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Strategic Management of Import Dependency in Regional Industrial Sectors: A Behavioral Approach to Organizational Resilience

Tofik Aidarov¹, Gaukhar Saimagambetova^{2*}, Leonid Elshin³⁻⁵, Almaz Mingulov⁶, Ekaterina Baldina⁷, Anna Zakharova⁸, Leyla Goyushova⁹, Alexander Verkhovod⁸, Olga Abramova⁸, Meruert Nurmaganbetova^{10,11}

¹Department of Management and Marketing, South Kazakhstan University named after M. Auezov, Shymkent, Kazakhstan.

²Department of Management, Yessenov University, Aktau, Kazakhstan.

³Center for Strategic Assessments and Forecasts, Kazan (Volga Region) Federal University, Kazan, Russia.

⁴Center for Advanced Economic Research, Academy of Sciences of the Republic of Tatarstan, Kazan, Russia.

⁵TISBI University of Management, Kazan, Russia.

⁶Kazan (Volga Region) Federal University, Kazan, Russia.

⁷Department of Economics and Humanities, Faculty of Higher Education, Kamyshinsky Institute of Technology, branch of Volgograd State Technical University, Kamyshin, Russia.

⁸Moscow Aviation Institute, Moscow, Russia.

⁹Department I-11 "Foreign Language for Aerospace Specialities", Moscow Aviation Institute 125993, Moscow, Russia

¹⁰Higher School of Economics and Management, Turan University, Almaty, Kazakhstan.

¹¹Faculty of Business and Tourism, Yessenov University, Almaty, Kazakhstan.

***Corresponding Author**

E-mail: gauhar1973@mail.ru

ABSTRACT

The study aims to develop and test methodological approaches for empirically assessing regional economic dynamics in the context of disrupted supply chains for industrial imports. This problem has gained particular relevance in recent years due to intensified sanctions, the withdrawal of foreign companies, and the reconfiguration of global trade flows. These factors have significantly affected Russian regions, especially those deeply integrated into international supply chains. Using a multi-factor regression model based on quarterly data from 2010 to 2021, the analysis evaluates the sensitivity of the gross regional product (GRP) of the Republic of Tatarstan to the development parameters of its most import-dependent sectors. The methodological framework combines economic and mathematical modeling with systematization and classification of regional economic risks that arise from restricted foreign supplies. In this context, the study identifies critical groups of imported goods, aligns them with sectoral activities under the Russian Classification of Economic Activities (OKVED), and applies cluster and scenario analysis to assess their impact on regional growth. The results show that a slowdown of 1% in petroleum and rubber product sectors leads to a cumulative 1.4% decline in GRP growth, while the motor vehicle and chemical industries contribute an additional 0.6% decrease. These estimates confirm that the structure of import dependence determines the vulnerability of regional economic growth to sanctions. The findings contribute to the development of adaptive policy measures for ensuring sustainable regional development and highlight the practical value of quantitative approaches for diagnosing risks in regional economies under external shocks.

Keywords: Region, Risks, Scenario modeling, Sustainable economic development, Types of economic activity.

Introduction

The sanctions war between Russia and other countries which escalated in 2022 has had a significant impact on the development of its national economy and regions. This is due to the restrictions imposed on imports and exports,

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limited access to international financial markets, the exodus of several foreign companies from the Russian market, and other factors. These changes have necessitated the reconfiguration of institutional, organizational, and structural connections and economic relations.

Given that the effects of external pressures on the national economy are most evident in foreign economic activities and the sectors linked to them, the search for mechanisms to diagnose and adapt economic systems to these transformations has become a critical issue in modern scientific and expert research (Morgan *et al.*, 2024).

These issues are particularly relevant at the regional level. Russian regions with varying degrees of cooperation in international economic relations demonstrate different levels of economic resilience amid the changing foreign economic environment. In this context, studies aimed at identifying the key parameters of regional development under external pressure and specific regional characteristics in terms of import and export dependence hold the potential for determining the directions for risk mitigation and state governance measures at the regional level.

It is important to emphasize that the greatest interest in the issues raised arises in the context of studying the donor regions of the Russian economy. These regions demonstrate the highest level of integration into international supply chains, and consequently, the sustainability of their economic development will significantly influence the prospects for economic growth of the Russian national economy. In this regard, the research focus of the present study will concentrate on these regional economic systems. The Republic of Tatarstan has been selected as the object of the study as one of the driving forces of the Russian Federation's economy, shaping its investment, industrial, and financial framework.

Literature Review

Sanctions and the Challenge of Economic Resilience

According to Morgan *et al.* (2023), sanctions have been applied by global regulators and individual states since the 1950s (**Figure 1**). However, the use of this mechanism intensified in the 2010s, triggering a surge in research activity aimed at finding models of sustainable development under sanctions and external pressure. Among the most notable works in this field is the research of Abalkin (2000), who delves into strategies for economic resilience due to external challenges. Pichurin and Blinov (2014) focus on ensuring import substitution in Russia after it acceded to the WTO, exploring how the country can develop self-sufficiency in key sectors. Other authors (Osipov, 2014; Pichurin & Blinov, 2014; Nevskaya, 2015; Osipov *et al.*, 2017) dwell on various aspects of regional economic development and resilience, particularly in the context of external pressure and import substitution. They examine strategies to enhance industrial competitiveness, promote technological innovation, and foster economic self-reliance.

Regional Dimensions of Economic Adaptation

Zhikharevich *et al.* (2020) and Klimanov *et al.* (2018) explore regional resilience and assess how regional economies adapt to shocks and external restrictions. Korchagina (2012) proposes methods to assess the sustainable development of socio-economic systems at the regional level.

The sustainable development of national economic systems under sanctions is also studied. Stone *et al.* (2021) analyze local trade requirements using a computable general equilibrium (CGE) model and highlight the restrictive impact of such policies on international trade dynamics. In (Stone *et al.*, 2015), the authors explore the growing challenges posed by localization policies and their effect on global trade, providing insights into the trade barriers created by these policies. Deringer *et al.* (2024) examine the economic effects of local requirements in specific industries (e.g., heavy vehicles) and how these policies influence production and trade flows. In particular, the methodological approach of Bas and Strauss-Kahn (2014), which models econometrically at the firm level the relationship between imports of intermediate goods coupled with export performance, provides valuable perceptions into how external inputs strengthen domestic production capacity.



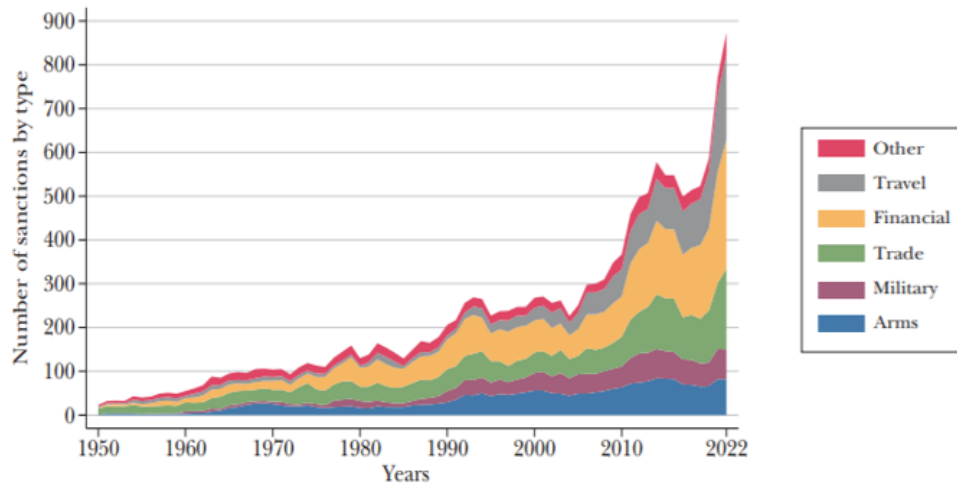


Figure 1. Evolution of sanctions against national economies in the world from 1950-2022

Research Gaps

Despite the increased research activity over the past decade in the sustainable development of economic systems under sanctions, regional aspects have not been considered. It is premature to claim that there is a unified position and methodological framework regarding these issues. In this regard, it is appropriate to develop regional economic theory, from a methodological perspective and in terms of conceptual and categorical foundations.

Most studies on the resilience and adaptability of regional economic systems to sanctions rely on descriptive evaluation and analysis methods. These approaches typically involve the systematization and examination of key trends that show the specific characteristics of regional economic development under the turbulence caused by sanctions. However, few studies are based on economic and statistical data and mathematical modeling. Such research is relevant as it identifies overt and hidden patterns and relationships through objective analytical methods. It shows distinctive features and the potential development of economic systems in the new institutional environment.

The present study builds upon this kind of perspective. Because a multi-factor regression framework is used, it extends firm-level econometric models' logic to the regional level. By linking international evidence with the context of Tatarstan, this lets us capture sectoral import dependence translation into regional GRP dynamics.

Thus, it is necessary to develop methodological tools for studying regional adaptability to sanctions, particularly by applying instrumental, economic, and mathematical analysis methods. A crucial component is the development of tools that assess the impact of regional import dependence on the region's sustainable development in the context of localized foreign economic relations.

Materials and Methods

The methodological approach also draws on the framework of Bas and Strauss-Kahn (2014), whose firm-level econometric evidence highlights the critical role of imported intermediate inputs in shaping production outcomes. By extending this logic to regional economic systems, we model sector-level import dependence as an exogenous driver that influences regional GRP dynamics. In contrast to micro-level regressions, our multi-factor model aggregates the effects of critical imported inputs across major industrial activities, thereby capturing the macroeconomic sensitivity of regional growth to external supply shocks.

The core of our approach is a multi-factor model that assesses the degree to which import supply restrictions in regional economic sectors influence regional economic dynamics. Given the wide range of imported goods, it is advisable to filter imported products based on their significance to the regional economy. This research stage is implemented by excluding insignificant product groups (where the share of imports in the total volume of goods supplied to the region from abroad does not exceed 0.5%).



In this study, the 0.5% threshold refers to the value-based share of each commodity group in the total annual import volume of the region. This criterion was selected to ensure that the analysis focuses on economically meaningful categories of imported intermediate goods that contribute to production continuity in key regional industries. Setting the threshold at 0.5% enables an analytically manageable dataset while preserving the structural integrity of the region's import profile, given that the original classification comprises 97 product groups (Anazi *et al.*, 2025; McLean *et al.*, 2025; Tadesse & Shiberu, 2025). Although alternative thresholds (e.g., 0.3% or 1%) could be examined, conducting a full sensitivity analysis falls outside the scope of this paper; however, we recognize its potential value and identify it as a promising direction for future research.

The remaining key product groups of imports form the basis for the analysis and construction of economic-mathematical models. Aligning these groups with the relevant types of regional economic activities builds a system of exogenous factors. The endogenous variable in this model is GRP growth.

The resulting estimates showing the influence of product groups and the corresponding economic sectors on regional economic growth dynamics serve as the foundation for cluster analysis. This enables the grouping of the region's economy based on its sensitivity to import supplies and the industries dependent on them.

A key feature of implementing the algorithm is the fulfillment of permissible conditions and adherence to the following methodological recommendations.

1. For the simulation modeling of growth dynamics in economic sectors vulnerable to critical import supplies, it is necessary to align the identified critical imports categorized by the Foreign Economic Activity Commodity Nomenclature (FEACN) with the regional economic sectors according to the Russian Classification of Economic Activities (OKVED-2) by the Federal State Statistics Service. This approach will match the analyzed product groups with their respective industries, resulting in a macroeconomic-level analysis. This approach will make it possible to correlate the studied commodity groups with industry-specific indicators, which will subsequently allow for a transition to the macroeconomic level of analysis. The correlation between FEACN and OKVED is carried out based on the transitional keys developed by the Ministry of Economic Development of Russia, linking the main types of the Eurasian Economic Union's FEACN with the OKVED. For example, FEACN code 40 ("Rubber and articles thereof"), which constitutes one of the major import-dependent groups in the region, corresponds to OKVED-2 division 22.1 ("Manufacture of rubber products").

2. To calculate the elasticity coefficients (regressors) for the exogenous factors in the constructed regression model (where the growth rates of the studied import-dependent economic sectors serve as exogenous factors), quarterly data were used. The endogenous factors are indicators evaluating the growth rates of GRP.

To prevent incorrect results due to high interdependence between the independent variables (multicollinearity), the model specification was verified through correlation analysis (Pearson's coefficient). Time series were tested for autocorrelation using the Durbin-Watson statistic. The resulting value fell within the interval 1.8–2.2, which is generally interpreted as indicating the absence of first-order autocorrelation. Model quality was additionally assessed using a cross-validation procedure, the results of which confirmed the stability and robustness of the final specification.

When modeling, it is advisable to test some explanatory variables for their inclusion in the regression equations with lags.

The estimates that characterize the influence of sectors dependent on critical imports on the dynamics of GRP allow a cumulative assessment of potential changes in the growth rates of GRP.

The sequence of implemented steps is demonstrated in **Figure 2**.



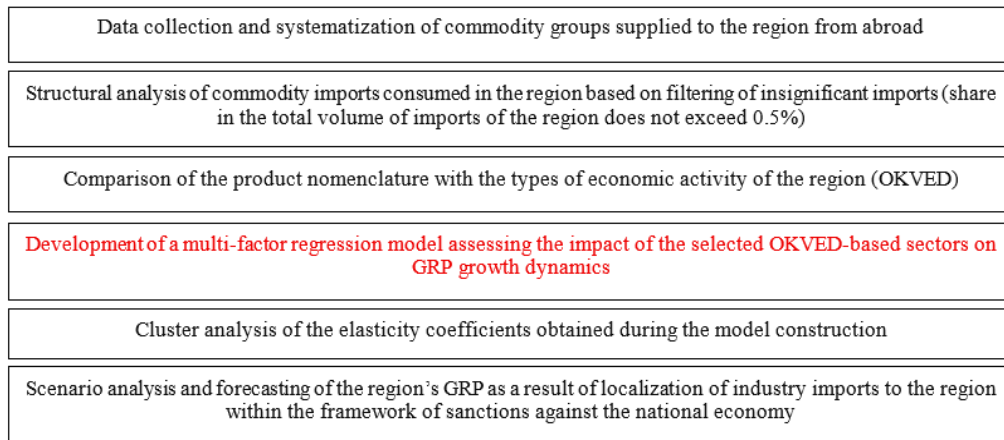


Figure 2. Algorithm for studying the impact of localization of industry imports on the sustainability of regional economic development under sanctions

The informational base, along with the subsequent assessments and calculations, is laid by open federal statistical data (EMISS (2023), Federal Customs Service of the Russian Federation (2023)). The methodology includes a dynamic analysis of imports across 97 product groups and supplier countries, a structural analysis of imported goods consumed in the region, a comparative analysis of product groups and types of economic activities by region, and the systematization of supply chains by regional economic sectors. The Republic of Tatarstan was selected as the research subject to test this methodology.

The customs data applied in this research related to 2021. This period represents the stable, pre-sanctions configuration of foreign trade flows, preceding the substantial geopolitical shifts and sanction regimes introduced in 2022. Using 2021 as a baseline ensures methodological consistency by capturing the region's import structure before external shocks occurred. This, in turn, allows for more accurate identification of structural vulnerabilities and for scenario and sensitivity analyses that rest on the region's actual economic conditions prior to the sanctions period.

When constructing the multi-factor regression equation assessing the impact of import-dependent economic sectors on the region's economic dynamics, the statistical database of the Territorial Body of the Federal State Statistics Service of the Republic of Tatarstan was used for the period from 2010 to 2021 (quarterly data).

Results and Discussion

There are significant shifts in the integration of the national economy into international supply chains due to the intensifying sanctions standoff between Russia and Western countries. As a result, several foreign companies exited the Russian market (**Table 1**). Due to the disruption of cooperative ties with former foreign partners, the structure and volume of imports and exports also change (**Figure 3**).

Table 1. Companies or organizations that left the Russian market by industries

Auto manufacturers	Renault, Volvo Cars, AB Volvo, General Motors, Daimler Truck, BMW, Ford, Harley-Davidson, Jaguar Land Rover, Toyota, Mercedes-Benz, Volkswagen, Eneos, Renault, Inchcape, Renault, Schneider Electric
Sports	FIDE, FIFA, UEFA, Formula One, IPC, Diamond League, Decathlon
Energy	BP, Equinor, TotalEnergies, Siemens Energy AG, Exxon Mobil, Shell, Rio Tinto, Equinor, RWE, Halliburton, Schlumberger, Baker Hughes, Weatherford, EnBW, Euronav, Kinross Gold, Saipem, Marubeni, SKF, ESI Group, Fortum, Equinor
Finances	HSBC, Nordea Asset Management, Visa, Mastercard, ING Groep NV, Mashreqbank, American Express, KPMG, Citigroup, Swiss Re, Allianz, Societe Generale, PPF
Air companies	AerCap Holdings, Boeing, Airbus



Technologies	Nokia, Apple, Spotify, Alphabet, Microsoft, Samsung, Netflix, TikTok, Spotify Technology, Hexagon, Intel, Ericsson, Nokia, Adevinata, DJI, Atos, Siemens, Oerlikon
Logistics	United Parcel Service, A.P. Moller-Maersk, MoneyGram, Mondi
FMCG	Canada Goose, Ikea, Nike, Airbnb, Booking, Inditex, Danone, Procter & Gamble, Coca-Cola, Ferrari, McDonald's, Yum Brands, Starbucks, Accor, Heineken, British American Tobacco, Imperial Brands, Abbvie, Novartis, Eli Lilly, Merck, Radisson Hotel Group, Nestle, Carlsberg, Heineken, Johnson & Johnson, GSK, Lavazza, ABB, ESSITY, Ab InBev, Valio, AAK, OBI, Coty, Tangiamo Touch, DSV, LPP, Raisio, Fazer, Paulig, McDonald's, Autogrill, Marriott
Economy	Hays Plc, InterContinental Hotels Group (IHG), Nestle, Publicis, BNP Paribas, Rabobank, Danfoss, Starbucks Corp, Sulzer AG
Individual wealth	Julius Bär, UniCredit, Global Payments
Manufacturers	Continental, IMCD, London Metal Exchange, Emerson Electric, Kemira, Delfingen, YIT Oyj
Construction	Holcim

Source: Compiled by the authors based on (Funakoshi *et al.*, 2022).

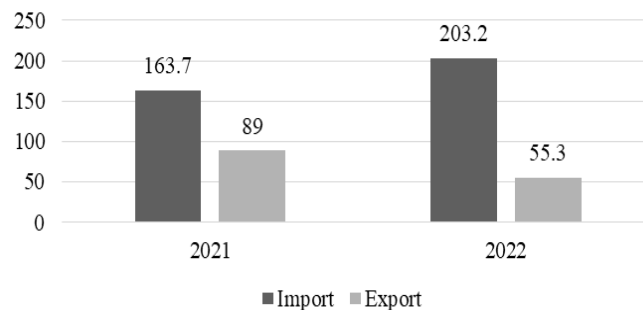


Figure 3. Changes in imports from EU countries and exports to EU countries from Russia before and after the introduction of sanctions, billion euros

Source: Developed based on data from the Institute of Economics of the Russian Academy of Sciences (Narbut & Shpakovskaya, 2023).

Due to the introduction of sanctions on foreign trade with the European Union, imports of goods from the EU to Russia have significantly decreased (**Figure 4**).



Figure 4. Commodity structure of EU exports to Russia before and after the introduction of trade restrictions, million euros

Source: Developed based on data from the Institute of Economics of the Russian Academy of Sciences (Narbut & Shpakovskaya, 2023).

Figure 4 shows that the value of all imported product groups decreased in 2022 compared to 2021. The product structure of European imports to Russia changed by 26% across all categories.

These key trends and characteristics of Russia's foreign economic activities indicate risks to the sustainable development of the national economy under sanctions. An important question is how evenly these risks are distributed across regional systems. As previously mentioned, the answer lies in building models that can identify the degree of regional threats arising from sanctions against the Russian national economy.

Following the methodological approaches, we analyzed patterns and prospects for the economic growth of Tatarstan in the context of disruptions in foreign economic relations during 2022-2023.

For the region, relying on the processed data on imports to the region by product groups (according to the Federal Customs Service) and guided by the proposed methodological toolkit, **Figure 5** presents the summarized results of the assessments.

The preliminary results indicate that 10 main import product groups account for 79.1% of the total goods supplied to the region. The remaining 20.9% was excluded from the analysis due to statistical insignificance as these groups represent less than 0.5% of the total volume of imports into Tatarstan. This approach may raise questions and spark debate. However, given the vast amount of data processed detailing the parameters of foreign supplies (according to the Federal Customs Service) to the region under study (with foreign trade relations in 2021 involving 150 countries supplying products across 97 product categories), and focusing research on the critical mass of imports, the study results consider solely product groups that account for no less than 0.5% of the region's total imports.

According to **Figure 5**, the final selection of product categories imported into the region includes the following nomenclature:

27 – Mineral fuels, oils, and products of their distillation; bituminous substances; mineral waxes

38 – Miscellaneous chemical products

39 – Plastics and articles thereof

40 – Rubber and articles thereof

73 – Articles of iron or steel

82 – Tools, implements, cutlery, spoons, and forks made of base metal; parts thereof made of base metal

85 – Electrical machinery and equipment, parts thereof; sound recording and reproducing apparatus, apparatus for recording and reproducing television images and sound, parts and accessories thereof

87 – Motor vehicles, other than railway or tramway rolling stock, and parts and accessories thereof

90 – Optical, photographic, cinematographic, measuring, checking, precision, medical, or surgical instruments and apparatus; parts and accessories thereof

94 – Furniture; bedding, mattresses, mattress supports, cushions, and similar stuffed furnishings; lamps and lighting equipment not elsewhere specified or included; illuminated signs, illuminated nameplates or addresses, and similar products; prefabricated buildings.



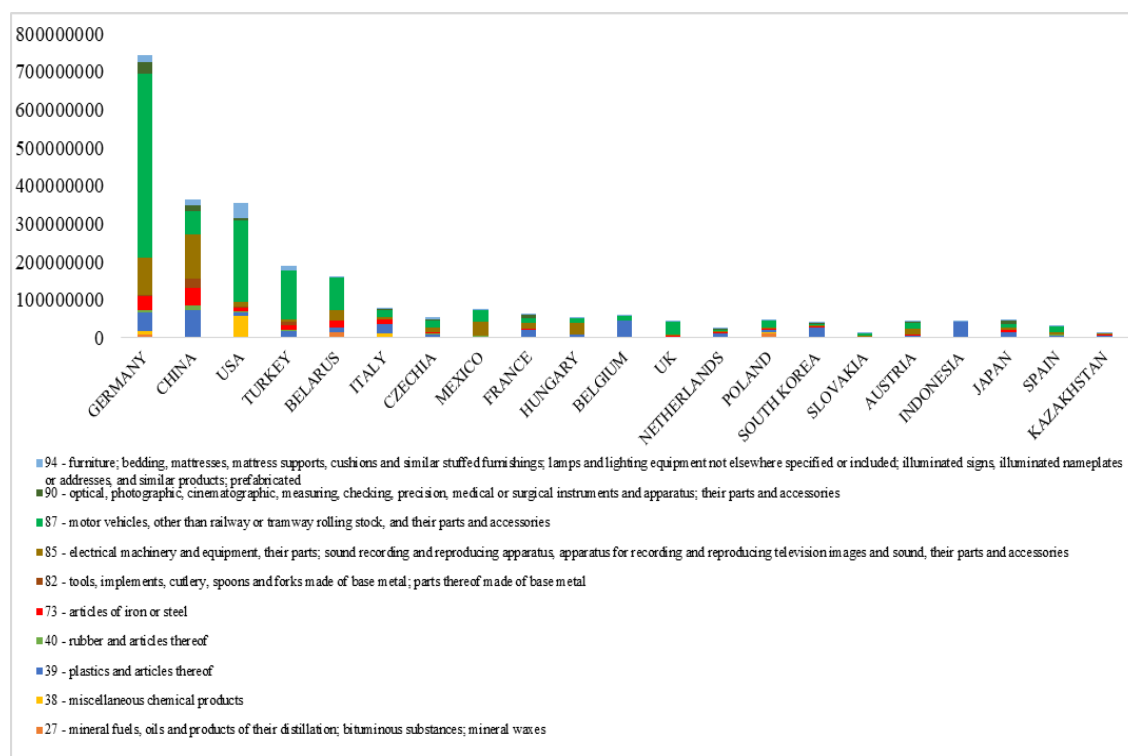


Figure 5. Structure of imports of the Republic of Tatarstan by importing countries and types of economic activity
Source: according to the data from (Federal Customs Service of the Russian Federation, 2024).

Next, guided by the principle of correlating the imported goods with the corresponding sectors under the Russian Classification of Economic Activities (OKVED), the following sectors of the economy of Tatarstan were identified as being the most dependent on imported supplies:

- x_1- Production of cutlery and tableware, tools, and universal hardware products;
- x_2- Production of cast iron, steel, and ferroalloys;
- x_3- Production of petroleum products;
- x_4- Production of rubber products;
- x_5- Production of electrical equipment;
- x_6- Production of other chemical products;
- x_7- Production of plastic products;
- x_8- Production of motor vehicles, trailers, and semi-trailers;
- x_9- Production of computers, electronics, and optical products;
- x_10- Furniture production.

Following the algorithm for constructing a model for assessing the impact of import-dependent sectors of the economy on the sustainability of regional economic growth (**Figure 2**), the corresponding assessments were made and regression equation 1 was constructed:

$$\text{GRP} = 0.002x_1 + 0.007x_2 + 0.008x_3 + 0.005x_4 + 0.0009x_5 + 0.02x_6 + [0.0002x_7 + 0.02x_8 + 0.0004x_9 + 0.005x_{10}] \quad (1)$$

$$R^2=0.89$$

The resulting equation adequately describes the initial time series. The determination coefficient is $R^2=0.89$. The value of $F_{\text{crit}} < F_{\text{tab}}$ indicates the significance of the regression equation.

The confidence intervals for the estimated regression equation parameters are presented in **Table 2**.

Table 2. Statistical Significance of Regression Equation Parameters

	Coefficients	Confidence Interval	
		Lower Bound	Upper Bound
x_1	0,002	-0,0001	0,0041
x_2	0,007	0,0002	0,0138
x_3	0,008	0,0001	0,0159
x_4	0,005	-0,0001	0,0101
x_5	0,0009	-0,00002	0,00182
x_6	0,02	-0,0004	0,0404
x_7	0,0002	-0,00002	0,00042
x_8	0,02	-0,0004	0,0404
x_9	0,0004	-0,00004	0,00084
x_{10}	0,005	0,003	0,007

The results presented in the table indicate the statistical significance of the obtained regression equations at the 5% significance level.

The estimates served as the basis for conducting cluster analysis to identify the sensitivity of the region's GRP to the development of identified import-dependent types of economic activity (**Figure 6**).

The classification of foreign economic activity (FEA) was carried out using Ward's method. This method is based on minimizing the total within-cluster variance (sum of squared errors, SSE) and is well-suited for forming compact and homogeneous clusters.

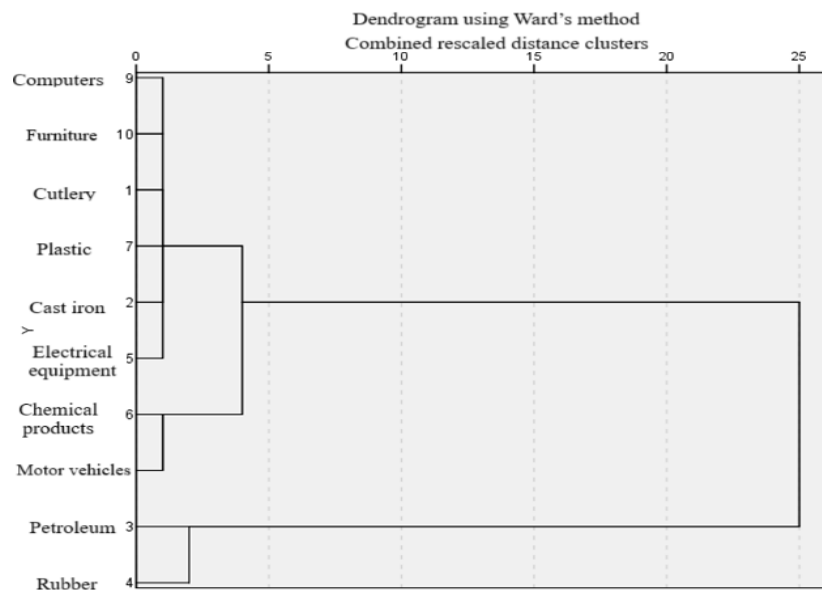


Figure 6. Cluster structure of import-dependent economic activities in Tatarstan, classified by their sensitivity to import restrictions

The results allow for the classification of the studied economic sectors into three groups based on their impact on the GRP dynamics of Tatarstan.

High-Sensitivity Sectors (Cluster 1). Activities with the greatest effect on GRP:

- Production of other chemical products;
- Production of motor vehicles, trailers, and semi-trailers.



Medium-Sensitivity Sectors (Cluster 2). Economic activities characterized by a moderate impact on the region's economic growth:

- Production of petroleum products;
- Production of rubber products.

Low-Sensitivity Sectors (Cluster 3). Economic activities with the least impact on the region's GRP dynamics among the assessed sectors:

- Production of cutlery, tools, and general hardware;
- Production of cast iron, steel, and ferroalloys;
- Production of electrical equipment;
- Production of plastic products;
- Production of computers, electronic, and optical products;
- Production of furniture.

The results identify the sectors of the regional economy most vulnerable to risks of sustainable development under sanctions and determine the extent of their influence on regional economic growth. Based on sensitivity analysis, **Table 3** shows the dependence of the GRP of Tatarstan on the potential slowdown of the examined economic activities by 1 percentage point.

Table 3. Scenario modeling of changes in the dynamics of the GRP of Tatarstan with due regard to the slowdown in the development of import-dependent sectors of the economy

Type of economic activity (FEA)	Growth rate, in % (fact)	Slowdown in the growth of foreign economic activity by 1 p.p.	Expected decline in GRP growth rate	Cumulative decline in GRP
Cluster 1				
Production of other chemical products	120.6%	119.6%	0.3%	0.6%
Production of motor vehicles, trailers, and semi-trailers	90%	89%	0.3%	
Cluster 2				
Production of petroleum products	113%	112%	0.9%	1.4%
Production of rubber products	101.3%	100.3%	0.5%	
Cluster 3				
Production of cutlery and tableware, tools, and general hardware	259.5%	258.5%	0.03%	0.42%
Production of cast iron, steel, and ferroalloys	119%	118%	0.13%	
Production of electrical equipment	105.8%	104.8%	0.15%	
Production of plastic products	120.6%	119.6%	0.05%	
Production of computers, electronic and optical products	134.3%	133.3%	0.01%	
Furniture production	101.8%	100.8%	0.05%	

Source: developed by the authors.

Based on the results, the restriction of imports in the most sensitive product groups will significantly affect the production of petroleum products and the production of rubber products from a macroeconomic perspective. A cumulative slowdown of 1% (p.p.) in the growth rates of these sectors leads to a 1.4% decrease in the dynamics of the GRP.

The second most significant group of import-dependent industries posing risks to the GRP growth rates of Tatarstan consists of economic activities included in the second group (Cluster 1). Although these industries moderately influence the GRP dynamics, according to cluster analysis, their combined contribution to the region's economy proves substantial (0.6%).

In the context of transforming foreign economic relations, a key element of state economic policy is identifying potential threats to economic growth due to the localization of import supplies (Safiullin *et al.*, 2011; Burganov, 2022). Given the different integration of regions into import and export chains, a priority issue is determining their vulnerability to import supplies that ensure the continuity of technological processes in specific economic sectors. Finally, the import-dependent sectors included in Cluster 3 have a minimal cumulative impact on the region's economic growth.

Conclusion

The proposed methodology allows to identify threats in terms of the region's economic growth prospects. Understanding emerging vulnerabilities ensures the timely implementation of management measures, including exploring new geographic supply channels to compensate for the localization of imports from countries imposing sanctions.

We can assert that the proposed methodological tools effectively identify the sectors that have the greatest impact on regional economic development in the context of localized import restrictions for specific product groups. This facilitates the development of adaptive mechanisms for regional growth amid systemic transformation caused by disruptions in established transnational supply chains.

In conclusion, we need to highlight that the developed methodological approach has several points of discussion, such as the focus on analyzing import product groups with a share greater than 0.5% of total foreign supplies. However, its emphasis on assessing import dependence in individual sectors, followed by evaluating the potential impact of their development slowdown, forms a comprehensive understanding of the region's economic development prospects under sanctions.

From a policy standpoint, the results can assist regional authorities in identifying those industrial segments where supply-chain vulnerabilities pose the greatest risks to growth. The quantitative estimates presented in this study may be used to prioritise targeted support measures, diversify external supply channels, and strengthen resilience planning for sectors that exhibit high sensitivity to import disruptions.

The authors acknowledge several limitations of the proposed empirical model. Although the specification covers the key import-dependent sectors of the regional economy, certain structural, institutional, or macroeconomic factors cannot be fully incorporated, which may introduce omitted-variable bias. The focus on product groups exceeding the 0.5% import threshold, while methodologically justified, may leave out smaller categories that could become significant under specific supply-chain shocks. The analysis is also constrained by the availability and granularity of regional statistical data. In addition, the potential presence of time lags in sectoral responses was examined during specification testing; however, lagged versions of the model did not improve its performance. Future research may therefore extend the approach to other regions, incorporate more detailed datasets, or apply advanced dynamic and forecasting methods to assess longer-term effects of import localization.

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