

# Assessing the relationship between critical imports and regional industrial development based on panel data analysis

Leonid Elshin <sup>1,4</sup> <sup>a</sup>, Dilara Abdrakhmanova <sup>2</sup> <sup>b</sup> Aliya Dinmukhametova <sup>1,3</sup> <sup>c</sup> Engzhe Safina <sup>4,5</sup> <sup>d</sup>

<sup>1</sup> Kazan (Volga Region) Federal University, Center for Strategic Assessments and Forecast, Kazan, 420008, Russia

<sup>2</sup> Volga State University of Physical Culture, Sports and Tourism, Department of Economics and Management in Sports, Kazan, 420010, Russia

<sup>3</sup> Department of Business Statistics and Economics, Kazan National Research Technological University, Kazan, 420015, Russia

<sup>4</sup> Center for Advanced Economic Research of the Academy of Sciences of the Republic of Tatarstan, Kazan, 420111, Russia

<sup>5</sup> Kazan (Volga Region) Federal University, Center for Advanced Development, Kazan, 420008, Russia


**Keywords :** Critical imports, region, sanctions pressure, industrial development, sanctions pressure, macroeconomic relationships, panel data.


**Abstract :** Growing sanctions External restrictions and subsequent logistical disruptions in import supplies pose risks to the sustainable development of the national and regional economic systems of the Russian Federation. In this regard, the development of adapted models for studying the prospects for economic development in the context of the new emerging macroeconomic agenda is becoming an extremely important task. This article is devoted to solving this problem, where an attempt is made to expand the existing range of methodological approaches to studying the impact of critical imports on regional development within the framework of the use of tools based on panel data analysis. **The aim** of the work is to develop methodological approaches to identifying critically important product nomenclatures imported from abroad and to develop models that determine their impact on the prospects for industrial development of regions. **The hypothesis** adopted is the assumption of a significant level of impact of critical imports of regions on the sustainability of their development in the context of sanctions pressure. Based on **the results** of the study, the main components that determine the substantive environment and conceptual basis for identifying critical imports of a region are identified; A methodological toolkit was developed for analyzing the relationship between critical product lines and the economic growth of regional economic systems under external constraints. It was shown that a 1 million ruble reduction in gross critical imports leads to a 750,000 ruble slowdown in industrial production in the studied regional group.


## 1 INTRODUCTION


In the context of rapidly accelerating systemic transformations in the global economy, manifested in the accelerating transition from globalization to the fragmentation of global economic relations, the strengthening of autonomy policies for national economic systems, the intensification of sanctions wars, external uncertainty, and so on, the

implementation of import substitution policies at the national and regional levels is acquiring particular significance for both theory and practice. Given the urgency of this issue in the current realities of the emerging new global order, its study requires a comprehensive, adapted approach that includes not only the identification of critical imports but also an assessment of their impact on the sustainability of economic systems' development dynamics, taking into account external perturbations. Addressing this

<sup>a</sup>  <https://orcid.org/0000-0002-0763-6453>

<sup>b</sup>  <https://orcid.org/0000-0002-4033-2603>

<sup>c</sup>  <https://orcid.org/0000-0002-0763-6453>

<sup>d</sup>  <https://orcid.org/0009-0006-0871-7948>

issue requires systematizing accumulated theories and developing improved methodological approaches to studying import substitution policies through the lens of the rapidly unfolding new geoeconomic agenda. It is important to emphasize that this formulation of the problem requires focusing attention not only on the national economic level but also on the regional one. This is due to the fact that meso-level economic systems, despite their integration into a unified national foreign economic policy, exhibit highly differentiated levels of adaptation to the transformation of international supply chains in the context of systemic changes. Therefore, a rethinking of the concept of adaptive import substitution policy in the context of the new order of global economic relations must take into account the regional component. This approach necessitates the development of relevant models of economic development at the regional level, taking into account a comprehensive assessment of the degree of integration of regions into export-import operations.

## 2 THEORIES

Regional import substitution economics is a complex economic category. Its complexity manifests itself primarily in the interpretation of both the category itself and the rationale for identifying critical imports, taking into account current institutional and economic challenges and constraints that determine its implementation forms (forced import substitution / import substitution as a mechanism for ensuring global competitiveness/ import substitution as a mechanism for stimulating the development of local production and increasing the effectiveness of structural economic development).

import substitution policy research is also understanding the directions of a region's strategic adaptation to the transformation of international supply chains. This aspect is determined by the severity of import supply restrictions for individual product categories imported into the region from abroad. Identifying and defining the parameters of critical imports at the regional level is a key tool for developing a comprehensive national import substitution agenda. One of the most significant issues in this context is defining "critical dependence" on imports (Chernova & Klimuk, 2017) and determining the macroeconomic risks generated by their localization within the context of unfolding restrictions in the external environment.

The aforementioned aspects, which are particularly relevant today for the Russian economy and other jurisdictions facing sanctions pressure, have generated a vast body of research devoted to developing models of import dependence and its impact on macroeconomic trends in the context of systemic transformations. However, all of these studies primarily focus their research on national economic systems. Regions and their economic development models remain unfairly marginalized in scientific research. Meanwhile, it is the regional level of import substitution research that forms the basis for developing a unified macroeconomic policy for tailored development programs at the macro level. Given this position, subsequent research will focus on reviewing, systematizing, and critically analyzing established theoretical and practical models and methods for assessing the import dependence of regional economic systems and the prospects for determining the dynamics of their economic development.

Regional aspects affecting the study of import substitution issues from the standpoint of substantive analysis of definitions are considered in the works of Russian researchers. These include the works of Moiseev V.V. (Moiseev, 2022), Kuklin A.A. (Kuklin, 2014), Makarov A.N. (Makarov, 2011), Kuznetsova O.V. (Kuznetsova, 2022), Animitsa P.E. (Animitsa, 2015), Bukhvald E.M., Ivanov O.B. (Bukhvald, Ivanov, 2017), Ershov P.A., Vyzhitovich A.M. (Ershov & Vyzhitovich, 2016), and others.

Regional features of the study of import dependence of regional economic systems and the development of adaptation mechanisms to perturbations in foreign markets can be found in the works of Averin A.V., Baranova A.F., Kuttyrev A.M. (Averin et al., 2023), Kuvalin D.B. (Kuvalin, 2022), Shavtikova L.M., Geriyev M.M., Seitov A.B. (Shavtikova et al., 2022), Peshkova G. Yu., Samarina A. Yu. (Peshkova & Samarina, 2022), and others.

Among the foreign works devoted to the study of issues related to the development of mechanisms for the implementation of a regional import substitution economy, including in the context of external restrictions, it is necessary to highlight the works of K. Ulrich (Ulrich, 2017), K. Dong (Dong et al., 2019), G. Alessandria (Alessandria, G., Choi, H., Ruhl, K. J., 2021), Asproumorgos T. (Asproumorgos, 1988), etc.

Despite the established scientific foundation for studying the economics of import substitution at the meso-level, the research block devoted to assessing and analyzing the impact of emerging import dependence parameters on economic growth

prospects remains the least developed. This makes it quite unique, especially if the research context focuses on regional economic systems. However, despite the limited number of scientific publications in this area of research, some works in this area are still available. These include, for example, the study by E.L. Andreeva and A.V. Ratner (Andreeva & Ratner, 2022). In this study, the authors, using statistical data analysis methods, analyze the import dependence of the Russian economy based on a number of indicators assessing the share of imports in the total consumption and production of similar products in the country. Implementation of this approach allowed the authors to formulate a set of heuristic assumptions about the prospects for economic growth in the face of possible changes in the structure of product supplies from abroad, broken down by critical imports.

A similar approach to assessing import dependence and its impact on the stability of macroeconomic processes is presented in the works of Feng, L., Li, Z., & Swenson, D. (Feng et al., 2012), Hufbauer G., Schott J., Elliott K., Oegg B. (Hufbauer et al., 2007), Adewale A. R. (Adewale, 2017), Bali M., Rapelanoro N. (Bali & Rapelanoro, 2021), Connolly R., Hanson Ph. (Connolly & Hanson, 2016), etc.

A radically different mechanism for assessing the impact of an economy's import dependence on its economic growth prospects is presented in the work of A.V. Belousova (Belousova, 2020). In her study, the researcher, relying on balance sheet data accounting methods and national accounting methodology, develops a financial flow matrix capturing the impact of imports on changes in financial flows in the Far Eastern Federal District of the Russian Federation. Using calculated multipliers, she demonstrates that activating import substitution policies significantly stimulates positive macroeconomic effects for the district.

The study by N.V. Krivenko and D.S. Epaneshnikova (Krivenko & Epaneshnikova, 2020) is noteworthy in the context of the issues under consideration. It proposes a unique tool for assessing the effectiveness of import substitution and its impact on the sustainability of economic dynamics based on the calculation of the dynamic import substitution coefficient. It is defined as the product of partial indicators that, according to the authors, characterize the effectiveness of import substitution policy implementation at the macro, meso, and micro levels. These include: investment activity aimed at producing import-substituting products; economic

productivity; and changes in the ratio of exports and imports of goods.

A separate study by M.R. Safiullin, R.T. Burganov, L.A. Elshina, and A.M. Mingulov (Safiullin et al., 2023) deserves special mention. In it, the authors attempt to identify critical imports supplied to the region by the TN VED, followed by the construction of econometric models assessing the impact of critical products on the region's economic growth.

Overall, despite the existing research in the area of import substitution economics at the regional level, there is a certain fragmentation in the development of methodological tools for assessing the impact of critical imports on the sustainability of regional economic growth. This issue is particularly relevant when examining the structural characteristics of import flows, their countries of origin, their contribution to the creation of added value for the final product in the region, and the subsequent determination of the impact of these parameters on economic growth prospects, taking into account ongoing systemic transformations in the geoeconomic agenda. Meanwhile, amid turbulence in foreign markets and the dynamic transformation of international supply chains, these components of the analysis of regional economic systems' import dependence currently play a decisive role. This conclusion necessitates further expansion of the methodological framework for studying the import dependence of regional economic systems and the subsequent development of models for their economic development prospects in the context of ongoing systemic transformations in the external environment.

The presented arguments and supporting conclusions predetermined the purpose of this study - the development of a methodological tool for a multi-component assessment of the region's critical imports and the development, on this basis, of a macroeconomic model that assesses the impact of import dependence on the sustainability of economic dynamics.

The stated goal determined the objectives of the study:

1. Identify the main components that determine the substantive environment and conceptual basis for interpreting the concept of "critical import of a region".
2. Justify the position on the need to take into account a multi-component authentication system when determining the critical import of a country.
3. Develop a methodological tool for analyzing the relationship between critical imports and

economic growth of regional economic systems based on panel data.

4. Based on panel data analysis, determine the patterns of influence of critical imports on the sustainability of economic dynamics of the regions of the Volga Federal District of the Russian Federation.

### 3 DATA AND METHODS

The research's methodological framework is based on studying the patterns that determine the impact of the transformation of international supply chains within regional economic systems' commodity nomenclatures on the sustainability of their development. In this regard, a key research step is identifying critical import positions across commodity nomenclatures of foreign economic activity (CN FEA), which form the basis and prospects for regional development and its key macroeconomic parameters, using probabilistic modeling of international supply chain (ISC) transformations.

The fundamental stage of research and authentication of a region's critical imports is the identification and selection of a sample of TN VEDs whose share exceeds 0.05% of the gross import volume into the regional economic system. This threshold is based on the need to exclude statistically insignificant TN VEDs whose contribution to the added value of the region's final product is not critical. Furthermore, eliminating this set of product categories imported from abroad creates a more robust and statistically significant empirical base for subsequent analysis in the context of constructing multivariate models.

Additionally, the criticality level of product categories imported into the region should be determined based on an assessment of the ratio of generated MVP to the production volume of similar products across the studied product categories in the region. This approach allows for the identification of the degree of vulnerability of regions to foreign product supplies across product groups used in the value-added chain, including at the level of individual economic sectors within the region. This approach can be implemented by calculating a coefficient that evaluates the ratio of imported TN VED to the production of similar finished goods by regional residents (1):

$$I_{\text{ИУТН}} = \frac{\text{ТНВЭД}}{\text{ОКПД}}(1)$$

Where:

$I_{\text{ИУТН}}$  - index of the region's vulnerability to imports of goods from abroad

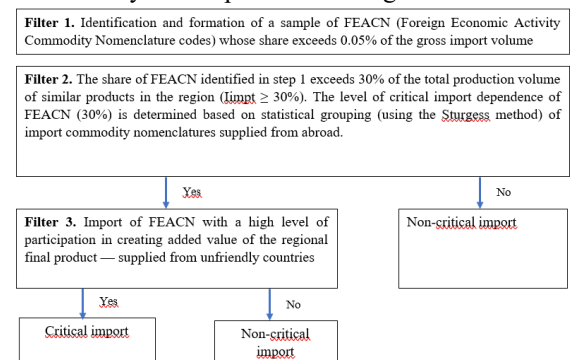
TN VED – types of commodity nomenclature of foreign economic activity imported into the regions of the Volga Federal District within the framework of established foreign economic supply chains (unit of measurement in monetary or natural units);

OKPD – products of own production, classified in accordance with OKPD, manufactured in the regions of the Volga Federal District.

The relationship between the TN VED and OKPD is carried out on the basis of the transition keys developed by the Ministry of Economic Development of Russia between the main types of commodity nomenclature of foreign economic activity of the Eurasian Economic Union (TN VED) and the all-Russian classifier of products by type of economic activity (OKPD).

A key element in determining whether a TN VED (Commodity Classification of Foreign Economic Activity) classifies a product as a critical import is its relationship to friendly and unfriendly jurisdictions involved in supplying it to the region. Therefore, filtering critically significant TN VEDs, determined in the previous step, by the country of origin of the imported products becomes a fundamental task. Thus, if the identified product items included in the critical import group in the first two iteration steps are supplied from friendly jurisdictions, it seems appropriate to exclude them from this cluster. This is because these TN VEDs do not fall within the high-risk zone of supply restrictions. Conversely, if product items supplied from abroad have a high impact on added value creation and are imported from unfriendly countries, their inclusion in the critical import group is strictly necessary.

A graphical interpretation of the three-level authentication of the critical import of the regional economic system is presented in Figure 1.

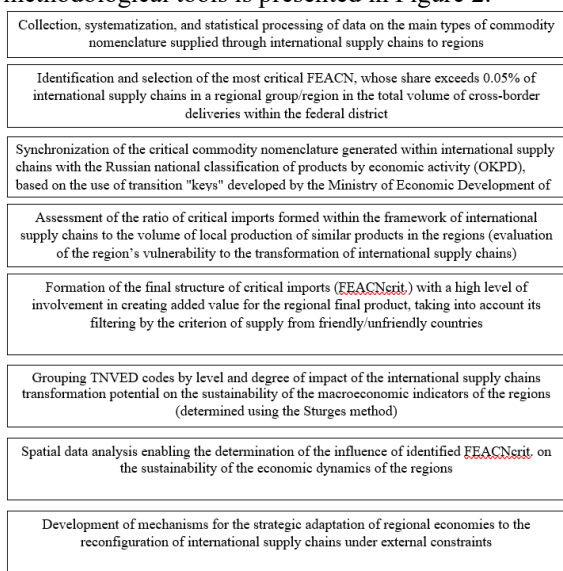


Source: developed by the authors. Figure 1: Three-level authentication (filtering) of the process of identifying critical regional imports.

Implementation of the proposed methodological solutions provides a basis for identifying critical imports generated within international supply chains in regional economic systems. Furthermore, the proposed methodological tools provide the potential for constructing economic and mathematical models that determine the prospects and potential for regional economic growth under scenario modeling of import flows within the established configuration of the international supply chain. This study addresses this issue by analyzing the relationship between critical imports and economic growth using panel data .

### 3.1. Model ( Methods or Model )

A graphical interpretation of the proposed methodological tools is presented in Figure 2.



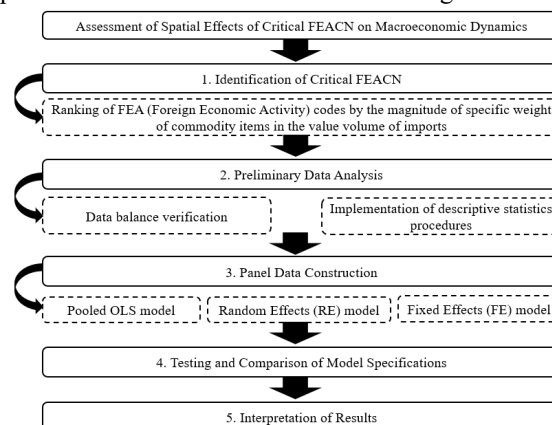
Source: developed by the authors. Figure 2: Interpretation of the methodological approach to assessing the transformation of international supply chains and their impact on the sustainability of regional macroeconomic development.

To answer the question "Is there a relationship between the volumes of critical imports and production volumes?"—that is, does a change in the volume of one imported commodity lead to a change in overall production volume?—this study constructs panel data models. Panel data were proposed at the end of the last century and represent a set of observations on a set of objects over a given time period. Unlike time series, panel data allow for the accounting of immeasurable individual differences between objects. The panel data structure includes an

object, variables, and a time period. In this study, the objects of study are critical commodity items supplied to regional economic systems from abroad ( TNVEDcrit ). Data on production volumes are chosen as the dependent variable, and import volumes as the independent variable.

The study's statistical base includes data for the period from 2015 to 2021 and reveals the characteristics of import flows through international supply chains to the regions of the Volga Federal District. The upper limit of the time series was determined based on the need to assess the impact of imports on the stability and prospects of economic development in the regions at the time of the escalation of the sanctions standoff in 2022. This approach allows us to identify foreign trade chains that formed during a period of relative stability and subsequently assess the characteristics of their transformation in the context of the impact of these processes on the economic dynamics of the studied regions. Reports from the Federal Customs Service of the Russian Federation served as the key data source.

In order to implement the panel data model, an algorithm is proposed consisting of 5 key steps, presented in the form of a flowchart in Figure 3.



Source: developed by the authors. Figure 3: Algorithm of the methodological approach to assessing spatial effects.

From an economic point of view, the proposed methodological approach allows:

- to propose and test a methodology for identifying industries that are critical for the regional economy in terms of the volume of imported goods;
- to prove the existence of random individual differences between the volumes of critical imports and the production of similar products in regional economic systems.

From a mathematical standpoint, the practical implementation of the proposed toolkit provides the opportunity to:

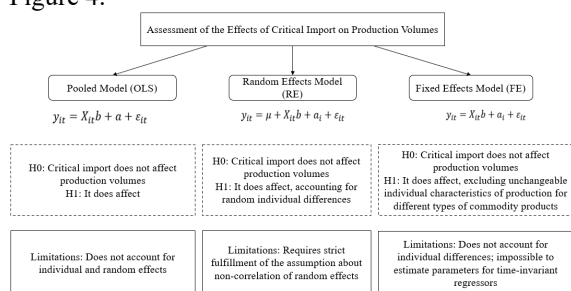
- develop and test spatial effects models (pool model, random effects model and fixed variable model) to assess the impact of critical import volumes on the macroeconomic dynamics of regional economic systems;

- prove or disprove that the relationship between production volumes and the amount of imported products that are critical for the regional economy is due to the presence of individual differences between the TN VED studied, but these differences are random.

The construction of panel data was implemented within the framework of the application of the following instrumental methods:

- pool model specifications;
- models with fixed effects and random effects;
- random effects models.

Their comparative characteristics are presented in Figure 4.



Source: developed by the authors.

Figure 4: Comparison of OLS, RE, and FE models.

At the final stage of the calculation part, the implemented models are compared using the Hausman and Breusch test. Pagana .

test allows one to test the choice between a random-effects model and a fixed-effects model. Two hypotheses are put forward:

H0 : The differences between the FE and RE models are insignificant, the RE model is preferred .

H1 : The differences are significant, the FE model is selected.

The Breusch-Pagan test allows one to choose between the pooled model and the random effects model.

The selection of the final model is carried out based on the results of testing the Hausman and Broesch criteria Pagana .

## 4 RESULTS

The study focuses on the regions of the Volga Federal District of the Russian Federation. The assessment is based on the main types of goods supplied to the Volga Federal District regions via international supply chain generation channels established in the pre-sanction period of 2022. This timeframe was determined based on the patchiness of published official statistics by region for the studied area after 2022, as well as the need to assess the established organization of export-import flows in Russia at the time of the intensification of sanctions pressure in 2022 .

Guided by the developed methodological approach to identifying critical imports, its structure and content were determined within the framework of the regional group under consideration (Table 1).

Table 1: Critical TN VED of the Volga Federal District, 2021

No.	TN VED
1	Internal combustion piston engines with compression ignition (diesel or semi-diesel )
2	Bulldozers with a fixed or angle blade, graders, planers, scrapers, mechanical shovels, excavators, single-bucket loaders, rammers and road rollers, self-propelled
3	Internal combustion engines with spark ignition, with rotating or reciprocating piston motion
4	Machines and devices for lifting, moving, loading or unloading (for example, elevators, escalators, conveyors, cable cars) other
5	Flasks for metal foundries; foundry pallets; foundry patterns; moulds for casting metals (except ingot moulds), metal carbides, glass, mineral materials, rubber or plastics
6	Fork lift trucks; other trucks fitted with lifting or handling equipment
7	Metal-cutting lathes (including multi-purpose lathes)
8	Machining centers, single-position and multi-position aggregate machines for metal processing
9	Machines and other mechanisms for moving, leveling, profiling, developing, ramming , compacting, excavating or boring soil, minerals or ores; equipment for driving and extracting piles; snow plows and rotary snow blowers
10	Hoists and hoists, except skip hoists; winches and capstans; jacks
11	Machine tools (including machines for assembling by nails, staples, glue or other means) for working wood, cork, bone, hard rubber, hard plastics or similar hard materials
12	Machines for roughing and grinding, sharpening, grinding, honing, lapping, polishing and for

	performing other operations of finishing metals or metal-ceramics using grinding stones, abrasives or polishing agents, except
13	Machine tools for cutting metal (including modular machines of linear design) for drilling, boring, milling, cutting external or internal threads by removing metal, except for lathes (including multi-purpose lathes )
14	Longitudinal planing machines, cross planing machines, slotting machines, broaching machines, gear cutting machines, gear grinding machines or gear finishing machines , sawing machines, cutting machines and other machines for processing metals or metal ceramics by removing material, in other places n
15	Electric motors and generators (except electric generator sets)
16	Receiving equipment for radio broadcasting, whether or not combined in the same housing with sound recording or sound reproducing equipment or a clock
17	Organic chemical connections
18	Compounds containing other nitrogen-containing functional groups
19	Connections organic-inorganic other
20	Flat rolled products made of iron or non-alloy steel, width 600 mm or more, cold rolled (cold reduced), unplated , not plated or coated
21	Ferroalloys

Source: compiled by the authors

Thus, 21 TN VEDcrit were selected , the volumes of which account for the largest share of the total volume of imports from unfriendly countries as of 2021 and play a significant role in the creation of the final and intermediate gross product of the studied regions.

As an empirical basis, they developed a panel dataset for the Volga Federal District regions, including industrial production volumes and critical imports. The relationship between changes in the volumes of imported goods classified as foreign trade activities and production volumes was explored using pooled models, fixed-effects models, and random-effects models.

The next step involved a primary data analysis. The parameters studied, characterizing import volumes according to critical HS codes, serve as explanatory factors. The resulting indicators were indicators revealing production volumes of similar products. Descriptive statistics for the initial data are presented in Table 2.

Table 2: Descriptive statistics of the raw data.

	Critical import	Volumes production
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Average	492396.23	45415.05
Standard error	171024.33	12295.94
Median	9117.65	582
Fashion	173	170
Standard deviation	1904446,377	141803.68
Dispersion samples	3.62692E+12	20108283649
Excess	16.03	11.81
Asymmetry	4.14	3.56
Interval	9775496	676961
Minimum	103	0
Maximum	9775599	676961

Source: calculated by the authors

In accordance with the proposed algorithm, the next step involved constructing panel data models. The results obtained and their description are presented below.

In the first stage, the pool model was implemented. The calculation results are presented in Table 3.

Table 3: Results of panel data modeling using the pooling method.

	Coefficients	Standard error	t-statistics	P-Value
Y-intersection	11555.43	4366,033	2.65	0.009
Volume import	0.72521	0.002	35.33	2.18E-59

Source: calculated by the authors

$$R^2 = 0,96; F_{stat}=0$$

The obtained calculations indicate the statistical significance of the model. Thus, in the absence of random and fixed effects, the influence of critical import volumes on production volumes can be expressed by the following equation (2):

$$V_{\text{произв}} = 11555,43 + 0,7V_{\text{имп}}(2)$$

In the next iterative stage, data analysis was performed based on the implementation of a fixed-effects model using the Within -transformation method . The results are presented in Table 4.

Table 4: Results of the fixed effects model.

	Coefficients	Standard error	t-statistics	P-Value
Volume import	0.145	0.0015	9.58	2,4041E-15

Source: calculated by the authors

$$R^2 = 0,99; F_{stat}=0$$

The resulting equation is statistically significant. Controlling for individual effects, an increase in imports by 1 million rubles leads to an increase in the production of similar products by 0.145 million rubles.

The results of the calculation of the random effects model are presented in Table 5 .

Table 5: Results of the random effects model.

	Coefficients	Standard error	t-statistics	P-Value
Y-intersection	9877.59	3316,4033	2.97	0.003
Volume import	0.75	0.0015	47.31	1,0847E-71

Source: calculated by the authors

$$R^2 = 0,98; F_{stat}=0$$

As with the previous ones, the resulting equation and its coefficients are statistically significant.

The results of the panel data model implementation are presented in Table 6.

Table 6 : Results of the panel data model implementation.

	R <sup>2</sup>	Coefficients		Standard error	t-stat	P-Meaning
		b <sub>0</sub>	b <sub>1</sub>			
Model pool	0.96	11555.43	0.725	0.002	35.33	2.18E-59
Fixed model effects	0.99		0.145	0.0015	9.58	2,4041E-15
Model with random effects	0.98	9877.59	0.75	0.0015	47.31	1,0847E-71
Hausman Test	0.09					
Breusch-Pagan test	0.005					

Source: calculated by the authors

The obtained calculations indicate the statistical significance of the obtained models . The value of the Hausman test is 0.09, which is greater than 0.05, thus the hypothesis of the presence of fixed effects is rejected.

the Breusch-Pagan test is 0.005, which is less than 0.05, thus the random effects model is preferable to the pooled model.

Thus, to model the dependence of production volumes on the volumes of critical imports, a model equation was chosen taking into account random effects (3):

$$V_{\text{произв}} = 9877,59 + 0,75V_{\text{имп}}(3)$$

The resulting equation indicates that an increase in critical imports by 1 million rubles leads to an increase in production volume by 750 thousand rubles.

## 5 CONCLUSIONS OR DISCUSSION AND IMPLICATION

The final conclusion drawn from the conducted assessments is that critical imports significantly determine the economic growth dynamics of the regional group under study. This conclusion is based on econometric modeling of panel data, in which production volume serves as the dependent variable and the volume of critical imports serves as the independent variable.

The results of the evaluations of the resulting models (pool model, fixed-effects models, and random-effects models) demonstrate a statistically significant positive relationship between the studied indicators ( V<sub>prod</sub> , V<sub>imp</sub> ) . However , based on the results of model testing, the fixed-effects hypothesis is rejected, and the random-effects model is preferable to the pool model. Thus, unaccounted for individual characteristics of critical TN VEDs have a random but significant impact on production volumes, emphasizing the complex nature of the identified relationship.

It is important to note that the obtained estimates largely correspond with previous research in this area. For example, the works of Russian scholars ( Bezpалov , 2020; Import Substitution ..., 2023; Danilova et al., 2019) also note the need, in the context of sanctions restrictions , to focus on activating state economic policy in the area of creating and developing domestic production in those areas classified as critical imports based on the results of the study (Table 1). This is justified by the fact that, in the context of external restrictions, these product categories, along with a number of others (including those included in the critical import group based on the results of the study), play a significant role in ensuring the stability and rhythm of economic development processes. Meanwhile, these studies are based primarily on an assessment of the shares of these import groups in the total volume of products

supplied from abroad. At the same time, the use of special models that assess the impact of possible restrictions on the supply of critically important TN VED on macroeconomic trends is not carried out.

The implementation of this study largely compensates for this gap and contributes to the further development of the theory of import substitution economics from the standpoint of expanding the methodological base, including in the context of identifying critical imports and developing, on this basis, economic and mathematical models of their impact on the economic growth of regions.

The scientific and practical value of the obtained results is expressed in the following key aspects:

From an economic point of view:

- A methodology for identifying sectors that are critical to the economy in terms of the volume of imported goods has been proposed and tested.

- The existence of random individual differences between the volumes of critical imports and the production of similar products has been proven.

- The results of the study can be used by government agencies in developing strategic planning documents.

2. From mathematical:

- Models of spatial effects (pool model, random effects model and fixed variable model) were developed and tested to assess the impact of critical import volumes on macroeconomic dynamics.

- It was determined that the relationship between production volumes and the amount of imported products, critical for the economy of the regions of the Volga Federal District, is due to the presence of individual differences between the studied TN VED, but these differences are random.

Overall, the results of this study demonstrate its scientific and practical significance. It contributes to the development of a theory of regional economic dynamics in the context of systemic transformations. The developed tools for identifying critical imports and subsequently constructing models to assess their impact on sustainable economic development opens a new, improved approach to studying the impact of international supply chain transformations on regional economic growth.

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