foundation of economic science was largely unsatisfactory, arguing that mathematical interpretations of economic theory often provide assertions rather than proofs, offering little more than verbal reasoning (J. von Neumann, O. Morgenstern, 2013).

Ramsey's model (Formula 1) is stationary. F. P. Ramsey himself emphasized the need for simplifying assumptions, stating that society must be assumed to exist forever without changes in population, capacity for enjoyment, or aversion to labor, that enjoyments and sacrifices at different times are independent and additive, and that no new inventions or organizational improvements occur beyond those resulting from the accumulation of wealth (Ramsey, 1928).

E. E. Slutsky, who formalized the methodology for the entire subject field, distinguished between instantaneous and prolonged stationary systems, effectively creating the theory of prolonged systems. He explained that a stationary system can be defined as one in which activities repeat periodically at known intervals. While assuming absolute stationarity is a necessary theoretical abstraction, studying a prolonged stationary system is more complex than an instantaneous one. Observing actual behavior over consecutive moments shows that constancy of utility functions cannot be assumed, highlighting the limitations of instantaneous models (Slutsky, 2010).

This distinction has two important implications. First, Ramsey's model (Formula 1) represents an instantaneous stationary system, whereas Formula 2 corresponds to a prolonged stationary system, derived from Slutsky's demonstration that the equilibrium conditions of a prolonged system can be reduced to those of an instantaneous system. Second, Ramsey's model assumes the calculation of the real discount rate, a condition inherent to the model. However, if government investments are implemented under conditions of prolonged non-stationarity, the social discount rate should be recalculated for each project as frequently as possible.

In accordance with the Order of the Ministry of Economic Development of Russia No. 794 of December 24, 2021, when determining the discount rate, it is taken equal to the average for the preceding half-year. Therefore, the values of the social discount rate presented in Table 1 reflect real interest rates calculated for a half-year period, in line with Ramsey's instantaneous stationary model, Slutsky's methodological provisions, and Order No. 794 of the Russian Ministry of Economic Development.

Concerning the Problem of Interpreting the Calculation and Values of the ρ Indicator

The rate (or norm) of temporal preference, ρ, is a controversial indicator whose value is determined heuristically. In general, it reflects the subjective valuation of consumption within a society at a given point in time. If the current generation adheres to the principle that the next generation should consume at the same level as the present one, then $\rho = 0$. This zero value corresponds to the concept of impartiality, succinctly formulated by D. Broome: "Each reckons only with himself and no more than with himself" (Broome, 1992).

When ρ is greater than zero, it implies that future consumption is valued less than current consumption. The larger the value of ρ, the more weight is placed on present consumption relative to future benefits. Conversely, a negative ρ indicates that future consumption is considered more important than current consumption.

Concerning the Problem of Interpreting the Calculation and Values of the μ Indicator

The μ indicator is a key component in the SDR calculation formula. Its interpretation has been complicated by the large number of secondary publications discussing F. P. Ramsey's 1928 work, which itself represents a concise presentation and interpretation of E. E. Slutsky's 1915 research. The elasticity of marginal utility, as measured by the μ indicator, has been expressed through multiple calculation formulas and interpretations, some of which provide only a limited reflection of economic reality. In the following, we clarify the content and the step-by-step procedure for calculating this indicator, drawing on the foundational works of E. E. Slutsky and F. P. Ramsey.

In Slutsky's 1910 work *The Theory of Marginal Utility*, he writes: "For saturating goods (Fig. 3),

$U'' \equiv \frac{d^2U}{dX^2} < 0$), and for non-saturating goods (Fig. 4) — $U'' \equiv \frac{d^2U}{dX^2} > 0$" (Slutsky, 2010), and "The limit of this ratio is evidently the derivative of specific utility, i. e., the second derivative of utility. We shall call this derivative the enjoyment of a given good… A concept analogous to acceleration and well known to mathematical economists. Large popularity it does not enjoy because the mathematical symbol $\frac{d^2U}{dX^2}$ is incomprehensible to many, and there is no special term for it. A case justifying, as it seems to me, even such an ugly neologism as 'enjoyment'" (Slutsky, 2010). Slutsky, using the phrase "incomprehensible to many," was optimistic, not anticipating that a century later, in Russian practice, interpretations would emerge that are not only difficult to understand but also bear little relation to reality. Therefore, we will attempt to explain the content of the μ indicator as simply as possible, using analogies from a high school physics course. To aid this explanation, let us turn to Figure 1.

Figure 1 presents two graphs: the marginal utility graph (red and concave) and the total utility graph (blue and convex). Consider two cases:

1) An airplane taking off (represented by the total utility graph);

2) An airplane landing (represented by the marginal utility graph).

What is the difference between these cases? In the first case, as the airplane takes off, it gains speed and acceleration — denoted in the figure by *a* — which is positive, though it can later become negative because, during takeoff, acceleration and speed are higher than during gliding. In the second case, as the airplane lands, its acceleration becomes negative (in Figure 1: $a < 0$).

This is precisely what Slutsky describes. He also explained the negative value of the first derivative (i. e., the speed of consumption), but we will not consider this here to avoid unnecessary complication. Ramsey summarizes more concisely: "This equation means that $u(x)$, the marginal utility of consumption, falls at a rate proportional to the rate of interest. Consequently, x is continually increasing until either df/dc or $u(x)$ disappears, and in this case it is easy to see that bliss is achieved" (Ramsey, 1928).

However, the phrase "incomprehensible to many" eventually led, for example, to the following formulae proposed by D. Pearce and D. Ulph in 1996: "$U''(C) = \frac{d^2U}{dX^2} < 0$. The elasticity of marginal utility of consumption μ measures the percentage by which marginal utility falls with each percentage increase in consumption. Formally: $\mu = \frac{CU''(C)}{-U'(C)}$" (Pearce et al. 1995).

M. Scasny and M. Opatrny (2022) defined it as:

$$\mu = -\frac{CU''(C)}{U'(C)} > 0,$$

where C denotes consumption, and μ — the curvature of utility, $U(C)$.

Given this definition, μ can be interpreted as a measure of Arrow-Pratt relative risk aversion (Scasny, Opatrny, 2022).

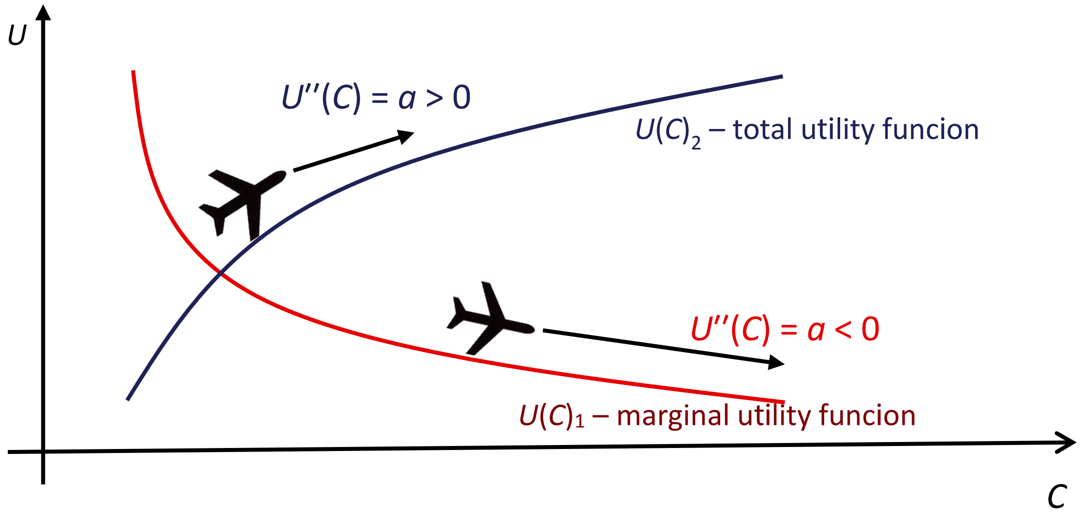

Figure 1. *View of marginal and total utility functions*

Source: developed by the authors

The problem is that in Pearce and Ulph's formulation, a minus appears in the denominator of the fraction, which can mislead many researchers. In Scasny and Opatrny's version, a minus is placed in front of the fraction. Mathematically, this is equivalent to the minus in the denominator, but heuristically it can also cause confusion. Furthermore, labeling μ as a measure of Arrow-Pratt relative risk aversion can further distort understanding.

To clarify what the researchers were attempting to convey, let us return to Figure 1. The marginal utility graph, representing an airplane landing, slows down, and acceleration becomes negative. Consequently, the expression in formula (1): $\mu \cdot g < 0$ also becomes negative, as does the entire social discount rate. To avoid this, researchers introduce a minus in front of the fraction. In Pearce and Ulph's formulation, the minus in the denominator is mathematically correct, so that minus × minus = plus, ensuring that the social discount rate becomes positive.

The problem is that such calculations and reasoning are not immediately obvious to outside researchers. Returning to the primary source, Slutsky explains: "…at the point of saturation $dU/dX = 0$, and when satiation has occurred $dU/dX < 0$ …" (Slutsky, 2010).

Referring again to Figure 1, when an airplane lands, it is usually not acceleration that becomes negative, but speed — precisely what Slutsky highlighted. To clarify a methodological point, which is inherently complex, we present it as simply as possible: if position is described by function $U(C)$, then speed $V(U(C))$ — is the first derivative of $U(C)$ with respect to consumption: $V(U(C)) = dU(C)/dC$, then acceleration $a(U(C))$ — is the second derivative of $U(C)$ with respect to consumption: $a(U(C)) = d^2U(C)/dC$ or the first derivative of speed: $a(U(C)) = dV(C)/dC$.

For both speed and acceleration to be negative simultaneously, the function $U(C)$ must be decreasing (motion in the negative direction), and the rate of this decrease must be increasing (acceleration in the negative direction). In this case, the ratio $(-d^2U(C)/dC^2)/(-dU(C)/dC$ represents the rate of change of speed along the C-axis (or the projection of the derivative of consumption speed onto the C-axis), and similarly along the U-axis. This ratio is not a standard physical quantity with a commonly accepted name, but it describes how the speed changes along a given coordinate.

We believe that for researchers with primarily humanitarian backgrounds, such reasoning may not be entirely intuitive. Therefore, the key takeaway is simple: no minus signs should be added in front of the fraction. The universal formula for calculating the indicator μ is as follows (Scott, 1989):

$$\mu = \frac{C \cdot U''(C)}{U'(C)}, \tag{3}$$

where $U''(C)$ shows how marginal utility changes as consumption increases. Since $U''(C) < 0$, marginal utility decreases — hence the term diminishing marginal utility. That is, the slope of the tangent declines as C increases, meaning the curve becomes less steep (concave downward), reflecting a slowing increase in utility from additional consumption; $C \cdot U''(C)$ reflects the curvature of the marginal utility graph (Figure 1), weighted by the current level of consumption, i. e., a "weighted" curvature relative to the consumption level; $U'(C)$ represents the slope of the tangent to the marginal utility curve, i. e., the marginal utility itself — the negative rate of change of total utility as consumption changes.

The $(C \cdot U''(C))/U'(C)$ ratio indicates how the rate of change of the curvature of the function $U(C)$, relative to current consumption, correlates with the slope of the tangent itself (marginal utility).

Due to the complexity and the variety of interpretations of this indicator, its calculation formulas can differ significantly. We will not review all existing formulas, but it is important to note that the "classical" formula is considered to be the one proposed by *N*. Stern in 1977 (Robinson, 1990) and later modified by M. F. G. Scott in 1989, as shown in Formula (4):

$$\mu = \frac{r - \rho}{\frac{S}{Y} \cdot (r - \gamma) + \gamma}, \tag{4}$$

where ρ is the rate (norm) of temporal preference, share; r is the rate of return on investments, share; S/Y is the ratio of savings sums to income sum, share; γ is the expected rate of growth of income (wages), share.

Practice of Calculating the SDR

The following notes provide details on the calculation:

1. The source data and the calculation itself are submitted to the editorial office along with the manuscript.

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2. All values in Table 1 are taken from official sources of statistical data: Rosstat, Central Bank, RIA Rating.

3. The indicator ρ is taken as equal to zero (explained above).

4. The indicator g — the rate of growth of consumption per capita — is taken from the *Balance of Monetary Income, Expenditure, and Savings of the Population*, Line IV (sum of lines I + II + III), column Rate, % of previous year: 13.2 % (0.132).[3]

5. The r indicator represents the rate of return on investments. It is determined heuristically based on Central Bank[4] data as an average of coupon rates and yield to maturity, taken here as 10 % (0.1). It should be noted that this value is determined exclusively heuristically. One could choose a slightly higher value, for example, 12 % or 14 %. The authors selected the lower boundary because financial risks and instability in the economic and geopolitical environment increased by late 2024 and early 2025 (e. g., U. S. presidential elections). This choice also reflects consideration of potential risks that could reduce expected investment returns.

6. The indicator γ — the expected rate of income growth (wages) — is taken as 5.5 % (0.055) as of October 1, 2024. The wage indexation rate in 2024 was 5.1 %, in accordance with the Decree of the Government of the Russian Federation, No. 2189-r, dated August 15, 2024[5].

Results

Based on the obtained SDR values, several clarifications are necessary. The SDR values — particularly for the Russian Federation as a whole (4.26 %)— contradict the Central Bank of Russia refinancing rate (CRR) of 18 % as of July 2024. In principle, the SDR should be lower than the CRR, but in this case, the discrepancy for the Russian Federation (first row of the calculation) amounts to 4.23 times. This raises a practical contradiction: government financing uses the CRR as a base interest rate, including for lending to the public and social sectors, so a four-fold difference is notable.

Nevertheless, this discrepancy can be explained. The Central Bank's inflation targeting via an increased CRR is primarily aimed at countering inflationary pressures from sanctions and distortions in the USD/RUB exchange rate. These are examples of so-called externalities — a concept introduced by A. C. Pigou: "…implicit real factors acting 'from outside' on industries in which resources are invested" (Pigou, 1985). Since early 2023, the CRR has effectively been used to counter negative external effects rather than internal ones, creating an instrumental contradiction with the SDR, which is designed to address internal effects. Therefore, considering the change in the essential and instrumental bases of both CRR and SDR since 2023, the significant discrepancy in their values is understandable.

It should be noted that SDR values for the North Caucasus Federal District closely match the Central Bank's CRR. Some regions are highly subsidized and thus operate largely due to external effects relative to the region itself. In such cases, the SDR accurately reflects the excess of subsidy amounts compared with their average levels for the Russian Federation.

Applied Purpose of the SDR

The social discount rate has critical applied significance. The practice of applying the SDR can be broadly divided into two areas of social and public policy:

1) Interest rates for government financing of public and social projects. This is most clearly seen in preferential mortgage lending as part of government programs and national projects.

2) Discounting public and social benefits. Within social and public projects, benefits are discounted using the SDR; accordingly, the higher the SDR, the higher the requirements for current consumption of social and public goods.

Discussion

The philosophical dimensions of ethics and the choice of a consumption ideology are most fully represented, at present, by J. C. Robinson, who in 1990 published *Philosophical Origins of*

[3] BALANCE SHEET OF CASH INCOME, EXPENDITURE, AND SAVINGS OF THE POPULATION for 2023. -https://rosstat.gov.ru/folder/13397# (25.09.2025)

[4] ОФЗ-26222-ПД. Par value: 1,000 rubles, maturity date: October 16, 2024, rate: 7.1 % per annum, yield: 12.04 %.

ОФЗ 26227-ПД. Par value: 1,000 rubles, maturity date: July 17, 2024, coupon rate: 7.4 % per annum, yield to maturity: 12.35 %.

ОФЗ 26234-ПД. Par value: 1,000 rubles, maturity date: July 16, 2025, coupon rate: 4.5 % per annum, yield to maturity: 12.52 %.

[5] Order of the Government of the Russian Federation dated 15.08.2024 No. 2189-r Retrieved from: http://publication.pravo.gov.ru/document/0001202408160001?ysclid=m6euvapxb9138847170 (25.09.2025)

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Table 1

Table 1 Calculation of SSD indicators

Country/Regions	Income (Y)	Saving (S)	S/Y	μ (Скотт, 1989) ρ = 0 γ = 0,055	SSD in shares	SSD in %
Russian Federation	61,20	346,60	5,66	0,32	0,04	4,26
Central Federal District (median value of the SDD is 4.93 %)						
Belgorod Region	51,80	248,40	4,80	0,37	0,05	4,87
Bryansk Region	48,80	181,10	3,71	0,45	0,06	5,95
Vladimir Region	42,80	244,90	5,72	0,32	0,04	4,22
Voronezh Region	51,40	267,30	5,20	0,35	0,05	4,57
Ivanovo Region	43,80	230,90	5,27	0,34	0,05	4,52
Kaluga Region	46,70	235,80	5,05	0,35	0,05	4,68
Kostroma Region	46,40	223,90	4,83	0,37	0,05	4,85
Kursk Region	49,70	201,50	4,05	0,42	0,06	5,56
Lipetsk Region	52,00	205,50	3,95	0,43	0,06	5,67
Moscow Region	75,30	320,00	4,25	0,41	0,05	5,36
Oryol Region	58,80	209,60	3,56	0,46	0,06	6,13
Ryazan Region	48,50	257,80	5,32	0,34	0,04	4,49
Smolensk Region	48,60	208,00	4,28	0,40	0,05	5,33
Tambov Region	52,20	170,20	3,26	0,50	0,07	6,54
Tver Region	49,80	222,80	4,47	0,39	0,05	5,15
Tula Region	50,40	235,30	4,67	0,38	0,05	4,98
Yaroslavl Region	53,50	295,30	5,52	0,33	0,04	4,35
Moscow	136,60	1351,40	9,89	0,20	0,03	2,64
Northwestern Federal District (median value of the average daily income is 4.74 %)						
Republic of Karelia	68,10	277,90	4,08	0,42	0,06	5,53
Komi Republic	55,40	284,60	5,14	0,35	0,05	4,61
Arkhangelsk Region	61,30	298,00	4,86	0,37	0,05	4,82
Nenets Autonomous Region	171,80	648,10	3,77	0,44	0,06	5,87
Arkhangelsk Region (excluding the autonomous district)	56,40	298,00	5,28	0,34	0,05	4,51
Vologda Region	46,60	236,50	5,08	0,35	0,05	4,66
Kaliningrad Region	47,10	318,90	6,77	0,28	0,04	3,67
Leningrad Region	52,30	146,60	2,80	0,55	0,07	7,29
Murmansk Region	83,80	429,70	5,13	0,35	0,05	4,62
Novgorod Region	43,10	195,70	4,54	0,39	0,05	5,09
Pskov Region	46,70	193,80	4,15	0,41	0,05	5,46
Saint Petersburg	85,20	679,40	7,97	0,24	0,03	3,19
Southern Federal District (median value of the average daily income is 6.59 %)						
Republic of Adygea	57,70	95,00	1,65	0,77	0,10	10,23
Republic of Kalmykia	35,40	86,70	2,45	0,61	0,08	7,99
Republic of Crimea	42,10	119,20	2,83	0,55	0,07	7,24
Krasnodar Region	62,40	260,80	4,18	0,41	0,05	5,43
Astrakhan Region	41,00	167,50	4,09	0,42	0,06	5,53
Volgograd Region	41,80	185,20	4,43	0,39	0,05	5,19
Rostov Region	65,90	244,80	3,71	0,45	0,06	5,94
Sevastopol	48,40	121,90	2,52	0,59	0,08	7,84

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Country/Regions	Income (Y)	Saving (S)	S/Y	μ (Скотт, 1989) ρ = 0 γ = 0,055	SSD in shares	SSD in %
North Caucasus Federal District (median SDI value — 11.07 %)						
Republic of Dagestan	34,30	45,00	1,31	0,88	0,12	11,58
Republic of Ingushetia	25,00	22,10	0,88	1,06	0,14	13,93
Kabardino-Balkarian Republic	45,70	65,20	1,43	0,84	0,11	11,07
Karachay-Cherkess Republic	31,20	59,90	1,92	0,71	0,09	9,34
Republic of North Ossetia — Alania	39,60	119,90	3,03	0,52	0,07	6,90
Chechen Republic	42,90	27,60	0,64	1,19	0,16	15,72
Stavropol Region	38,10	160,90	4,22	0,41	0,05	5,39
Volga Federal District (median value of SDD — 4.88 %)						
Republic of Bashkortostan	44,60	172,20	3,86	0,44	0,06	5,77
Republic of Mari El	35,20	171,80	4,88	0,36	0,05	4,81
Republic of Mordovia	36,90	156,20	4,23	0,41	0,05	5,38
Republic of Tatarstan	56,80	260,70	4,59	0,38	0,05	5,05
Udmurt Republic	46,30	205,20	4,43	0,39	0,05	5,19
Chuvash Republic	38,30	231,70	6,05	0,31	0,04	4,03
Perm Region	49,00	232,20	4,74	0,37	0,05	4,92
Kirov Region	43,10	206,20	4,78	0,37	0,05	4,88
Nizhny Novgorod Region	60,00	297,60	4,96	0,36	0,05	4,74
Orenburg Region	40,30	178,70	4,43	0,39	0,05	5,19
Penza Region	43,50	209,50	4,82	0,37	0,05	4,86
Samara Region	49,60	293,60	5,92	0,31	0,04	4,11
Saratov Region	36,80	185,80	5,05	0,35	0,05	4,68
Ulyanovsk Region	40,70	194,90	4,79	0,37	0,05	4,88
Ural Federal District (median value of the average daily income is 5.19 %)						
Kurgan Region	40,20	145,50	3,62	0,46	0,06	6,06
Sverdlovsk Region	66,00	304,30	4,61	0,38	0,05	5,03
Tyumen Region	71,90	275,50	3,83	0,44	0,06	5,80
Khanty-Mansi Autonomous Region	74,10	405,70	5,48	0,33	0,04	4,38
Yamalo-Nenets Autonomous Region	139,00	473,60	3,41	0,48	0,06	6,34
Tyumen Region (excluding autonomous districts)	48,00	275,50	5,74	0,32	0,04	4,21
Chelyabinsk Region	48,50	214,80	4,43	0,39	0,05	5,19
Siberian Federal District (median value of the SFD is 5.50 %)						
Altai Republic	42,30	98,40	2,33	0,63	0,08	8,27
Tuva Republic	32,20	82,90	2,57	0,59	0,08	7,73
Khakassia Republic	40,70	156,10	3,84	0,44	0,06	5,80
Altai Region	40,20	165,30	4,11	0,42	0,05	5,50
Krasnoyarsk Region	55,50	216,90	3,91	0,43	0,06	5,72
Irkutsk Region	49,00	209,20	4,27	0,40	0,05	5,34
Kemerovo Region	46,40	195,40	4,21	0,41	0,05	5,40
Novosibirsk Region	58,10	291,10	5,01	0,36	0,05	4,71
Omsk Region	46,70	192,10	4,11	0,42	0,05	5,50
Tomsk Region	47,20	218,40	4,63	0,38	0,05	5,01
Far Eastern Federal District (median SDI value — 5.47 %)						
Republic of Buryatia	45,00	144,20	3,20	0,50	0,07	6,63

Country/Regions	Income (Y)	Saving (S)	S/Y	μ (Скотт, 1989) ρ = 0 γ = 0,055	SSD in shares	SSD in %
Republic of Sakha (Yakutia)	75,50	212,40	2,81	0,55	0,07	7,27
Zabaykalsky Region	48,10	156,00	3,24	0,50	0,07	6,57
Kamchatka Region	96,10	445,20	4,63	0,38	0,05	5,01
Primorsky Region	63,20	360,10	5,70	0,32	0,04	4,24
Khabarovsk Region	61,80	316,50	5,12	0,35	0,05	4,62
Amur Region	61,00	256,10	4,20	0,41	0,05	5,41
Magadan Region	130,00	538,10	4,14	0,41	0,05	5,47
Sakhalin Region	102,00	425,20	4,17	0,41	0,05	5,44
Jewish Autonomous Region	51,60	182,50	3,54	0,47	0,06	6,16
Chukotka Autonomous Region	164,90	391,80	2,38	0,62	0,08	8,15

Source: developed by the authors: Line 2 — Rosstat (FSGS) data. — https://rosstat.gov.ru/folder/13397# (accessed: 09.25.2025) Line 3 — RIA Rating data.[6] — https://riarating.ru/infografika/20240205/630256997.html (09.25.2025).

the Social Rate of Discount in Cost-Benefit Analysis. This work deserves attention as it offers a relatively successful attempt to explain the essential nature of the SDR indicator.

Nevertheless, Robinson's research exhibits a significant limitation common to the entire field: it considers the subject exclusively through the lens of market theories and economic liberalism. Social and public goods are evaluated primarily in terms of consumption costs, monetary benefits, and expenditures, that is, as commodities or services in a market. This approach reflects the long-standing dominance of the idea of perfect competition in Western economic thought since the early 20th century. Within this ideology, perfect competition is seen as a hallmark of a developed country economy, whereas in underdeveloped or less developed countries, competition is considered imperfect. Notably, the classification of developed countries is influenced by political factors, so nations deemed "acceptable" economically are labeled developed, while all others are regarded as underdeveloped. For example, in England and the USA, markets with near-perfect competition have existed for most of the last century, and this position remains largely unchanged.

This perspective creates a serious practical problem in calculating and assessing the SDR, which highlights a fundamental challenge in government financing of public and social activities. Consider Table 1 as an example. At first glance, the indicators may seem non-contradictory. However, the SDR value for Moscow is 2.64 %, while for the Republic of Altai it is 8.27 %. That is, the requirement for public benefits for residents of Altai is 3.13 times higher than for residents of Moscow. At the same time, the income of Moscow residents is 3.22 times higher, and their savings are 13.7 times higher. Clearly, residents of Altai require more state support, yet for them, the social discount rate is higher, meaning the cost of social benefits relative to their needs is greater. In other words, wealthier people receive more social and public goods at lower relative costs than poorer populations. This creates a situation in which the rich become progressively wealthier, and the poor become progressively poorer — a consequence of the state acting as a market agent.

This outcome is justified within the ideology of markets and perfect competition that has dominated Western economic theory for more than a century. But what about social justice? This problem was highlighted by one of the truly significant economists of the 20th century, Joan Violet Robinson. In 1933, she published the seminal work *The Economics of Imperfect Competition* (Robinson, 1986), demonstrating that "perfect" competition does not exist. As one account notes, "In her own camp, Robinson was a 'heretic'..." (Robinson, 1986). Unfortunately, Robinson's works are largely ignored in modern economics textbooks,

[6] Prepared by experts from the RIA Rating Center for Economic Research, part of the *Rossiya Segodnya* media group, commissioned by RIA Novosti. Calculations were based on data from the Central Bank and Rosstat.

as are Slutsky's contributions. Consequently, the research field, applied methods, and the practice of calculating and assessing SDR are significantly distorted by an artificially imposed ideological framework.

Conclusion

This study achieved its objectives, confirming the validity of the social time preference (STP) approach and enabling the development of a methodological tool for calculating the social discount rate (SDR) across Russian regions. A key finding was the substantial spatial variation in SDR values, reflecting differences in the socio-economic conditions of Russia's regions. These results may be of interest to policymakers, underpinning the improvement of public financing mechanisms and the effectiveness of state socioeconomic policy.

The research has enabled a comprehensive analysis of the theoretical foundations and practical application of the SDR, demonstrating its critical role as an instrument of government socio-economic policy. Using the STP approach, the SDR was calculated for Russia and its constituent entities, revealing substantial regional differentiation — from 2.64 % in Moscow to 15.72 % in the Chechen Republic. These results have practical value for substantiating financing rates for social and public projects and highlight the need for deep methodological and philosophical reconsideration of the SDR's role under modern conditions.

The main conclusion is that the simplified stationary Ramsey model (Formula 1), which assumes constant parameters, inadequately reflects actual economic dynamics. In contrast, calculations using the universal non-stationary model (Formula 2) align more closely with reality, requiring consideration of temporal changes in parameters such as the rate of time preference (ρ) and the elasticity of marginal utility (μ). This underscores the need to move away from simplified calculation practices toward more methodologically rigorous approaches rooted in Slutsky's work.

The significant discrepancy between the calculated average SDR for the Russian Federation (4.26 %) and the Central Bank key rate (18 %) is not a statistical error but reflects a fundamental difference in their nature. While the SDR serves as an instrument for assessing long-term social benefits and intertemporal resource distribution, the key rate currently functions primarily to counter external shocks and inflation arising from geopolitical instability. This discrepancy, therefore, highlights the distinction between long-term social planning and short-term monetary policy rather than a failure of SDR methodology.

A particularly acute problem, with both economic and ethical dimensions, emerges from the analysis of regional SDR differentiation. An inverse relationship between regional income levels and SDR values creates a paradox: poorer regions, such as the Republic of Altai (SDR = 8.27 %), must demonstrate much higher returns on social investments than wealthier regions, such as Moscow (SDR = 2.64 %), to receive equivalent government support. This means that efficiency requirements for social projects in needy regions are overstated, reinforcing existing inequalities. This phenomenon reflects the dominance in Western economic theory of the ideology of "perfect competition," which, as J. Robinson rightly noted, is an artificial construct that disregards the realities of imperfect markets and social justice.

Therefore, the research concludes that the role of SDR requires ideological and methodological reconsideration. Its application should not be reduced to mechanistic efficiency assessment based solely on market logic. Instead, the SDR should serve as an instrument for advancing social justice, consciously addressing market imbalances. This requires moving away from viewing government financing as equivalent to private investment and acknowledging the state's unique role in allocating resources to benefit future generations and disadvantaged populations.

The calculations and analysis presented provide a solid foundation for revising current practices in assessing public projects in Russia. Implementing regionally differentiated SDR values, calculated using dynamic models and employed as normative, rather than purely computational, instruments, can enhance both the justification and fairness of government socio-economic policy. Future research should focus on developing adaptive SDR models that integrate not only economic but also social and environmental dimensions of public welfare.

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