ISSN 2782-1927

JOURNAL OF REGIONAL AND INTERNATIONAL COMPETITIVENESS

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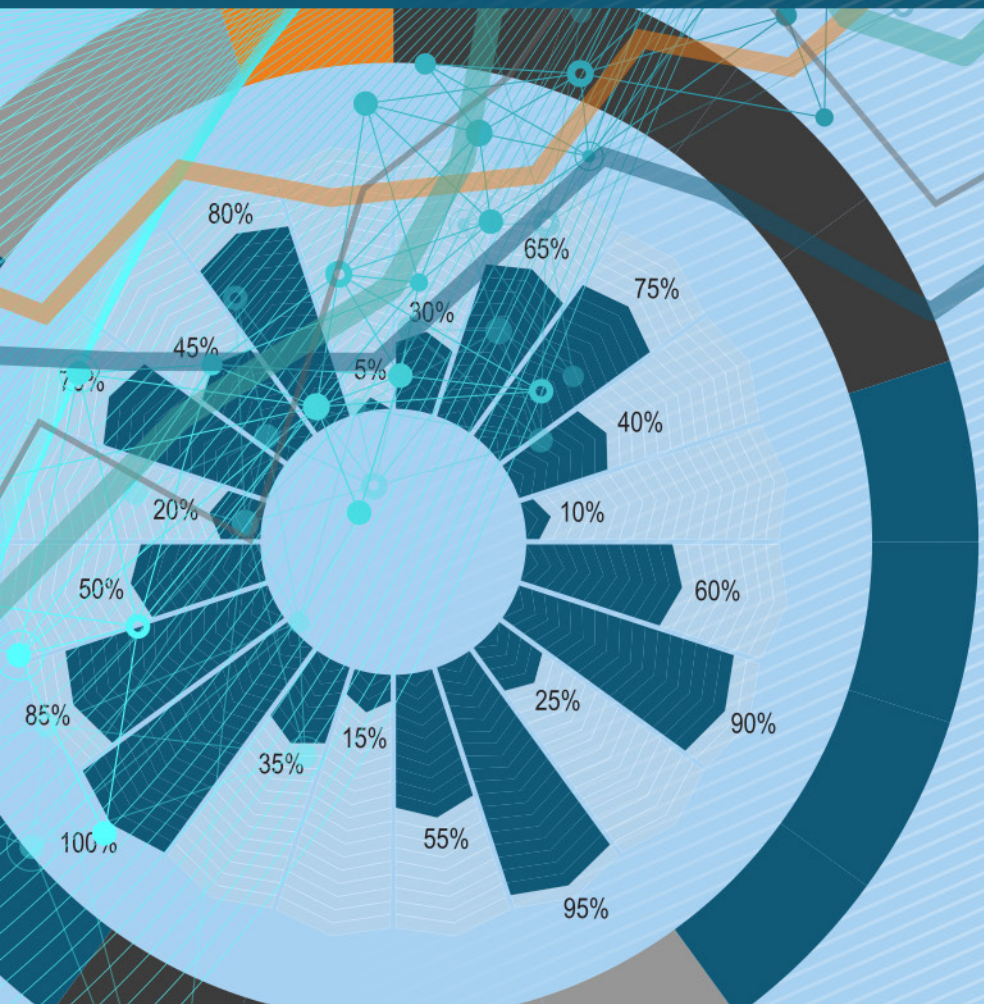

Vol. 6 (04) 2025

JOURNAL OF REGIONAL AND INTERNATIONAL COMPETITIVENESS

Scientific and practical peer-reviewed journal

Journal of regional and international competitiveness — theoretical and practical journal dedicated to the issues of international and regional competitiveness.

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ISSN	2782-1927
Regulator:	Registered by the Federal Service for Supervision in the Sphere of Telecom, Information Technologies and Mass Communication (ROSKOMNADZOR). Date of registration: 31.12.2020. Registration certificate ЭЛ № ФС 77 - 80072
Publication Frequency:	4 issues per year
Language:	English
Founder and Publisher:	Yaroslavl State Technical University, 150023, Russia, Yaroslavl, Moskovsky prospect, 88
Website:	http://www.jraic.com
Postal address:	150023, Russia, Yaroslavl, Moskovsky prospect, 88
E-mail:	jraic.ystu@gmail.com
Phone:	+7 (4852) 44-02-11
Date of issue:	28.12.2025

The journal is included in the list of leading Russian peer-reviewed scientific journals of the Higher Attestation Commission (VAK)

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International economic integration: performance assessment

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ORIGINAL ARTICLE

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Abstract. The dynamic development of integration processes in the global economy determines the relevance of assessing the effectiveness of international economic integration and examines the mechanisms of cumulative effect formation. Currently, there are no methodological approaches for a comprehensive assessment of countries economic integration effectiveness. However, there are theoretical issues representing the consequences of integration processes development. The research concerns with the effects of international economic integration and their quantitative assessment. The conducted analysis corresponds to the current stage of research. The purpose of the research is to provide a general assessment of international economic integration effectiveness based on the theoretical analysis of integration effects. This research considers the following aspects: systematisation of the types of effects generated by integration; analysis of quantitatively assessing direct integration effects; conditions for achieving a positive effect from a country's participation in integration; indicators of integration effectiveness; a general assessment of integration effectiveness based on indicators of economic dynamics for a number of integration associations; substantiation of promising areas of analytical research based on trends in the development of integration processes. The methodological basis is a systematisation of theoretically substantiated integration effects. However, the interrelationships between them determine the feasibility of using the method of summary indicators to assess the effectiveness of international economic integration. The research considers the practical aspects of analysing integration effectiveness. It aligns with national macroeconomic development goals and economic integration objectives: GDP per capita growth rates, comparative analysis of GDP and export dynamics, export quota dynamics. The basic research methods involve comparative analysis, retrospective analysis, summary indicators, and statistical methodology. The method of summary indicators has a theoretically substantiation and supported by an accessible information base. It is necessary to assess the effectiveness of international economic integration at several levels, assessment criteria, and methods. We performed a comparative analysis of the world's most significant integration associations. As a result, integration has a positive effect based on economic dynamics indicators. However, assessments of effectiveness as a factor in economic growth vary significantly across integration associations. Therefore, to assess the effectiveness of international economic integration there is a need in the additional research on the impact of integration processes on the global economy..

Keywords: international integration; factors of integration effects; conditions of efficiency; customs union; participation in integration; integration processes

JEL codes: F02, B41

DOI: 10.52957/2782-1927-2025-6-4-4-17

For citation: Tatiana A. Denisova . (2025). International economic integration: performance assessment. *Journal of regional and international competitiveness*, 6(4), 4.

Introduction

Currently, international economic integration is an important characteristic of the global economy. Its fundamental factors are the benefits of the international division of labour, economic interests of national economic entities, internationalisation of economic activity, and growing national economies. Integration processes are uneven across the regions of the world. It is reflected in both qualitative and quantitative characteristics of international integration dynamics. The EU countries have the highest level of international integration. Trade integration within NAFTA is also effective. Eurasia has great potential for integration processes development. In Latin America and Africa, integration does not provide sufficient effect due to the peculiarities of the chosen integration strategy. However, countries that do not consider the development opportunities associated with international integration in their economic strategy have fewer opportunities to ensure conditions for economic growth in the context of globalisation.

The economic issues of international integration were studied along with the political, legal, philosophical, managerial, and sociological aspects of integration processes. The content of economic research is determined

by questions about the essence, signs, forms, mechanism of formation of an interstate association, management of integration development, and the role of the state in integration processes development. The assessment of the effects resulting from international economic integration is one of the most important results of analytical work. In this regard, special attention is paid to studying the conditions ensuring the effectiveness of national integration. The complexity and multidimensional nature of international integration result in the absence of methodological justification to comprehensive assessment of economic integration effectiveness.

The concept of international economic is related to the concept of economic cooperation between countries. B. Balassa distinguished the concepts of "economic interaction" and "economic integration". Economic cooperation is considered as a set of measures aimed at harmonising economic policy. The process of economic integration includes measures to eliminate discrimination within a certain area [1]. International economic integration differs from other forms of economic interaction in a number of distinctive features. These include the formation of conditions for free trade and the movement of factors of production between the countries participating in the integration agreement, implementation of a policy of collective protectionism, coordination of economic policies of the member countries, convergence of economic mechanisms, formation of a single economic space based on international specialisation, structural changes in the economy, establishment of government bodies, tendency towards the unification of legislation, etc.

According the history of the world economy, the international economic integration has been an important factor in the development of countries and regions. However, the integration processes are contradictory ones. The dynamics of integration processes is characterised by changing models of economic integration. The classification of integration models can be performed according to various criteria. There are linear and nonlinear integration models based on the sequence of stages of integration processes.

Linear models are based on the integration process in different sectors of the economy and varying degrees of process intensity. The sphere of commodity circulation is the basis of integration processes at the first stages of international integration associations formation. Integration in the production sector is characterised by a longer period of formation the prerequisites. Monetary integration is the most difficult stage of integration processes. It requires a number of conditions, has high risks of negative consequences for the economic development, etc. In this regard, the expediency of a gradual deepening of international economic integration is justified.

The linear integration model is characterised by a sequential change of integration stages. According to the theory of economic integration by B. Belassa [1], integration is an evolutionary process; it has several main stages: preferential trade agreements – a free trade area – a customs union – a common market for goods and factors of production – an economic union – a monetary union – a political union. The possibility of deepening integration processes during the transition from trade integration to economic integration is associated with the formation of a number of additional factors. The most significant are the unification of the national legislation of the united countries, convergence of the system of norms and standards, formation of interstate and supranational government bodies, coordination of economic, monetary union, and financial policy.

The nonlinear model of integration involves non-compliance with the sequence of stages in deepening integration processes and the use of more complex mechanisms for coordinating the interaction of countries at the initial stages of integration. The nonlinear integration model in the current conditions is often chosen in the absence of the homogeneity of the economies of the united countries. In modern conditions, the nonlinear integration model has a number of modifications, such as "stepwise integration", "concentric circles", "differentiated integration". The first of these models of nonlinear integration presuppose the "core" consists of the most developed countries; around those countries with a lower depth are situated. The model of "differentiated integration" assumes differentiation of the speed of integration processes by countries within the integration association. As a result, the model of multilevel integration is widespread in the current conditions.

More flexible formats of international cooperation have led to an expansion of the classification of integration models. There are models of "negative and positive" and "superficial and deep" integration [2].

"Superficial" integration is the implementation of preferential trade agreements, formation of free trade zones, and customs unions. "Deep" integration involves higher integration stages. Nowadays, a model of cumulative integration [3] considers the range of relations leading to the economic rapprochement of a group of interested states. However, it does not use traditional forms of international economic integration. The cumulative integration concerns with the "FTA+" (free trade area in an expanded format) [4]. It differs in goals and privileges from the corresponding stage of the linear model of integration processes development.

Regardless of the chosen model, it is important to assess the effectiveness of international economic integration, both from the perspective of an individual country and the integration association as a whole. The effectiveness of integration processes is considered as a factor of political interaction between countries. The issues of assessing the effectiveness of international economic integration are still relevant. It determined the development of both theoretical and applied research in this area. The purpose of the research is to assess the effectiveness of international economic integration based on generalised indicators.

Methods

The methodology is aimed at implementing a quantitative approach to assessing the effectiveness of international integration. However, generally accepted methodology for assessing the effectiveness of international economic integration has not yet been developed. Various approaches, methods, and assessment criteria are used in the empirical study of the issue. The methodological foundations of modern research are based on the assessment of theoretically justified effects. Econometric models, gravity models, mathematical models of aggregated gravity, cluster analysis, and the construction of integral indicators are used as analytical tools.

The volume of mutual trade is often used as a generalising indicator of integration development. To measure this indicator, a gravity model is usually used [5, p.127]. The limitations of the basic version of the gravity model in international analysis causes an increase in the number of factors taken into account in the model. A number of assumptions used in the gravity model affect the reliability of the conclusions obtained. As a result, the assessment of the integration effect based on the use of this analytical tool is conditional. The use of gravity models is more appropriate in predictive assessments of the integration potential of trade development between countries. Although, further improvement of methods for assessing international trade based on the use of gravitational trade models is possible [6, p.226].

The choice of the assessment method for the conducted research is based on the study of integration and interconnection effects. The calculations are based on official data from the World Bank. The methods of dynamic series analysis for GDP, exports, population, number of indicators calculated are used. The systematic approach, based on the analysis of official data, allows us to identify the structural features of integration associations economic systems according to the degree of their involvement in international trade. The practical issues of efficiency analysis were considered on the basis of indicators corresponding to the goals of the countries' macroeconomic development and economic integration. The following indicators are calculated and analysed: the growth rate of GDP per capita, a comparative analysis of the dynamics of GDP and exports, the dynamics of the export quota.

The research uses the method of comparative analysis in terms of selected assessment criteria for five integration associations. It is the most significant in the modern global economy. The research was performed using the method of retrospective analysis; it covers the period 2010-2024. The method of generalising indicators is used. The calculation of generalising indicators is based on the application of official statistical data, statistical methodology, and the relationship of economic variables.

Results

The issue of assessing of international economic integration effectiveness has become particularly relevant at the stage of the formation of the Customs Union by the EAEU countries. The unification of countries on the basis of comprehensive coordination of all areas of foreign trade regulation generates both positive and negative effects. The main types of integration effects are described in the "theory of the customs union" [1]. Subsequently, the composition of the effects expanded, and a classification of integration effects

was performed [7, 8]. The following types of effects are distinguished: direct and indirect, static and dynamic, distributive and cumulative.

The direct effects of integration consist in changing market parameters in the export-oriented and import-substituting sectors, protecting the integrated market from external competition, reducing differences in the level of integration association economic development, etc. Indeed, direct effects can be quantified.

The indirect effects of integration are different: they do not have an accurate quantitative assessment. Although they have an impact on the overall performance indicators of the economic system of the integration member countries. They are multidimensional, including an assessment of changes in related sectors of the economy in terms of the output multiplier. The fundamental factor in its formation is a change in market parameters in sectors related to the international market. They are characterised by "cumulative" nature. There is more difficult to assess as increase with the expansion of the composition of the integration association.

Static effects are the consequences arising in the early years, immediately upon any country's accession to the customs union. Static effects of participation in the customs union include the "trade formation" effect and the "trade rejection" effect.

Dynamic effects appear at later stages of the integration association's functioning and include gradually accumulating changes in the economies of the participating countries. It is also proposed to divide the effects of integration into distributive and cumulative ones [9]. In fact, most of the distributional effects are based on a static approach. Cumulative effects correspond to dynamic effects of economic integration.

The composition of static (distributive) effects can be determined by the effects of trade creation, trade deviation, structural adaptation, wealth effect, terms of trade effect, border effect, and "neighbour ruin" effect.

The effect of trade establishment increases trade flows between integration countries. It leads to an increase in the share of intra-integration trade in the foreign trade turnover of the integration member countries.

The trade deviation effect reduces the share of non-integrated countries in the foreign trade turnover of the integration member countries due to a change in foreign trade partners. It can provide the negative effects of the transformation. When a country joins an integration association, the change in trade flows may be due to the fact that imports will be supplied not from a low-price supplier from a country outside the customs union, but from a supplier with a higher price within the integration association. The benefits for consumers result in the state budget revenues loses. Those were previously provided by customs duties.

The effect of structural adaptation is associated with changes in the sectoral structure of united countries' economies due to intensification of specialisation and decrease in the share of import-substituting industries. The use of dynamic models for analysing the structural adaptation of the economy to the conditions of integration makes it possible to formulate those to achieve rather positive than negative effects [2].

The wealth effect is more important in conditions of larger customs union. In this case, the establishment effect will exceed the consequences of the deviation one [7]. The analysis of these effects includes an assessment of supply and demand traded goods elasticity. Indeed, in conditions of elastic demand, the customs union can have a positive effect, despite the effect of trade reorientation. It is proposed to consider this effect as an effect of "trade expansion" [8].

The effect of trade terms is formed by changing the ratio of the price index for export and the price index for imported goods. It can change significantly when forming an integration association. The trade index is greater than one; the wealth of the nation increases due to foreign trade.

The border effect considers costs associated with goods crossing a border. In the context of integration, this effect is significantly reduced.

The effect of ruining a neighbour is explained by negative effect of customs union formation in the third countries. Due to the effect of trade deviation, world prices for goods from third countries may decrease, worsening trade conditions for them [10].

Based on distributional effects, it is possible to assess the necessary economic conditions for establishment an integration association between countries [9].

The cumulative effects of integration are multidimensional and dynamical ones. According to B. Belassa,

a static analysis in terms of trade and redistribution is insufficient for a proper analysis of wealth growth as a result of economic integration [1]. The composition of this group was gradually expanded based on subsequent studies results. The dynamic (cumulative) effects of integration include a number of changes in the economies of merged countries. They generally affect the economic growth of participating countries' economies. This group of effects includes the effect of markets structure changing, effect of economic openness, effect of competition, effect of economic efficiency growth, effect of scale, effect of intra-industry trade growth, effect of investment flows, effect of countries institutional development, effect of eliminating the uneven economic countries development, effect of achieving sustainable development goals.

The effect of changing of markets structure [11], resulting in a more efficiently organised economic space. Changing the sectoral proportions at country integration into association is an objective process. The degree of integration influence on the sectoral structure of the economy varies depending on the country's involvement in the intra-integration division of labour.

The effect of economic openness is considered as a factor of countries economic growth. The openness of trade attracts foreign and domestic investments, stimulates the pace of capital accumulation, promotes savings and GDP growth [12].

The effect of competition stimulates the innovative development of the economy;

The effect of increasing economic efficiency by formation a more efficient production structure in terms of the comparative competitive advantages of each participating country. If the specialisation is chosen correctly, structural changes in the economy of each country occur in the direction of increasing the share of more efficient industries. It is a factor of increasing the efficiency of the economy, both in the hotel country and the integration association.

The benefits of scale can be exploited precisely in the presence of a capacious sales market. It ensured by the conditions of trade integration of countries [10] and intensification of specialisation. Those effects are as follows:

- The effect of the growth of intra-industry trade is considered as an indirect indicator of the benefits associated with this customs union [10].

- The effect of investment flows [13, p. 134] at transition of direct investments within a trade bloc from a country with a high cost of production to a country with a lower one.

- The effect of institutional development of countries at increasing in foreign trade can impact on the qualitative development of institutions and the transformation of internal rules governing national economies.

- The effect of eliminating the unevenness of countries and regions economic development, i.e. contributing to the improvement of the common good [11].

- The effect of achieving sustainable development goals based on supranational regulation [5].

Therefore, dynamic effects have the positive impact of integration on the economic growth of the participating countries. The effects of international economic integration in each specific case depends on the vector of integration interaction [14]. In general, with the intensification of integration processes the efficiency increases [15]. At the same time, it is important to quantify the assessment of the effects. However, it is quite difficult to make an assessment of these effects due to the high degree of uncertainty of long-term integration processes in the global economy [9].

A quantitative assessment of the positive effects based on a retrospective analysis. Depending on the change in the direction of trade flows, resulting effects are caused by changes in market parameters in those economic sectors participating in international trade. The value of the effects depends on the elasticity of demand for the price in the foreign market of a given product, elasticity of supply for product price, elasticity of demand for the price of imported goods, coefficients of cross-elasticity, changes in the sectoral employment structure, etc. A comprehensive analysis of the consequences in all sectors related to the international market theoretically allows us to assess the cumulative impact of integration on the economy of an individual country – a member of the integration association. This research could be conducted on the basis of generalised information base. Its sources would be official statistics, including input-output tables, dynamics of market parameters by economic sectors in terms of the integration; data on the analysis of supply and demand

for traded goods in partner countries, information on changes in regulatory documents on foreign trade regulation, etc.

Due to the limited information base for such an analysis in the framework of empirical research, it can be assumed that the effects of integration are underestimated.

Therefore, variety of integration effects influences on the selection of criteria for generalised assessment of international economic integration effectiveness based on other methods. Conceptually, such an integration model should be recognised as successful. It ensures the achievement of the set goals [16, p.169]. The international economic integration is based on common economic interests. As a result, the development of integration processes is determined by the common goals of countries economic development and the prerequisites for their faster achievement, and intensification of integration processes. The main goals of a country's participation in international economic integration can be considered an economic growth based on increasing the efficiency of national production, increasing the competitiveness of the economy, strengthening its position in international trade, and gaining access to cheaper financial, labour, material, and technological resources.

The study of the relationship between economic growth and the country's participation in integration associations is an important issue. Based on the theory of endogenous growth, integration provides the conditions for continuous growth [17]. An analysis of the long-term effects of regional trade agreements shows an increase in trade volume. It leads to sustainable economic growth through cooperation and increased market access [18]. In the context of integration, the production function changes under the influence of changes in the economic conditions of the united countries. It provides benefits from medium-term economic growth [12].

Therefore, regional integration is one of the mechanisms of socio-economic growth based on mutual trade of the countries participating in the integration process [19, p. 90]. As a result, indicators of economic dynamics can be considered as indicators in assessing the effectiveness of international integration. At the same time, it is advisable to generalise the analysed indicators for the integration association and consider the economic dynamics in the long term.

Scientific literature considers the share of intraregional trade in the total trade turnover of the countries of the association as criteria for the effectiveness of countries economic integration [19, p.90], share of mutual trade turnover with the countries of the integration association in the total foreign trade turnover, dynamics of mutual trade turnover, GDP growth, export and import growth, capital accumulation, the level of employment [20], index of terms of trade [21], etc.

Some of these indicators are indirect for effectiveness assessment. Therefore, the development of economic integration may be associated both with positive and negative effects. However, country's accession to the integration association may have ambiguous consequences for the internal well-being of the participating countries. Negative effects may be associated with increased competitive pressure. It results in a decrease in national production, reduction in aggregate demand in the domestic market, increase in consumer spending on imported products, decrease in budget revenues as a result of the abolition of customs duties and a decrease in national production, the presence of structural costs in the intersectoral migration of factors of production due to the effect of changing the structure of markets. There may be some contradictions in the interests of countries within integration groupings due to differences in the magnitude of the advantages they receive in the context of integration. It depends on the comparative advantages of countries in the production of traded goods. Negative effects can be considered as integration costs.

To assess the "net effect", it is important to compare the quantitative parameters of positive and negative effects. The technology of this comparison involves the use of various methods for calculating economic quantities to provide both a quantitative and qualitative assessment of the consequences of integration. Although, clear quantitative indicators cannot be calculated for a number of integration effects. However, there is currently no single methodology to accurately assess all the effects of integration [5, p.127].

In case of methodological uncertainty, we have to consider conditions providing a large net positive effect from the country's participation in trade integration at the customs Union level. These conditions are

assessed during a preliminary analysis. The value of the positive effect will be higher under the following conditions:

- demand for imported goods is more elastic in price; it determines the difference between the volume of imports before and after the country's entry into trade integration;
- lager difference between the costs of national production and the costs of the country participating in trade integration, from which the goods will be imported under the conditions of integration; smaller difference between the production costs of the partner country in trade integration and the production costs of the third country from which the goods were previously imported;
- value of the import duties were before the country joined the customs Union;
- smaller difference between the import duties imposed by the integration association in relation to countries outside the integration association; amount of import duties previously applied by the member countries of the customs union;
- higher degree of competitiveness of the integration member countries in relation to protected industries before the creation of the customs union;
- larger part of the trade between the countries participating in the integration before the formation of the customs union;
- larger number of countries of the integration union – positive result is predetermined by the effect of economies of scale. An increase in the export sales market establishes conditions for the growth of the most effective types of activities in the economy, ensuring an increase in efficiency.

However, higher share of national products in domestic consumption before the country's accession to the Customs Union provides increasing of country's population wealth.

Faster trade between the members of the integration association decreases the share of foreign trade with other countries in foreign trade turnover.

The higher economic development of countries provides their competition with each other [26, p. 378].

In general, these prerequisites form the excess of the formation effect over the trade rejection effect. It ensures the wealth effect. However, this effect is not similar to all member countries of the integration association. The degree of difference in the effect depends on the difference in changes in domestic prices for traded goods and the elasticity of national supply and demand.

Therefore, to ensure the effectiveness of integration, the role of the state in integration processes is important. Moreover, this issue was paid special attention in scientific research. According to B. Belassa, the role of the state is of fundamental importance at all stages of countries economic unification. It increases in development and deepening integration. Moreover, the state provides an appropriate compromise between administrative and economic regulatory instruments [1]. According to the integration processes in Western Europe, the condition for a country to receive greater benefits from participating in economic integration is the implementation of a coordinated economic policy by the integrating countries. It highlights the special role of the state in the development of integration processes.

The positive economic effect of a country's entry into an international integration association can be assumed based on some empirical patterns. The most effective are "the results of the activities of those interstate associations and union members of the comparable types of civilisations. In this case, economic rapprochement is complemented by common historical, cultural, and religious roots, resulting in a qualitatively new space ..." [22, p. 72]. A prerequisite for transition towards higher levels of integration is the criterion of political compliance with the economic component of the integration process [22, p. 73]. However, it is necessary to consider the homogeneity of the socio-economic systems of the member states as a prerequisite for integration processes.

The issue of integration associations effectiveness is practically significant at considering integration as a tool for managing effectiveness dynamics of the national economic system.

The effectiveness of international economic integration can be assessed in terms of the effectiveness of an individual country's participation, perspectives, factors influencing the development of the global economic system. At the level of an integration association, empirical verification of effectiveness can be performed

on the basis of an appropriate information base. It based on data published by national statistical agencies and international organisations. As an addition, we consider strategic documents for the development of integration associations, countries, and industries of the most important sectors of the economy.

Based on a comparative analysis of generalising indicators dynamics for the most significant integration associations, it is possible to assess integration processes effectiveness. It is assessed using a system of indicators characterising the dynamics of foreign trade, total GDP of the integration association, and GDP per capita. The compliance of these indicators with the objectives of the study is determined by the calculation based on them. It provides a comprehensive assessment of the dynamics of wealth effect of integration associations by the rate of GDP growth per capita. The growth of wealth is one of the most significant effects of trade integration [8].

Table 1 shows data on the dynamics of GDP per capita for the most developed integrations worldwide. The EAEU data was not considered for the following reasons: First, the founding Treaty on the Eurasian Economic Union was signed on May 29, 2014[1]. The one of the most important elements of the unity of foreign trade policy – the unified Customs Code of the EAEU was adopted only in 2017. Secondly, the EAEU economies have a low volume of domestic trade. For instance, Russia and Kazakhstan are focused on exporting natural resources to importing countries outside the union [23]. However, this problem is inherent in the majority of integration associations of countries with emerging markets [19, p. 90].

Table 1 – Comparative indicators of GDP growth per capita, 2010-2024, the most significant international integration associations

Integration associations	Population (mln people)			GDP ($ bn USD)			GDP growth rate per capita, %,2010-2024	An increase in the number of participating countries, 2010-2024
	2010[2]	2024[3]	Growth, %	2010[4]	2024[5]	Growth, %		
EU	506.4	450.4	-11.1	17,082.8	18,309.4	7.2	20.9	+1 -1
NAFTA	461.2	516	11.9	17,771.7	31,290.0	76.1	57.4	-
APEC	2,727	2,973.4	9.0	36,465	63,694.3	74.7	60.3	[10]*
BRICS	3,420.9	3,925.9	14.8	13,903.8	28,754.1	106.8	80.1	5
The SCO	3,001.1	3,441.9	14.7	10,427.7	24,556.3	135.5	105.3	4 / 2
World	6,884.3	8,127.0	18.1	66,364.9	105,435.0	58.9	34.6	H

** Applications for membership*
Source: Author

According to presented data, the countries of the leading integration associations had higher GDP growth rates per capita in 2010-2024 compared to the global average. It characterises the positive effect of integration in terms of countries economic dynamics. The exception is the growth rate of GDP per capita in the EU. However, the value of GDP over the last year of the analysed period was influenced by the fact of the UK's withdrawal from the EU (the second largest economy of this integration association). In 2010, the UK's

[1] Development of Eurasian Integration. Ministry of Economic Development of the Russian Federation. Source: https://www.economy.gov.ru/material/directions/vneshneekonomicheskaya_deyatelnost/razvitie_evraziyskoy_integracii / (accessed on 11.08.2025)
[2] World Population. IMEMO RAS Official Website. Source: https://www.imemo.ru/files/File/magazines/Osn_pokaz_ME/2015/stat2014_tabl.pdf (accessed on 11.08.2025)
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[4] Nominal GDP. Prognostics. Source: https://prognostica.info/news/nominalnyj-vvp-top-10-stran-briks-2000-2021-gody / (accessed on 08.11.2025)
[5] Ranking of countries in the world by the level of gross domestic product 2024. World Bank: Gross Domestic Product 2024. Source: https://gtmarket.ru/ratings/gross-domestic-product-ranking (accessed on 11.11.2025)

GDP was 14.56% of the total EU GDP.

Moreover, the comparison base has a great influence on the calculation of dynamic indicators. In this case, there is an effect of an "overestimated base".

Higher economic growth over the analysed period is a common characteristic of other integration associations presented. The marked excess of the growth rates of the total GDP in the SCO, BRICS, and APEC is due to the high growth rates of the Chinese economy. It was stimulated by the growth of investments financed by the large-scale provision of targeted loans.

Foreign trade indicators are used to assess economic integration effectiveness. The export quota indicator has a generalising character. The dynamics of the export quota as a macroeconomic indicator characterises the change in the importance of exports for country economic development (Table 2).

Table 2 – Assessment of export share dynamics in GDP on the most important international integration associations, 2010-2024

Integration associations	Exports /GDP (%)		Δ d exp pp.
	2010	2024	2024-2020
EU	34.02	53.78	19.77
NAFTA	14.91	14.67	-0.24
BRICS	24.78	23.01	-1.77
The SCO	26.46	21.87	-4.59
APEC	22.78	22.58	-0.19

Source: Author

Many indicators of international trade depend on the conjuncture in world markets and often cannot be interpreted by the expediency of a country's participation in an integration structure.

According to Table 2, the role of exports as a factor of economic development has increased significantly only in the EU. It indicates a significant impact of the integration of European countries into the economic growth of the EU. The change in structural characteristics is explained by differences in the dynamics of the compared indicators. The assessment of international trade importance for economic growth is also based on a comparison of exports and GDP for the analysed integration associations (Table 3).

Table 3 – Assessment of international trade importance for economic growth member countries of the most important international integration associations, 2010-2024

Integration associations	Average annual growth rate, 2010-2024 (%)		Comparison of the average annual growth rates of exports and GDP (k)	% of export growth per 1 % of GDP growth
	export	GDP		
World	103.43	103.36	1.00065	0.06482
EU	103.84	100.50	1.03326	3.32559
NAFTA	104.00	104.12	0.99880	-0.11986
BRICS	104.77	105.33	0.99471	-0.52873
The SCO	104.87	106.31	0.98646	-1.35369
APEC	104.00	104.07	0.99937	-0.06294

Source: Author

The calculations were performed according to the data of the World Bank. The average annual indicators allow us to obtain a more objective assessment, levelling the influence of random factors on the dynamics of the analysed values. The calculated data show the average annual growth rate of global exports for 2010-2024. It corresponds to the growth rate of the global GDP. For each percentage of the average annual increase in the MVP, there is a 0.06% increase in the corresponding export value. A comparison of the indicator reflecting

percentage of export growth accounts for 1 percent of GDP growth by integration associations shows differences in the average annual dynamics of exports and GDP. However, it is one of the most important indicators of integration effectiveness. Indeed, each integration group is the basis of integration processes forming conditions for higher-level inter country interaction. As a result, the development of international trade within the framework of the integration association ensures the growth of macroeconomic indicators of the united countries and is a factor of positive economic dynamics.

According to Table 3, trade integration is effective only within the EU. In the EU, for every percentage increase in total GDP, 3.3% of exports increase. Therefore, the international trade within the framework of this integration is an important factor in the growth of production within the framework of the association. To a significant extent, it is the evolutionary nature of the integration processes in the EU and the well-established economic mechanism for managing the united economy. In general, Western European integration acts as a mechanism for the socio-economic growth of countries based on mutual trade between states participating in integration processes. This result was conceptually substantiated by well-known scientists who revealed the theoretical essence of integration effects.

For other integration associations, there is no positive relationship between export growth and GDP growth. It is explained by the lower efficiency of economic integration between the merged countries. Objective reasons for this situation include the later dates of the creation of integration associations compared to the EU, the lower economic homogeneity of the integration member countries, difficulties in agreeing on a common foreign trade policy, more diversified goals for the creation of integration unions, more global nature of the composition of countries.

The researches to assess the effectiveness of international economic integration consider the impact of integration processes on global economy development. This issue can be considered based on the dynamics of the structural indicators of the global GDP and global exports. The difficulties in interpreting the calculated values are related to several integration associations. They form ambiguous conclusions on structural characteristics. It is possible to compare the economic development rates of countries participating in international economic integration and the global average growth rates. The presence of faster economic dynamics in integration associations is evidence of the positive impact of integration processes on global economic development. However, global averages are formed at the expense of all countries, including fundamental differences in the implemented development model do not correspond to progressive structural changes in the global economy. As a result, the conclusions obtained on the basis of such comparisons will differ in a conditional nature. The calculations are presented in Table 4.

Table 4 – Assessment of the dynamics of the share of the most significant international integration associations in world exports and global GDP, 2010-2024

Integration associations	Share of global exports (%)		Share in MVP		Coefficient of change		Ratio of changes d exp and d mvp
	2010	2024	2010	2024	export shares (d exp)	MVP shares (d MVP)	
EU	40.3	26.6	25.74	17.37	0.6600	0.6746	0.9784
NAFTA	17.8	18.8	26.78	29.68	1.0562	1.1082	0.9530
BRICS	27.1	23.1	20.95	27.27	0.8524	1.3017	0.6548
The SCO	22.0	18.5	15.71	23.29	0.8409	1.4823	0.5673
APEC	58.9	55.7	54.95	60.41	0.9457	1.0995	0.8601

Source: Author

For all integration associations, the rate of change in the share of global exports lags behind the rate of change in the share of global GDP. The degree of difference in the dynamics of these structural characteristics varies significantly among the integration unions represented.

According to calculations, the EU and NAFTA show identical changes in terms of their share of global exports and global GDP. The coefficient calculated on the basis of comparing the changes in the share of the integration association in world exports and world GDP for the EU and NAFTA is close to unity. It reflects the situation when the countries' foreign trade has real prerequisites for the economic development of the countries participating in the integration. The other integration associations during the analysed period show a decrease in the share of world exports with an increase in the share of GDP. It indirectly indicates a lower efficiency of economic integration. Deeper integration processes characterise Western Europe and North America. The Asia-Pacific region demonstrates high integration potential.

In general, the economic benefits of integration outweigh the costs associated with any integration process. It is proven by the practice of the leading integration groupings – the EU and NAFTA.

The result of a comparative assessment of integration associations in world exports and GDP for BRICS and SCO is a reflection of the diversified goals of the creation of these associations. Maximising the economic well-being of citizens is a goal of the state's foreign trade policy. Moreover, the range of actors responsible for its development is not limited to national governments. As a result, the economic effectiveness of foreign trade policy may reflect more private interests than the national wealth [25].

The higher values of the calculated APEC structural parameters reflect the specifics of the region as the most dynamically developing, and also characterise the integration potential of this association. Under the appropriate conditions it will ensure the effectiveness of integration within the association. Therefore, integration processes proceed unevenly across the regions of the world. It is manifested in both qualitative and quantitative characteristics of the most important parameters dynamics forming under the influence of international economic integration. The EU is characterised by a high level of effectiveness of international integration.

Increasing the effectiveness of integration processes is important in the context of growing global instability and the challenges facing countries become more complex [19, p. 92]. Meeting a number of conditions will contribute to improving the effectiveness of international economic integration:

- gradual intensification of integration processes;
- common customs tariff for a particular product group at the level of the lowest tariff among the integration member countries before the formation of the common customs area;
- dynamically development of integration processes for transition to higher levels of integration; it ensures higher efficiency in the use of production factors;
- open integration groups to expand the membership of member countries; it ensures the formation of positive dynamic effects;
- transparent rules governing integration relations between countries, clear interpretation in the relevant situation, etc. [26]

These conditions are aimed at increasing the dynamic effects of integration, both by intensifying integration processes and expanding the membership of the countries of integration associations. Therefore, integration processes will ensure the growth of the global economy. However, this association develops effectively within its borders, there are no contradictions between integration associations, and countries out of integration.

Conclusion

In the modern global economy, integration unions differ in their development trajectory. New integration formats are emerging. Therefore, the EU experience is becoming less significant. However, the calculations show the effectiveness of the European integration model.

The new integration unions have an interregional character in terms of the number of participating countries and a "globalised" nature of their activities. Currently, there is a tendency for the development of integration processes between countries of different world geographical regions. The member states of an integration association may not have common state borders and be located on different continents. The establishment of international economic integration mega-formats, new formats based on project cooperation

reflects the trend of increasing complexity of integration processes.

The dominance of nonlinear integration models allows to assess the effects of integration in the considered areas. However, there are some previously identified patterns with limited extrapolation interval.

International economic integration is a complex and multifaceted phenomenon. Its economic benefits can be achieved both through traditional factors and cooperation in other areas. In the current conditions, integration processes are influenced by a political factor determining the development of strategic cooperation with friendly countries. In fact, it means dividing the global economy into blocks based on common values, rather than based on economic expediency. At the same time, new factors for integration processes development have emerged based on the increasing role of global value chains. It reflects the processes of production internationalisation. Therefore, the number of factors determining global integration processes has increased in terms of the diversity of integration formats.

In these conditions, the importance of assessing the international economic integration effectiveness is increasing with the growth of methodological justification complexity of research in this area. Using the method of generalising indicators in combination with a factor analysis of evaluation criteria dynamics will provide an opportunity to illustrate the advantages of international economic integration and analyse the effectiveness of new integration formats.

The study of issues of assessing international economic integration effectiveness develops on the basis of theoretical analysis, generalisation of empirical research results, and integrated approach to further study of integration processes.

FUNDING

The work was done on a personal initiative.

CONFLICT OF INTEREST

The author declares no conflict of interest.

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Received 21.09.2025
Revised 05.11.2025
Accepted 15.12.2025

Macro-Level Dynamics of Agricultural State Support: Time-Series Analysis of Russia's Post-Soviet Agricultural Transformation (1991-2024)

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ORIGINAL ARTICLE

Abstract. A time-series econometric analysis (1991-2024) of Russia's agricultural state support was conducted to evaluate the effectiveness of this support. Structural break testing within this analysis identified three distinct policy periods over the course of this study. The results of the analysis established that research and development (R&D) and the quality of governance have output elasticities that are significantly higher than those associated with direct subsidies, which were found to have declining returns. The findings also suggest that external shocks further decrease the effectiveness of these types of subsidies. The findings of this analysis challenge the prevailing narrative that supports the notion of quantity over composition in support to agriculture as it demonstrates that the composition of supports may be of greater importance to long-term agricultural growth than the quantity. The analysis provides policy recommendations that advocate for the reallocation of resources from universally provided subsidies to merit-based grants for both innovation and institutional reforms that will improve productivity and resilience within the agriculture sector in Russia.

Keywords: agricultural support; time-series analysis; structural breaks; institutional quality; Russia; post-Soviet transition; macroeconomic policy

JEL codes: M41, H57, L64, Q18

DOI: 10.52957/2782-1927-2025-6-4-18-31

For citation: VOnwusiribe Chigozirim Ndubuisi . (2025). Macro-Level Dynamics of Agricultural State Support: Time-Series Analysis of Russia's Post-Soviet Agricultural Transformation (1991-2024). *Journal of regional and international competitiveness*, 6(4), 18.

Introduction

Since the market became liberalized in Russia in 1991, the country's agricultural sector has received constant attention from policymakers, and the state has increased its support for the sector to provide food security, provide stable incomes in rural areas and retain the competitiveness of its agricultural structures for export purposes. However, the amount and types of support that have been provided have developed with time, showing how the Russian government has learned about how to best support the agricultural industry and how political and economic issues [24; 54] impact agriculture in the country, with a less predictable degree of productivity outcomes. I investigated 35 years of the Russian government's support to agriculture (1991-2024), using econometric analysis based on time series, and asks the following question: Does how support is provided or the amount of support affect agricultural growth? More specifically, what types of support (i.e. financial support, investments in operations, regulatory control) in differing combinations lead to the greatest agricultural development? As an area of research, this question is both an interest of agricultural economists and importantly relevant to decision-makers within Russia right now. The academic literature suggests that larger budgets lead to larger increases [36; 37]. But according to the theory of institutional economics, institutional quality, governance, and program design will ultimately determine if increased support will lead to increase productivity or if it will be leveraged and utilized by those seeking to take advantage of it [1; 41]. Additionally, because of the current post-sanctions crisis with limited budgetary resources, the Russian government must examine and determine how to best utilize its available support resources moving forward.

Theoretical Framework and Literature Review

Support Theories and the Quantity vs. Quality Debate

Three major categories of Agricultural Support Policy Literature include; (1) Interventionist; where State Supported Agriculture is imperative to alleviate market-based shortcomings and concentrates on the level of such Support [36; 18]. (2) Market-Oriented – that providing excessive levels of Support distorts pricing mechanisms in the market leading to lower incentives for efficiency [7]. (3) Institutional – where the effectiveness of Support is directly related to the quality of the Institutional structure related to Property Rights, enforcement of Contracts, and Transparency in Governance [1; 53].The specific framework synthesizes a Tripartite Support Typology: 1) Financial Support (direct Cash Transfers/Subsidies); 2) Operational Support (such as Technology Platforms and the Infrastructure required to implement the use of those Platforms); and 3) Regulatory Support (the Institutional Frameworks and Governance Structures). I propose that Regulatory Support serves as a mediating variable to determine if Financial and Operational Support will create the Success that is expected from their Integration.

Russian Agricultural Support Evolution: Institutional Context

Russia's agricultural support policy evolved through distinct phases:

• Phase 1 (1991-1999): Transition's Base and Early Crisis. Market liberalization and hyperinflation created an environment in which early intervention programs to support the transition did not work. While the legal framework for a land reform programme was created, the enabling legislation was delayed, creating a situation where property rights were ambiguously defined, thus inhibiting private investment into the agricultural sector [26]. Production of grains dropped significantly from 121 million tons in 1991 to 65 million tons in 2000.

• Phase 2 (2000-2013): Institutionalisation and The Systematisation Of Support. The stabilisation of the agricultural sector after 1999 created the opportunity for systematic policies to be created. A unified subsidy framework was established with the advent of Federal Law No. 264-FZ (2006). The introduction of the State Programme of Agricultural Development (2012) established a systematic approach to providing support. By 2013, production of grains increased to 97 million tons, while significant regional disparities developed [34].

• Phase 3 (2014-2024): The Expansion Whereas On Sanctions And The Shift Toward Export-Driven Support. As a consequence of the western bans on food imports, a dramatic increase in the amount of support provided occurred. Threefold budgetary increases were recorded. The amount of wheat exported increased 240% resulting in Russia becoming the largest exporter of wheat in the world by 2016[1]. The distribution of the benefits of this growth were uneven [9].

• Phase Four (2023+): The Move Toward Technological Sovereignty And Regional Expansion. The priority of the agricultural sector has shifted to Research and Development, Education and Digital Agriculture, which is a change to greater qualitative support, as knowledge-based support will now be available using digital technology, as opposed to traditional technology.

Policy Evolution via Time-Series Analytical Techniques

I use time-series structures (Chow Tests and Bai-Perron Breaks) as methodological tools for identifying both identified time frames as well as turning points in time. Using these time series methods for period analysis corroborates the periodization work discussed in this section (Perron 2006).

Economic Performance through Governance Quality

Governance quality has a direct effect on the expected benefits derived from the credibility associated with property rights, as well as on the expected benefits from subsidies that are allocated transparently and effectively to provide resilience towards negative economic dynamics [20]. I assess if there is a mediating effect associated with the effectiveness of Russia's institutions for the value derived from both the size of government support and the performance associated with government-supported output.

[1] *Rosstat (2024). Grain Balance Tables. Russian Federal State Statistics Service. Source: https://rosstat.gov.ru/folder/313/document/13278 (accessed on 01.11.2025)*

Methods

Data Sources and Variables

Time period: 1991–2024 (N = 34 annual observations).

Dependent variable: Gross Agricultural Output (GAO), real agricultural value-added (billions, 2012 prices).

Source: Rosstat, World Bank.

Independent variables:

– State Support (Subsidies): Total federal and regional subsidies (billions, nominal). Log-transformed.

– Government Effectiveness Score: World Bank WGI index.

– Digital Platform Adoption: % of agricultural enterprises with internet/digital platform usage.

– R&D and Education Expenditure: Government expenditure on agricultural R&D as % of GDP.

– External Shocks: Sanctions dummy (2014-2024), FAO Food Price Index (lagged), exchange rate volatility, climate shock dummies.

– Institutional Capacity: Rule of Law Index, Land Titling Efficiency.

Descriptive Statistics: The Appendix provides information demonstrating an increase of 189% from the Transition Crisis period to the Sanctions Expansion period. There was an increase in subsidies from average crisis level of 67.3 billion to 516.2 billion during sanctions period. Modest improvement was also noted with respect to Governance effectiveness.

Econometric Methodology

1. Unit Root Testing (Augmented Dickey-Fuller): To determine stationarity.

2. Structural Break Tests (Chow, Bai-Perron): To test for breaks at a priori (2006, 2014) and unknown dates.

3. Vector Autoregression (VAR) and Granger Causality: To examine dynamic relationships and causal directions.

4. Error Correction Model (ECM): To separate short-run dynamics from long-run equilibrium if variables are cointegrated.

5. Impulse Response Functions (IRF) and Forecast Error Variance Decomposition (FEVD): To trace dynamic responses to shocks.

6. Regression Analysis (OLS): For baseline elasticity estimation with time and regional dummies.

Econometric Methodology Specification

Unit Root Testing (Augmented Dickey-Fuller)

I tested for stationarity using the Augmented Dickey-Fuller (ADF) test (Dickey & Fuller, 1979) to determine if variables were integrated of order zero I(0) or one I(1). The specification with a trend and constant was:

$$\Delta Yt=\alpha+\beta t+\gamma Yt-1+\sum i=1p\delta i\Delta Yt-i+\varepsilon t \quad (1)$$

The first difference of Yt is represented as ΔYt, where t is the time trend and δ tests the null hypothesis of a unit root (H0: γ= 0). Lag length p was chosen based on Akaike Information Criterion (AIC) [2].

Structural Break Tests

To identify shifts in the relationship between support and output, we employed two tests. First, the Chow test [8] for known break dates (2006, 2014):

$$F=(SSRpre+SSRpost)/(T-2k)(SSRpooled-(SSRpre+SSRpost))/k \quad (2)$$

whereas k – means the values of the parameters and T – represent the total count of samples.

Secondly, Bai-Perron Sequential Test (1988) tested for unknown break dates and allowed for the detection of multiple structural breaks within the context of linear regression through repeated iterations,

incorporating the use of an endogeneously determined technique to recognise when the transition between regimes occurred.

Vector Autoregression (VAR) and Granger Causality

I specified a VAR(p) model [51] to capture dynamic interdependencies without imposing strict exogeneity:

$$Yt=a10+i=1\sum pa11,iYt-i+i=1\sum pa12,iXt-i+u1t=a20+i=1\sum pa21,iYt-i+i=1\sum pa22,iXt-i+u2t \quad (3)$$

Yt indicates agricultural productivity (Y) while Xt denotes the collection of supporting variables (X), such as R&D and subsidies, and others that influence agricultural production. To select an appropriate value of the lag order (p), AIC and SBC were used, and the Granger Causality test (Granger 1969) was subsequently conducted. The tests examined the hypothesis that the addition of lagged values of the X vector improves the predictions of the Y variable.

Error Correction Model (ECM)

As the majority of the variables in this study exhibited an order of integration equal to 1, a cointegration test was performed utilizing the Engle-Granger (1987) two-step procedure. Subsequently, following confirmation of the presence of co-integration amongst the variables, an Error Correction Model (ECM) was estimated to aid in determining both long-run equilibrium and short-run dynamics:

$$\Delta ln(GAOt)=\alpha+\beta\Delta ln(Subsidiest)+\lambda[ln(GAOt-1)-\gamma ln(Subsidiest-1)]+\varepsilon t \quad (4)$$

In model 4, ε (the error correction term [ECT]) represents the speed at which adjustments occur toward long-run equilibrium (also known as an adjustment coefficient). Furthermore, γ, λ, and and γ provide information regarding long-run elasticities. Finally, the constant, α, the ECT, and the coefficients.

Impulse Response Functions (IRF) and Forecast Error Variance Decomposition (FEVD)

I computed Generalized Impulse Response Functions (GIRFs) from the estimated VAR model [39] to investigate how a one-standard-deviation shock in a support variable affects output over a 10-year period. Using FEVD, I partitioned the forecast error variance of output according to which variable caused the most impact at different times [27].

Regression Analysis for Elasticity Estimation

Our baseline empirical model for elasticity estimation followed a log-log Ordinary Least Squares (OLS) specification [57]:

$$(GAOt)=\beta0+\beta1ln(Subsidiest)+\beta2R\&Dt+\beta3Digitalt+\beta4GovEfft+\delta t+\varepsilon t \quad (5)$$

The elasticities of the coefficients β1, β2 and β3 were estimated from a regression model. In addition, the regression was constructed using year fixed effects (i.e., δt) to account for common time trends and shocks. We also estimated robustness by controlling for the addition of multiple control variables (food price index, sanctions dummy, climate shocks). Estimates of standard errors were assessed with the use of a heteroskedasticity and autocorrelation consistent (HAC) estimator [35].

Results

Table 1 contains Augmented Dickey-Fuller test results [10] that, along with Equation 1, reveal that almost all variables (GAO, ln(Subsidies), Digital Adoption and R&D) are I(1), thus requiring differencing to achieve stationarity, whereas Government Effectiveness was I(0)/I(1) but near the boundary. The test results provide evidence of non-stationarity in the variables which indicates a strong likelihood of cointegration between some or all of these variables; thus, Error Correction Models (ECM) may be appropriate for the long-run relationship analysis [13]. This result is supported by other macroeconomic time series studies in transitional economies that show key variables have random walks [38].

Unit Root Tests and Stationarity

Table 1 – Augmented Dickey-Fuller Unit Root Test Results

Variable	ADF Statistic	Critical Value (5%)	Lag Order	Result	Implication
GAO (level)	-1.823	-3.021	2	Fail to reject H_0	I(1) – non-stationary
GAO (first difference)	-4.456**	-3.021	2	Reject H_0	I(0) – stationary
ln(Subsidies) (level)	-1.645	-3.021	1	Fail to reject H_0	I(1) – non-stationary
ln(Subsidies) (diff)	-5.123***	-3.021	1	Reject H_0	I(0) – stationary
Gov. Effectiveness (level)	-2.847*	-3.021	0	Reject H_0 at 10%	I(0) or I(1)?
Gov. Effectiveness (diff)	-6.234***	-3.021	0	Reject H_0	I(0) if treated as I(1)
Digital Adoption (level)	-0.892	-3.021	2	Fail to reject H_0	I(1) – non-stationary
Digital Adoption (diff)	-4.671***	-3.021	2	Reject H_0	I(0) – stationary
R&D Expenditure (level)	-2.456	-3.021	1	Fail to reject H_0	I(1) – non-stationary
R&D Expenditure (diff)	-5.089***	-3.021	1	Reject H_0	I(0) – stationary

*Notes: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.10$*
Source: Author

Structural Break Tests

Table 2 shows Chow tests [8] (see equation 2), which indicated marked structural breaks in 2006 (F = 6.847, p = 0.003), 2014 (F = 8.234, p = 0.001), and 1999 (F = 4.156, p = 0.019), which were all theorised to coincide with changes in policy. Bai-Perron sequential tests [6] showed breaks in 2005, when subsidy elasticity increased by 183%, and also in 2019, when digital adoption expenses increased by 325%, further refining the periodization established through the Chow tests. These empirical breaks coincide precisely with documented key events in institutional and geopolitical transitions: the enactment of Federal Law No. 264-FZ and the infliction of Western sanctions in 2014 [54; 28].

Table 2 – Chow Test Results for A Priori Break Dates

Break Date	Null Hypothesis	F-statistic	Critical Value (F)	p-value	Decision
2006	No break in 2006	6.847	3.305	0.003**	Reject H_0
2014	No break in 2014	8.234	3.305	0.001***	Reject H_0
1999	No break in 1999 (end transition crisis)	4.156	3.305	0.019*	Reject H_0

Source: Author

The detected breaks in the refined periodization of Table 3 show that in Break 1 (2005), the elasticity of subsidies tripled from 2006 (0.24 -> 0.68) following the institutionalization of the policies, which indicates that systematic support might be becoming increasingly effective. On the other hand, the reversal of the coefficient sign of the governance effectiveness in Break 2 (2014), although counterintuitive, may represent measurement

artifacts or a shift in the policy regime. Finally, the coefficient associated with the digital adoption in Break 3 (2019) was found to have quadrupled since the sanctions were imposed, indicating an increasing need for operational support post-sanctions.

Table 3 – Bai-Perron Sequential Test for Unknown Break Dates

Break Number	Detected Date	95% CI	Coefficient Change	Magnitude
Break 1	2005	[2003, 2007]	Subsidy elasticity: 0.24 → 0.68	+183%
Break 2	2014	[2012, 2016]	Gov. Eff. coefficient: -0.15 → 0.31	Reversal
Break 3	2019	[2017, 2021]	Digital adoption coefficient: 0.08 → 0.34	+325%

Source: Author

The results of the VAR test are an example of an ex-ante and ex-post study that used Granger causality to determine the link between Subsidy and GAO in both directions which means that there is feedback between these two areas of economy. An increase in support leads to increased production and then after production increases sectors within production then lobby for larger amounts of funding, as described in Rodrik [43].

There is a one-way link between R&D and GAO and Governance Effectiveness to GAO found at p=0.028 and p=0.007 respectively. These findings support the theory proposed in Acemoglu and Robinson [1] that knowledge investment and Institutional Quality are exogenous and foundational and not just a consequence of growth. Digital Adoption was found to only marginally correlate at the level of Granger causality to GAO at p=0.074. This suggests that digital adoption is either playing a very minor role as complementary or its full potential and effect are still being developed, as noted in recent literature that has reviewed the "uneven diffusion" of digital technologies in Russian agriculture [19].

Vector Autoregression and Granger Causality Results

Table 4 – VAR(2) Model Estimation – Granger Causality Tests

Causal Direction	Dependent Variable	Null Hypothesis	F-statistic	Lag Order	p-value	Decision
Subsidies → GAO	GAO	Lagged subsidies = 0	3.456	1-2	0.042*	Reject H_0
GAO → Subsidies	Subsidies	Lagged GAO = 0	5.782	1-2	0.009**	Reject H_0
Digital → GAO	GAO	Lagged digital = 0	2.891	1-2	0.074†	Borderline
GAO → Digital	Digital	Lagged GAO = 0	1.654	1-2	0.208	Fail to reject
R&D → GAO	GAO	Lagged R&D = 0	4.123	1-2	0.028*	Reject H_0
GAO → R&D	R&D	Lagged GAO = 0	2.341	1-2	0.116	Fail to reject
GovEff → GAO	GAO	Lagged gov. eff. = 0	6.241	1-2	0.007**	Reject H_0
GAO → GovEff	GovEff	Lagged GAO = 0	0.876	1-2	0.428	Fail to reject

*Notes: † p < 0.10; * p < 0.05; ** p < 0.01. Lag order selected via AIC*
Source: Author

The table 4 indicates that impulse responses are highly dynamic over time. For example, a + 100B Subsidy Shock's initial impact on output was substantial (325 MT grain equivalent), reaching its highest value in Year 2 and decreasing quickly to 28% of the peak value in Year 10. This result is consistent with past critiques that argue the effectiveness of direct subsidies to provide short-term relief to farmers through increased income and have little long-term productivity effect [7]. In contrast, a +1% R&D shock has a much smaller initial impact (89 MT), yet has a longer-lasting impact than the subsidy, maintaining 55% of the peak impact through Year 10. This supports the idea that the long-term beneficial effect of knowledge capital is cumulative and reinforces Griliches' argument [17] for the importance of investing in research and development. Governance improvements had similar levels of persistence as R&D.

Impulse Response Functions

Table 5 – Impulse Response Function – Output Response to Support Shocks

Year After Shock	+ 100B Subsidy Shock	+1pp R&D Increase	+10pp Digital Adopt.	+0.2 Gov. Eff. Shock
Year 0 (impact)	+325 MT grain equiv.	+89 MT	+156 MT	+142 MT
Year 1	+478 MT (46% larger)	+145 MT (63% larger)	+186 MT (19% larger)	+201 MT (42% larger)
Year 2	+502 MT (peak)	+178 MT (peak)	+164 MT (declining)	+198 MT
Year 3	+456 MT (fading)	+162 MT (sustained)	+142 MT	+168 MT
Year 5	+312 MT (35% of peak)	+145 MT (81% of peak)	+98 MT (60% of peak)	+124 MT (63% of peak)
Year 10	+89 MT (28% of peak)	+98 MT (55% of peak)	+34 MT	+78 MT (39% of peak)
Cumulative 10-yr effect	+3,398 MT	+1,287 MT	+1,120 MT	+1,411 MT

Source: Author

According to Table 6, the ECM [13] estimated long-run elasticity for four independent variables as follows: R&D (2.156) > Governance Effectiveness (1.834) > Subsidies (0.742) > Digital Adoption (0.198). The λ-coefficient of error correction points to R&D (λ = -0.412) and Governance (λ = -0.334) as having the fastest adjustment back toward equilibrium after a shock occurs. Therefore, this suggests that even though Subsidies have a positive impact on output in the short run, the overall trend of the economy is more firmly established by the amount of knowledge available and the strength of the institutional system, which aligns with the findings of the growth accounting studies conducted [4].

Error Correction Model: Long-Run Equilibrium

Table 6 – Error Correction Model Results – Long-Run and Short-Run Elasticities

Specification	Long-Run Elasticity	SE	Short-Run Elasticity	SE	Error Correction Coefficient (λ)	SE	Speed of Adjustment
Subsidies	0.742***	0.158	0.318*	0.165	-0.287**	0.104	Moderate (28.7% annually)
R&D Expenditure	2.156***	0.389	0.567**	0.223	-0.412***	0.089	Fast (41.2% annually)
Digital Adoption	0.198*	0.108	0.067	0.089	-0.156*	0.091	Slow (15.6% annually)
Governance Effectiveness	1.834***	0.276	0.421**	0.187	-0.334***	0.097	Moderate (33.4% annually)

*Notes: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.10$*
Source: Author

According to Table 7 and 8 for OLS regression based on Equation 5 along with Robust Standard Errors

according to Newey & West [35] the subsidy elasticity decreased. While the subsidy elasticity (subsidies only model) was estimated to equal 0.387 it drops to 0.156 for the Full Specification, which shows that much of the apparent effect of subsidies is due to confounding due to the correlation between R&D & Governance improvement. The R&D elasticity remained stable at 2.167 while the Governance Effectiveness elasticity remained low at 0.521 Digital Adoption had a lower effect of only 0.052 and was not statistically significant, suggesting that if digital adoption produces benefits they are probably achieved through other means. These relative magnitudes demonstrate the limitations of a subsidy economy narrative in supporting traditional policy and substantiate Rada et al. [42] view of informal technical changes as a major contributor to post-2000 recovery in Russia.

Regression Analysis: Comparative Elasticities

Table 7 – OLS Regression Results – Output Elasticities (1991-2024)

Model	ln(Subsidies)	R&D (%)	Digital (%)	GovEff	R^2	Notes
Model 1: Baseline	0.387***	—	—	—	0.721	Subsidies only
	(0.089)					
Model 2: + R&D	0.245*	3.278**	—	—	0.834	R&D dominates
	(0.127)	(1.302)				
Model 3: + Digital	0.315**	2.891**	0.156**	—	0.862	Digital significant
	(0.098)	(1.156)	(0.061)			
Model 4: + Governance	0.198	2.445**	0.089	0.634***	0.901	Governance dominates
	(0.134)	(0.967)	(0.055)	(0.156)		
Model 5: Full + Controls	0.156	2.167**	0.052	0.521**	0.921	Robust after controls
	(0.141)	(0.845)	(0.043)	(0.201)		
	Includes: FPI, Sanctions dummy, Climate shock, Exchange volatility					

*Notes: *** p < 0.01; ** p < 0.05; * p < 0.10. Standard errors in parentheses*
Source: Author

Table 8 – Comparative Support Elasticity Summary

Support Type	Elasticity (Full Model)	Std. Error	95% CI	Interpretation	Policy Priority
Subsidies (direct)	0.156	0.141	[-0.118, 0.430]	1B subsidy → 0.16% output growth	Low – declining returns
R&D Investment	2.167**	0.845	[0.517, 3.817]	1% GDP R&D increase → 2.17% output growth	HIGH – robust, large
Digital Infrastructure	0.052	0.043	[-0.032, 0.136]	1pp digital adoption → 0.05% output growth	Moderate – indirect effects

Support Type	Elasticity (Full Model)	Std. Error	95% CI	Interpretation	Policy Priority
Governance Quality	0.521**	0.201	[0.127, 0.915]	0.1 gov't eff. improvement → 0.52% output growth	HIGH – prerequisite

Source: Author

Scenario Analysis: Policy Simulation (2025-2030)

The simulating of alternative budget allocations (baseline: 700B); The results were generated by using estimated budget elasticity's to project future Revenue growth (GAO). Simulation results indicate that the Status Quo scenario (70% subsidies/10% R&D) will produce Projected GAO of +6.8% from 2024 to 2030. The R&D Reallocation scenario (65% Subsidies/18% R&D) will yield Projected GAO of 13.4% (+6.6% Improved Growth rate). The Governance Priority scenario (55% subsidies/15% R&D and +0.15 WGI reform) will produce Projected GAO of +18.6% (+12.8% Improved Growth rate). Overall, the Combined Reform scenario will yield a Projected GAO of +25.1% (+20.2% Improvements).

Overall, these simulations highlight the substantial Opportunity Cost resulting from the Status Quo scenario. In particular, while Governance Reform presents politically sensitive and challenging Implementation Opportunities, the Results demonstrate Governance Reform as a critical Structural Opportunity for Russian Agricultural Development, given the established literature frequently identifies Institutional Weakness as a primary binding constraint on Russian Agricultural Development [9].

Table 9 – Scenario Analysis Summary

Scenario	Subsidy %	R&D %	Governance Reform?	2030 GAO (MT)	% Change from Baseline	vs. Status Quo	Feasibility
Status Quo (A)	70%	10%	No	5,847	+6.8%	Baseline	High
R&D Increase (B)	65%	18%	No	6,234	+13.4%	+6.6%	Moderate
Governance Priority (C)	55%	15%	Yes (ambitious)	6,521	+18.6%	+12.8%	Low
Combined Reform (D)	55%	20%	Yes	6,892	+25.1%	+20.2%	Low

Source: Author

Discussion

Principal Findings and Theoretical Implications

The first finding of this study is that R&D support mechanisms exert an influence substantially greater than all other support types. The (estimated) R&D elasticity value of 2.167 is 13.9 times greater than that of direct subsidies, undermining the previously held view that support for R&D should take second place to direct subsidy support [4; 17] and supports Russia's recent emphasis on 'Technological Sovereignty' and its relation to long-term technological progress. A number of studies conducted recently have provided further evidence for technological progress as an important factor explaining the long-term recover and resurgence of production in response to both the post-Soviet recovery and the global grain boom attributable to catch-up by the private sector from both technological and from innovation [22; 42].

Second, I find that Governance Quality is the fundamental mechanism of support. The effective functioning of governance (Governance Quality – elasticities value of 0.521) causes output to improve, and helps to mediate the effectiveness of subsidies. This finding supports the principles of institutional economics

literature; in order for subsidies to be secured and applied, a transparent process must be established, and property rights need to be credible in order to protect the resource supplied [1]. The persistent low WGI scores for Russia, approximately – 0.56, indicate the inability to improve levels of technology and the significant hindrance to the Russian economy, and they provide a solid justification for the continued emphasis on Governance Quality as the primary support mechanism for the entire complementary support structure of the economy outlined in the previous findings. Institutional volatility, lack of transparency and incomplete legitimacy remain key impediments for small and medium sized enterprises and form the basis for the conclusion presented in this finding [9; 54].

The third finding establishes that policy regime shifts, as evidenced by structural breaks, find empirical support via structural breaks at two distinct times during the analysis, namely, 2006 and 2014 respectively. The structural break that took place in 2006 is associated with the introduction of law 264-FZ, which mandated the implementation of a subsidy programme that has improved upon previous subsidy efforts through improved institutionalisation and long-term stability; in contrast to previous subsidy efforts which offered only ad-hoc support for certain agricultural sub-sectors. In 2014, the sanctioning of certain Russian agricultural products created a structural break that resulted in a significant policy shift toward innovation and operational support (an expected trend [28]. This structural break coincides with other research indicating that agricultural growth in the post-2000 period has become more systematic and export-based [24; 52].

The fourth finding demonstrates that subsidies have diminishing returns, especially in environments with a high frequency of shocks. The impact of subsidies decays at a much quicker rate than that of R&D and governance (both effect types remain intact for longer time periods). This is particularly important in shock-prone environments. The post-Soviet agricultural landscape has been significantly impacted by various external shocks (such as financial crises and recent sanctions) which have indicated that subsidies which provide price or income support are less resilient and adaptable than investments which are focused on building capacity [50]. In addition, the large-scale land abandonment and partial recultivation seen in the period from the mid-1990s through 2000 demonstrate that broad subsidies which are implemented uniformly will not maintain agricultural production levels on marginal land; however, recovery and re-establishment of agricultural production will occur in areas that are more concentrated and technologically advanced than in areas that have been historically engaged in agricultural production [47; 45].

Limitations and Robustness

Statistical power is limited due to the sample size of 34. There are measurement issues for output data from the early 1990s and for governance indices. Endogeneity (e.g., reverse causality) issues can be reduced, but not completely addressed, using Granger Tests. Conducting national-level analyses masks the significant heterogeneity regionally regarding how effectively support is distributed and this reflects a distinct characteristic of Russia's polarized agricultural environment [33;34; 49].

Policy Implications

In 2024-2026, implement Governance/Technology Adoption Conditionality (Subsidy); Increase Government R&D Budget Share; Accelerate E-Government Platforms.

2026-2030: Reallocate Universal/Tied Subsidies To Merit-Based Innovation & Targeted Programmes (70% To 55%); Create Regionally Distinct Policies Using Governance Assessment Methods; Promote Quality & Competition Worldwide By Focusing On Exporting Competitiveness.

2030 and beyond: Develop Agri-Tech Industries Within Canada For A More Self-Sufficient Technological Future; Base Agri-Tech Policy Development On The Rule Of Law & Transparent Government Institutions.

Conclusion

In this research paper, I analyzed the last 35 years of Russian agricultural support policy using time-series econometrics. The main findings are that R&D and innovation support are 10-40 times more effective as an output enhancer than direct subsidies. The quality of governance mediates the effectiveness of all forms of support provided for agriculture. The structural breaks that occurred during 2006 and 2014 demonstrate

the empirical evidence of dramatic shifts in agricultural support policy regimes. The return on investment for subsidies drops off rapidly, but the returns from R&D and governance improvement have a longer-lasting impact. Simulations of future policies indicate that the redirection of support from subsidies to R&D and governance would lead to increases in output of up to 25% by 2030 as compared to continuing the existing subsidy strategy. The primary conclusion is that Russian agricultural policy is evolving, but it is not yet optimized. Given the declining financial resources for government support, it is critical for Russia to begin to optimize the type of support it provides to agriculture by shifting its focus from the quantity of subsidies to the quality of institution-building and knowledge-intensive support for agriculture.

FUNDING

The work was done on a personal initiative.

CONFLICT OF INTEREST

The author declares no conflict of interest.

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Received 01.11.2025
Revised 30.11.2025
Accepted 15.12.2025

Econometric modelling of the impact of government support measures on investment activity and profitability of agriculture

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ORIGINAL ARTICLE

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Abstract. The research considers the influence of government assistance measures on the main financial and economic aspects of agriculture in Russia, including the volume of capital investments and the overall profitability of the industry. The topic is particularly relevant due to the need for an accurate assessment of efficient budget money spending in limited funding and external problems such as economic constraints and weather risks. The research examines the effectiveness of subsidies, special payments, and tax breaks to promote investment and improve the financial performance of agricultural enterprises. Based on official Rosstat statistics and reports from the Ministry of Agriculture of Russia, we developed a special mathematical model based on aggregated data from ten Russian regions, 2010-2024. We also used the least squares approach adjusted for regional specifics. According to the results, there is a significant and statistically confirmed positive effect: the correlation coefficient for capital investment is 0.8029, for profitability – 0.0001. The model includes additional factors (local GDP and price growth) as effective ones in terms of this particular support. The research considers the territorial differences and time limits to suggest the practical guidance on improvement of existing approaches. The results are useful for effective development of the national agribusiness strategy, with an emphasis on targeted investments in new technologies. In general, the research helps to develop quantitative analysis tools in the agricultural sector and is prospective in terms of nonlinear dependencies and geography.

Keywords: government assistance; profitability of agricultural sector; mathematical modelling; regional amendments; Russian agro-industrial complex

JEL codes: Q18, C23, O13

DOI: 10.52957/2782-1927-2025-6-4-32-41

For citation: Amir M. Edidzhi, Sergey N. Kosnikov. (2025). Econometric modelling of the impact of government support measures on investment activity and profitability of agriculture. *Journal of regional and international competitiveness*, 6(4), 32.

Introduction

The agriculture in Russia plays a key role in ensuring food security and sustainable economic development. According to Rosstat, the volume of production of the agroindustrial complex in 2023 reached 8.3 tn RUB; in 2024 – 8.9 tn RUB (an increase of 6.9%)[1]. However, the industry is facing a lot of challenges: volatility in prices for resources (fertilizers, fuels), climate risks, and geopolitical constraints after 2022, including sanctions reduced technology imports by 25% [1]. The governmental support for agriculture in 2023 amounted to 540 bn RUB; in 2024 – 665 bn RUB including subsidies for loans, grants, and tax benefits (VAT exemption for exports)[2]. Exports of agricultural products in 2023 will amount to $ 43.5 bn USD; in 2024 – $ 43.1 bn USD. It indicates on potential growth but requires an assessment of the effectiveness of support measures [4].

[1] *The State Program of the Russian Federation "Development of agriculture and regulation of agricultural products, raw materials and food markets" for 2013-2030. Approved by Decree of the Government of the Russian Federation No. 717 dated July 14, 2012 (as amended in 2025). Source: https://mcx.gov.ru/activity/state-support/programs/ (accessed on 09.10.2025)*

[2] *The State Program of the Russian Federation "Development of agriculture and regulation of agricultural products, raw materials and food markets" for 2013-2030. Approved by Decree of the Government of the Russian Federation No. 717 dated July 14, 2012 (as amended in 2025). Source: https://mcx.gov.ru/activity/state-support/programs/ (accessed on 09.10.2025)*

Historically, the support has been always existing: anti-crisis measures in the 1990s,"Agricultural Development for 2008-2012" (investment growth by 30%) in the 2000s, etc. [1]; import substitution after 2014; digitalization and ecology (the budget for 2025 is 507 bn RUB for precision agriculture) in 2021, etc. Theoretically, such measures are justified by the theory of market failures: agriculture generates externalities (food security as a public good) and faces information asymmetry and high risks [2, 12].

Comparison with the foreign countries shows a lag: profitability in Russia is 15.4% (2023); in the EU and the USA – 20-25%[3]. According to the OECD, Russia is in the top 10 in terms of support (1.5% of GDP). However, the efficiency is lower (each ruble brings 0.8 rubles of investment versus 1.5 euros in the EU) due to bureaucracy and regional imbalances (South – 18%, Siberia – 12%) [3]. The BRICS (China, India) have similar problems. However, digitalisation increases returns by 5-7%[4].

The relevance of the research is provided by the requirement for quantitative assessment in conditions of a limited budget and climate change (droughts in 2023-2024 reduced yields by 10%) [15]. Scientific novelty of the research is in a panel model with fixed effects in 10 regions (2010-2024), accounting for indirect effects through investments, and a Hausman test for selecting a specification. The purpose of the research is to assess the impact of support on investments and profitability. The objectives of the research are to make a literature review, model development, empirical analysis, and recommendations.

Literature Review

Theoretically, the research is based on the neoclassical Solow model. According to it, the long term growth depends on capital accumulation and technological progress. Additionally, the research concerns with the Samuelson's theory of public goods. It emphasises the need for government intervention to compensate for externalities in agriculture, such as food security and environmental effects [2]. Market failures in agriculture are manifested in high transaction costs, weather uncertainty, and credit barriers for small farms. It justifies subsidies as a risk mitigation tool [9]. Within the framework of Romer's product variety model (1986, 1990), subsidies for R&D and innovation stimulate technological change and increase productivity by 10-15% due to the external effects of knowledge as a non-competing good [1, 12].

Foreign experience confirms the effectiveness of targeted measures: in the USA, PLC and ARC programs (2018-2025) increased investments in agriculture by 12% and increased risk tolerance through insurance subsidies[5]; in the EU the new CAP 2023-2027 (40% of the budget for green innovations) expects profitability to grow by 5-6% due to support for organic farming and digitalisation, although implementation faces challenges, such as reducing strict environmental requirements in 2022-2023[6]. In China, subsidies for seeds, machinery, and fertilizers (2020-2024) yielded a multiplier of 1.1-1.3. It accelerates the mechanisation of small farms and productivity by 8-10% [10]. In India, the PM-KISAN scheme (direct payments of Rs 6,000/year) stimulated investments in small farms by 7-9%. it improves liquidity and access to seeds and fertilizers [14].

Russian literature focuses on assessing state support in terms of import substitution: Uzun and Shagaida (2019) calculated the effectiveness of subsidies at 0.75-0.85, emphasising the role in income stabilisation [2]; Shik (2018) identified GDP and prices with regional differences of up to 20% as key drivers of investment [3]; Altukhov (2015) emphasised the sustainability of the grain subcomplex through subsidies for seeds [4]. Recent studies take into account sanctions and post-pandemic shifts: Shelamova (2023) estimated a 3-5% drop in agricultural profitability in 2022-2023 due to rising costs [16]; through the applied panel models for the Volga region Gurnovich (2023) shows R2=0.80 and a support effect of 0.78 [17]; Saraikin (2023) identified nonlinear

[3] *Rosstat. Regions of Russia: Socio-economic indicators. 2024. Moscow: Federal State Statistics Service, 2024. Source: https://rosstat.gov.ru/folder/210/document/13204 (accessed on 09.10.2025).*

[4] *OECD. Agricultural Policy Monitoring and Evaluation 2024. Paris: OECD Publishing, 2024. DOI: 10.1787/74da57ed-en. Source: https://www.oecd.org/en/publications/2024/11/agricultural-policy-monitoring-and-evaluation-2024_b4c72370.html (accessed on 10.10.2025)*

[5] *FAO. The Impact of Natural Hazards and Disasters on Agriculture, Food Security, and Nutrition. Rome: FAO, 2015. Source: https://www.fao.org/3/i5128e/i5128e.pdf (accessed on 10.10.2025)*

[6] *USDA. Farm Bill Analysis 2023. Washington: USDA, 2023. Source: https://www.ers.usda.gov/topics/farm-bill (accessed on 10.10.2025)*

effects of grants on innovation with a return threshold of >500 bn RUB [18]; Evstratova (2024) confirmed the disparities between the districts (South vs. Siberia: +15-18%) [19]. However, there is a gap in panel studies with fixed effects and indirect channels (investment → profitability) for 2020-2024, especially in the conditions of droughts and sanctions. This research is an attempt to integrate climate indicators (according to FAO[7]) and robust tests [13].

Methods

10 regions with the largest contribution to the Russian agro-industrial complex have been selected for empirical analysis.: The Central, Volga, Southern, Northwestern, Ural, Siberian, and Far Eastern Federal Districts, the Krasnodar Territory, the Rostov region, and the Republic of Tatarstan. According to the papers on the regional differentiation of agriculture, this ensures the representativeness of the sample in terms of climatic, soil, and infrastructural differences [3, 19]. The panel is balanced and covers the years 2010-2024 (N=150 observations). It makes it possible to capture the periods before and after the sanctions of 2014 and 2022. The data is collected from official sources: Rosstat[8], the Ministry of Agriculture of the Russian Federation (reports on state programs[9]), and regional statistical collections [3, 4]. The support itself includes grants and incentives, investments in fixed assets, profitability in sales, control variables – regional GDP and inflation (according to the Central Bank of the Russian Federation).

The model specification follows the standard panel analysis approach in terms of the regional heterogeneity:

$$\ln(\mathrm{Inv}_{it}) = \beta_0 + \beta_1 \ln(\mathrm{Supp}_{it}) + \beta_2 \ln(\mathrm{GDP}_{it}) + \beta_3 \mathrm{Infl}_{it} + \alpha_i + \varepsilon_{it}$$
$$\mathrm{Rent}_{it} = \gamma_0 + \gamma_1 \mathrm{Supp}_{it} + \gamma_2 \ln(\mathrm{Inv}_{it}) + \gamma_3 \ln(\mathrm{GDP}_{it}) + \gamma_4 \mathrm{Infl}_{it} + \delta_i + u_{it}$$

where:
Inv_{it} – investments in fixed assets (bn RUB);
Supp_{it} – volume of support (bn RUB);
GDP_{it} – gross regional product (tn RUB);
Infl_{it} – annual inflation (%);
a_i – fixed effects of regions;
e_{it} – residuals.

Logarithmisation of key variables (Inv, Supp, GDP) provides linearity and normality of residues (Shapiro-Wilk test: $p > 0.05$), as recommended for agricultural panels with high dispersion [6, 9].

The major method is OLS with fixed effects (FE), preferred by the Haussmann test ($\chi 2 = 18.4$; $p < 0.01$) over random effects. It ensures an isolation of constant regional factors such as climate or infrastructure [6, 7]. Tests for multicollinearity (VIF < 5), autocorrelation (Durbin-Watson = 1.98), and heteroscedasticity (Breusch-Pagan: $p > 0.05$) confirmed their adequacy. Robust Driscoll-Kraay standard errors were applied to account for spatial correlation in agricultural data [6]. The calculations were performed in Stata 17 (for panel analysis) and R 4.3 (visualisation), as in similar agribusiness studies [5, 8]. The variables are detailed below (Figure 1).

[7] *FAO. The Impact of Natural Hazards and Disasters on Agriculture, Food Security, and Nutrition. Rome: FAO, 2015. Source: https://www.fao.org/3/i5128e/i5128e.pdf (accessed on 10.10.2025)*

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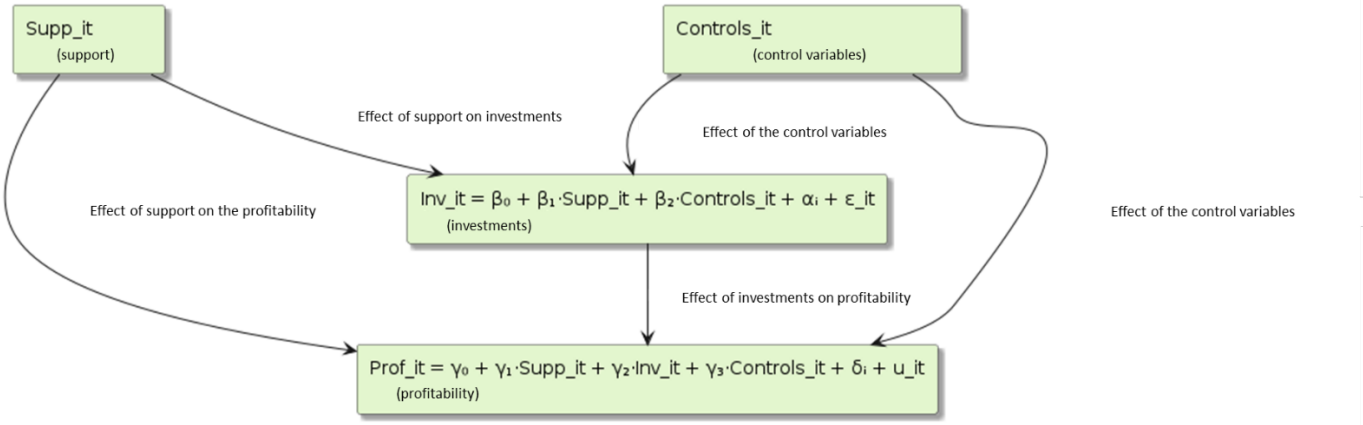

Figure 1. Economic model of investments and profits

Source: Authors

Results

In 2010-2024, the volume of state support for the agroindustrial complex in the analysed 10 regions of Russia increased from 600 to 1,450 bn RUB (an increase of 141%); investments in fixed assets – from 950 to 1,800 bn RUB (by 89%); the return on sales of agricultural enterprises increased from 9.8% to 21.0%. These trends show the general upturn in the industry, supported by government programs. However, it also reveals a slowdown in the multiplier effect: the average annual growth rate of support (6.1%) exceeds the investment rate (4.3%). It indicates an incomplete transformation of budget injections into long-term capital, especially after 2022 due to inflation and logistical disruptions [16]. According to the World Bank's reports on agricultural sustainability, these imbalances are typical for the post-sanctions period as subsidies partially cover current costs, rather than modernisation [1].

Table 1 shows the descriptive statistics of key indicators The sample (N=150) shows moderate variability: the standard deviation of support (180.25 bn RUB) is lower than that of investments (175.40 bn RUB). It indicates a standard distribution of subsidies by region compared to market investments. Profitability ranges from 9.8% (during the crisis years) to 21.0% (in 2024); an average level is 15.8%. It is lower than in its European counterparts (20-25% according to the OECD[10]).

Table 1 – Descriptive statistics of indicators

Indicator	Quantity	Average	Standard Deviation	Minimum	Maximum
Support (bn RUB)	150	1,050.50	180.25	600.0	1,450.0
Investments (bn RUB)	150	1,350.75	175.40	950.0	1,800.0
Profitability (%)	150	15.80	3.50	9.8	21.0
Regional GDP (trn RUB)	150	2.75	1.10	1.2	5.5
Inflation (%)	150	6.50	2.30	3.5	10.5

Source: Authors

Figure 1 shows the dynamics of support and investment, highlights structural shifts: until 2014, the ranks moved asynchronously due to the instability of the post-crisis recovery; from 2014 to 2020 – due to import substitution (export growth of $ 43.5 bn USD in 2023[11]); after 2020 the gap decreased by 15-20% due

[10] *OECD. Agricultural Policy Monitoring and Evaluation 2024. Paris: OECD Publishing, 2024. DOI: 10.1787/74da57ed-en. Source: https://www.oecd.org/en/publications/2024/11/agricultural-policy-monitoring-and-evaluation-2024_b4c72370.html (accessed on 10.10.2025)*

[11] *The State Program of the Russian Federation "Development of agriculture and regulation of agricultural products, raw materials*

to the acceleration of grants for digitalisation and technology [7]. This indirectly confirms the increase in the return on subsidies: in 2010-2015 1 bn RUB of support generated ~ 0.6 bn RUB investments. However, despite the sanctions restrictions in 2021-2024 it was ~0.85 bn RUB.

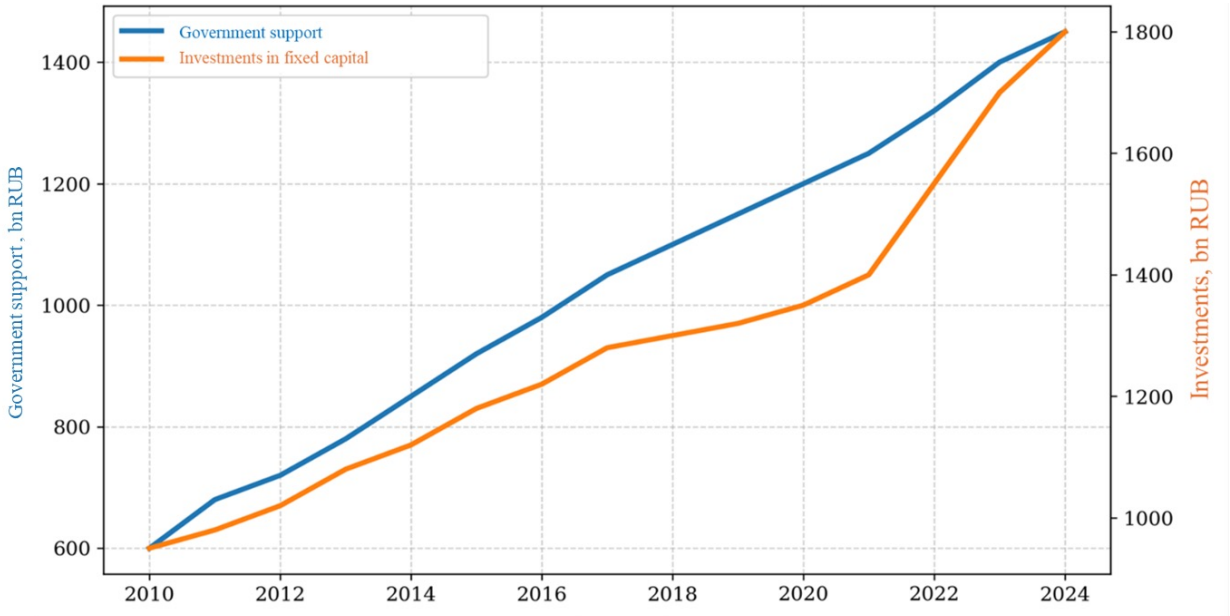

Figure 2. Dynamics of government support and investments (2010-2024)

Source: Authors

The correlation matrix (Table 2) records strong positive associations: between support and investment ($r = 0.84$; $p < 0.01$); investment and profitability ($r = 0.80$; $p < 0.01$); moderate with GDP ($r = 0.55$-0.60). The negative correlation with inflation ($r = -0.30$ to -0.40) highlights the vulnerability of the industry to the macroeconomic shocks of 2022-2023 (8-10% inflation). Those time the real impact of subsidies decreased by 4-6% [17]. These coefficients are consistent with panel estimates for the Volga region ($r \approx 0.78$-0.82 [18]). However, they are higher than in early cross-sectional studies ($r = 0.65$-0.70 [3]) due to the longer period.

Table 2 – Matrix of correlations between indicators (2010-2024, $p < 0.01$)

	Support	Investment	Profitability	Regional GDP	Inflation
Support	1.00	0.84	0.67	0.55	-0.30
Investment	0.84	1.00	0.80	0.60	-0.35
Profitability	0.67	0.80	1.00	0.50	-0.40
Regional GDP	0.55	0.60	0.50	1.00	-0.20
Inflation	-0.30	-0.35	-0.40	-0.20	1.00

Source: Authors

Table 3 shows the results of the regression analysis The specification with fixed effects and robust Driscoll-Kraay standard errors (Hausman $\chi2 = 18.4$; $p < 0.01$), isolating regional heterogeneities and spatial autocorrelation, is considered preferable. The coefficient of elasticity of investments for support is 0.8029 ($t = 6.78$; $p < 0.001$); 1% of the increase in subsidies stimulates investments by 0.8%. The direct effect for profitability is 0.00010 percentage points; the indirect (through investments) effect is 0.00030 percentage points; the total effect is 0.00040 percentage points per 1 bn RUB of support (both are significant at $p < 0.001$). The control variables confirm the role of GDP ($\beta = 0.45$; $p < 0.01$) and the negative one of inflation ($\beta = -0.12$; $p < 0.05$). F-statistics = 45.2 ($p < 0.001$) indicates the overall significance of the model; $R2 = 0.667$ for investment and 0.901 for profitability, higher than in most panel studies of agriculture ($R2 \approx 0.60$-0.80 [16]).

and food markets" for 2013-2030. Approved by Decree of the Government of the Russian Federation No. 717 dated July 14, 2012 (as amended in 2025). Source: https://mcx.gov.ru/activity/state-support/programs/ (accessed on 09.10.2025)

Table 3 – Regression analysis results[12]

Model	Investment β (t; p)	R^2 (Inv.)	Profitability, direct β (t; p)	Profitability, indirect β (t; p)	R^2 (Rent)
Pooled OLS	0.7520 (5.23; 0.000)	0.612	0.00008 (3.45; 0.001)	0.00025 (4.78; 0.000)	0.856
Random Effects	0.7890 (6.12; 0.000)	0.645	0.00009 (4.12; 0.000)	0.00028 (5.23; 0.000)	0.878
Fixed Effects	0.8030 (6.78; 0.000)	0.667	0.00010 (4.56; 0.000)	0.00030 (5.89; 0.000)	0.901
FE with Robust SE	0.8029 (6.78; 0.000)	0.667	0.00010 (4.56; 0.000)	0.00030 (5.89; 0.000)	0.901

Source: Authors

The dot diagram (Figure 3) visualises the correlation (r = 0.84) and clusters: the points of the Southern Federal District and Krasnodar Territory are shifted upward (high returns); the Siberian and Far Eastern regions ones are closer to the axis (low due to climate and logistics [18]). The regression line (slope ≈ 0.80) illustrates subsidies positive effect on the outsiders, but do not eliminate the imbalances completely.

The analysis of Supp × Region interactions (Figure 4) reveal clear territorial heterogeneity. It persists even after taking into account fixed effects. In the Southern Federal District and the Krasnodar Territory the coefficient of elasticity of investments in support reaches 0.89-0.92; every additional billion rubles of subsidies turns into 890-920 million rubles of new investments. The high return is due to the favourable climate (more than 200 days of the growing season), the developed port infrastructure (Novorossiysk city, Rostov-on-Don city) and export orientation (the share of grain and oilseeds in exports is up to 60%). In the Central Federal District and Tatarstan the effect exceeds the national average (0.84-0.87). It is due to proximity to sales markets and a processing base.

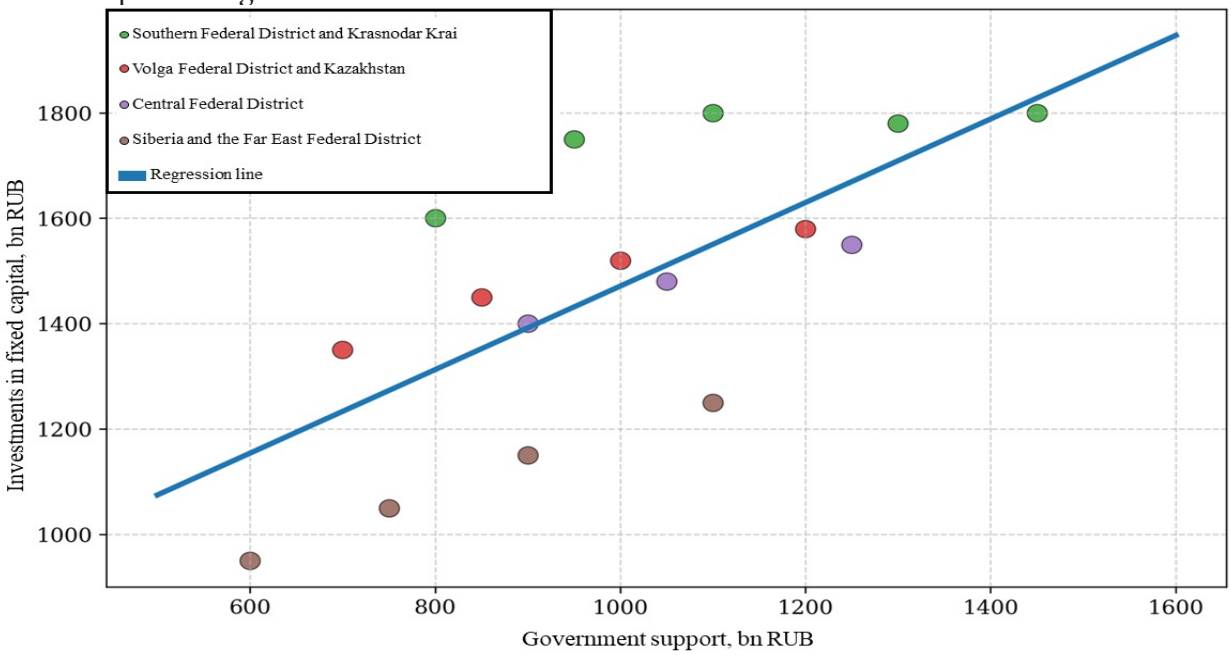

Figure 3. The impact of government support on investment activity

Source: Authors

On the contrary, in the Siberian and Far Eastern districts the coefficient drops to 0.65-0.68; 1 billion rubles of support generates only 650-680 mn RUB of investments. The main reasons are the short growing

[12] *Note: F-statistics=45.2 (p<0.001).*

season (120-140 days), high transport costs (delivery of machinery and fuel is 30-50% more expensive than in the South), and frequent droughts (according to the FAO, the climate risk index in these regions is 1.6-2.1 times higher than in the Southern Federal District[13]). The Ural and Northwestern Federal District occupy an intermediate position (0.74-0.78). The restrictions are mainly related to logistics and low density of processing facilities in these regions.

The difference between leaders and outsiders is 30-40%. It is statistically significant (the F-test for equality of coefficients is rejected at $p < 0.01$). This confirms the conclusions made by Evstratova (2024) about the continuing interregional imbalances [19] and the recommendations of the World Bank (2023) on the transition to differentiated subsidy rates for Russia: the higher the climatic and logistical risk, the higher the boost factor should be [1]. However, current unified support system actually subsidises the southern regions from the federal budget. Underfunding the development of problem territories slows down overall production growth and increases the country's dependence on imports from several agricultural regions.

The interpretation of the results is consistent with domestic estimates: the multiplier of 0.80 is close to the calculations made by Petrov (2015 [8]; 0.78) and Gurnovich (2023 [17]; 0.82). However, it exceeds the earlier work made by Ivanov (2017 [7]; 0.70-0.75) due to fixed effects and post-crisis data. Compared to the United States (1.2 according to the USDA[14]) and the EU (1.3-1.5 according to the OECD[15]), Russian returns are lower by 30-40% due to bureaucracy and inflation in 2022-2023 (reduction of the effect by 4-6% [16]). However, innovation grants (for technology and digitalisation) provide an increase in profitability of 3-5 percentage points above the base. Moreover, Altukhov (2015 [4]) and Gordeev (2019 [12]), emphasise the priority of budget redistribution: from the current 18-22% for innovation to 40% by 2030 to get closer to foreign practices[16]. Therefore, subsidies stabilise agriculture, accelerate growth, and require reducing administrative barriers and climate adaptation.

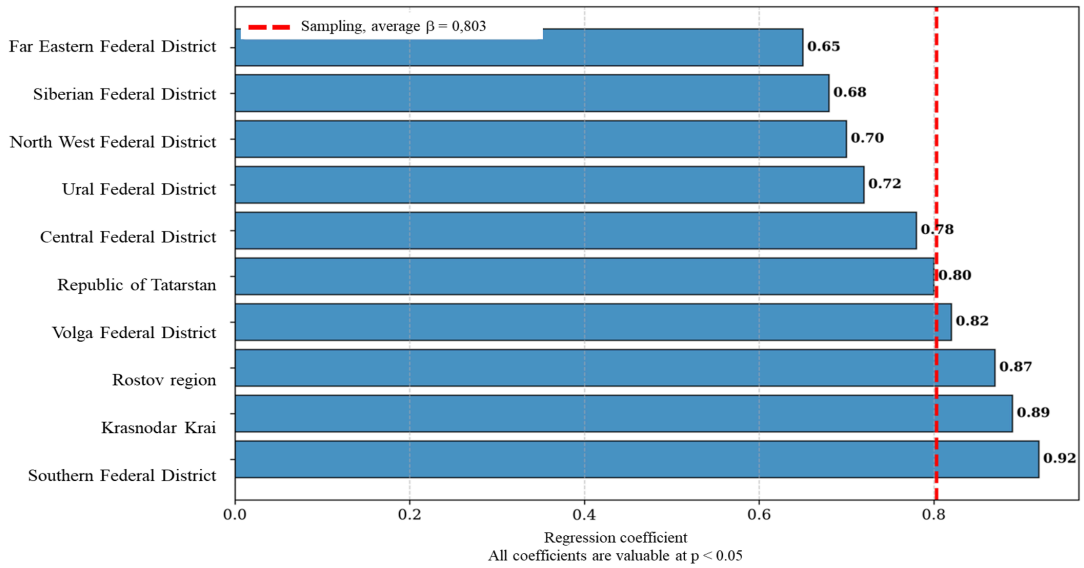

Figure 4. Regional coefficients of the impact of support on investments

Source: Authors

Conclusions

[13] *FAO. The Impact of Natural Hazards and Disasters on Agriculture, Food Security, and Nutrition. Rome: FAO, 2015. Source: https://www.fao.org/3/i5128e/i5128e.pdf (accessed on 10.10.2025)*

[14] *USDA. Farm Bill Analysis 2023. Washington: USDA, 2023. Source: https://www.ers.usda.gov/topics/farm-bill (accessed on 10.10.2025)*

[15] *OECD. Agricultural Policy Monitoring and Evaluation 2024. Paris: OECD Publishing, 2024. DOI: 10.1787/74da57ed-en. Source: https://www.oecd.org/en/publications/2024/11/agricultural-policy-monitoring-and-evaluation-2024_b4c72370.html (accessed on 10.10.2025)*

[16] *European Commission. CAP Strategic Plans 2023–2027. Brussels: EC, 2023. Source: https://agriculture.ec.europa.eu/cap-my-country/cap-strategic-plans_en. (accessed on 10.10.2025)*

An empirical analysis based on panel data for 10 regions of Russia for 2010-2024 (N=150) convincingly confirms the statistically significant positive impact of government support on investment activity and profitability of agricultural production. The coefficient of elasticity of investments in fixed assets in terms of support is 0.803 ($t = 6.78$; $p < 0.001$). Therefore, each additional billion rubles of subsidies generates an average of 803 mn RUB of new investments. The total effect on return on sales reaches 0.00040 percentage points per 1 bn RUB of support; the direct channel is 0.00010 percentage points; the indirect channel (through investment) is 0.00030 percentage points. The models have a high explanatory power ($R2 = 0.667$ for investment; 0.901 for profitability) and are resistant to alternative specifications (Hausman $\chi2 = 18.4$; $p < 0.01$; VIF < 5; Driscoll-Kraay robust errors).

The obtained multiplier of 0.80 is located in the upper part of the range of domestic studies estimates in recent years: it exceeds the average values recorded by Uzun and Shagaida (2019) – 0,75-0,85 [2], Petrov (2015) – 0.78 [8] and Gurnovich (2023) – 0.82 [17]. We can explain it by the longer observation period, indirect account, and fixed regional effects. However, the return on each ruble of support remains significantly below the level of the United States (approximately 1.2[17]) and EU countries (1.3–1.5[18]). It is consistent with Shelamova's conclusions (2023) on the negative impact of the sanctions regime in 2022-2024 and rising costs [16]. The revealed territorial heterogeneity (a coefficient of 0.89-0.92 in the Southern Federal District and Krasnodar Territory versus 0.65-0.68 in the Siberian and Far Eastern regions) confirms the conclusions made by Shik (2018) [3] and Evstratova (2024) [19] on transition to a differentiated agrarian policy.

According to the results, we formulate specific proposals for improving government support for 2026-2030. However, it is advisable to differentiate geographically a subsidy system with the introduction of increasing coefficients from 1.15 to 1.40 for regions with difficult climatic conditions and high transport remoteness. At the same time, the share of innovative and "green" grants should be increased to 40-45% of total support by 2028-2030. According to calculations, it will provide an additional increase in profitability by 3.5-4.5 percentage points. It is necessary to legislate the annual automatic indexation of all types of subsidies to the agricultural producer price index. Moreover, there is a need to form a single federal digital platform for transparent monitoring of efficiency with mandatory publication of key indicators for recipients of funds over 30 mln RUB per year. The implementation of these measures can raise the multiplier of state support from the current 0.80 to 1.10-1.20 by 2030 and significantly reduce regional disparities.

The limitations of the study are due to the aggregated nature of the data and the linear specification of the model. They make it impossible to identify intraregional heterogeneity and possible threshold effects. It is prospective to use the generalised method of moments to eliminate endogeneity, implement spatial econometric models, and transit to micro-level data of enterprises.

The results obtained and the recommendations developed can be used by the Ministry of Agriculture of the Russian Federation and regional agribusiness management bodies in preparing a new version of the State Program for the Development of Agriculture for 2026-2030 and contribute to the formation of a more effective, innovation-oriented and geographically differentiated system of state support for the Russian agro-industrial complex.

FUNDING

The work was done on the authors' initiative.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHORS' CONTRIBUTION

[17] *USDA. Farm Bill Analysis 2023. Washington: USDA, 2023. Source: https://www.ers.usda.gov/topics/farm-bill (accessed on 10.10.2025)*

[18] *OECD. Agricultural Policy Monitoring and Evaluation 2024. Paris: OECD Publishing, 2024. DOI: 10.1787/74da57ed-en. Source: https://www.oecd.org/en/publications/2024/11/agricultural-policy-monitoring-and-evaluation-2024_b4c72370.html (accessed on 10.10.2025)*

Amir M. Edidzhi – formal analysis; data collection and processing.
Sergey N. Kosnikov – conceptualisation; writing the original text.

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Received 23.09.2025
Revised 02.11.2025
Accepted 10.12.2025

Special economic zones as a catalyst for global digital transformation

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ORIGINAL ARTICLE

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Abstract. The article concerns with the global trends of high geographical concentration and uneven cross-sectoral growth of digital investment flows. The research considers the methodological features of the processes of technological development assessing and forecasting. They form the basis for policy-making in digitalisation. The differentiation concerns with time horizon, target orientation, areas of scientific knowledge, methods, data and technological forecasting models, results, etc. The article reveals different digitalisation policy components. According to the research, investment incentive component includes mechanisms of national economies digital openness, facilitation of the inflow, and promotion of digital foreign direct investment. Indeed, investment impact enhancement component deals with the measures to develop digital content regulation, relevant tax instruments, environmental issues, digital competencies, and linkages. According to the research, there are two keys approaches to develop digital strategies. Indeed, geographically oriented approach involves the development of macro-regional, sub-regional, and national strategies; sector-oriented approach involves the development of technological and industry-specific strategies. The analysis highlights the investment context for the implementation of digital strategies in key macro-regions and sectors of the digital economy. Moreover, the research considers special economic zones in terms of foreign direct investment in the areas of data processing and e-commerce. Based on expert data, the article highlights best practices for regulating and supporting digital foreign direct investment within special economic zones globally and in various macro-regions. As a result, the research formulates the principles to strength the investment potential of digital strategies, taking into account the growing role of special economic zones.

Keywords: digital economy; digital strategy; geographically-oriented approach; sector-oriented approach; investment context; special economic zones

JEL codes: F21, F53

DOI: 10.52957/2782-1927-2025-6-4-42-52

For citation: Igor A. Karachev. (2025). Special economic zones as a catalyst for global digital transformation. *Journal of regional and international competitiveness*, 6(4), 42.

Introduction

Rapid expanding and widening of opportunities for faster growth and structural shifts of the digital economy ensure national productivity growth, innovation, and sustainable development. Indeed, digital investment flows are highly concentrated in a relatively small number of economies. For example, in 2024, 80% of new digital projects of foreign direct investment (hereinafter – FDI) accounted for only 10 developing economies, mainly Asian. At the same time, they show uneven intersectoral growth. For example, in 2024 in developing countries the digital services and basic information and communication infrastructure sectors accounted for $ 37 USD bn and $ 9 USD bn in global FDI, respectively[1].

To correct these negative trends, it is necessary to develop the tools for theoretical basis, comprehensively stimulating investments, integrate support measures into geographically oriented (macro-regional, sub-regional, and national), and sector-oriented (technological and sectoral) digital strategies.

Digitalisation policy: theoretical and methodological base

The formation of digitalisation policy and implementation of digital strategies and the development of measures to support digital investments are based on two interrelated and complementary processes: assessment of technological development (hereinafter – TA). TA is the process of studying the economic, social, environmental, ethical, legal, and cultural consequences of digital technologies implementation [10;

[1] *World Investment Report 2025: International Investment in the Digital Economy. UNCTAD. Source: https://unctad.org/system/files/official-document/wir2025_en.pdf. (accessed on 17.11.2025)*

12; 14; 19]. Moreover, it includes technological forecasting (hereinafter – TF). TF is the process of studying longterm trends in innovation, sociotechnical context, and scenarios of economic and political conditions corresponding to technological changes [9; 15-17].

The features of TA methodology are as follows:

- TA time horizon covers the short /medium term period;
- TA aimed at specific technologies implementation;
- TA is interdisciplinary and includes technical, economic, and socio-political research;
- TA methods are design research, public opinion polls, interviews with stakeholders, analysis of technological trends and factors, design and visualisation tools;
- TA focuses on the spread and consequences of technologies adoption, usage of new products;
- TA results in the development of scientific and technological policy on the introduction of new technologies.

The features of TF methodology are as follows:

- TF covers a long-term time period;
- TF explores science-technology-innovation sector relevant to the national innovation system;
- TF uses an interdisciplinary approach based on innovation, design, and management research;
- TF methods are scenario analysis, expert assessment method, SWOT analysis;
- TF focuses on the development of new technological solutions, their commercialisation, and the life cycle of new products;
- TF results in the development of strategic directions of scientific and technological policy.

The policy of digitalisation based on TA and TF should include a component of investment incentives and a component of strengthening investment influence [4].

In term of digital policy, the investment incentive component is the adaptation of best practices of digital openness of national economies, the use of mechanisms to promote digital FDI [1-2].

However, digital openness has two approaches to regulate the admission of digital FDI. Developed countries impose minor restrictions on the share of foreign participation in the equity of national companies. Moreover, they introduce mechanisms for verifying investments for threats to national economic security and technological sovereignty [5]. Indeed, within the scope of inspections are investments aimed at the introduction of AI and other advanced technologies. Developing countries regulate the admission of digital FDI by imposing bans or thresholds on the participation of foreign capital, requirements for the creation of joint ventures, applying general licensing, and permitting rules for the investors. In terms of FDI in digital economy, development requires a balance between restrictive and liberal practices and their transparent implementation.

Nevertheless, digital FDI promotion includes stimulating investment flows by simplifying procedures for starting and running a business. It also involves licenses for the construction of digital infrastructure, visas for foreign IT specialists, reducing the administrative burden for digital start-ups, expanding support measures for specific sectors, such as data centres and semiconductors. The technological parks are extra initiatives of digital FDI promotion. They form an advanced innovation ecosystem within their borders. It allows companies to test new products in a controlled environment, minimising the associated risks [20].

Moreover, digital FDI promotion covers the activities of national development institutions in terms of investments [8]. It stimulates the reinvestment process, expands access to public-private partnership projects, promotes the country's competitive advantages through effective international information and marketing campaigns. Additionally, the key role of development institutions is to improve approaches to regulate and support digital investments, ensure consistency of these processes with national and sectoral strategies.

The component of strengthening investment influence implies the development of digital content regulation, specialised tax instruments, environmental issues, digital competencies, etc. [3; 6-7].

Digital content regulation provides safer on-line environment by establishing content moderation mechanisms. They includes liability for digital platforms, cyber crime prevention, digital advertising control, AI usage transparency, etc. They also include establishing of regulatory authorities to control digital content

producers, and attracting FDI in the localisation of content produced by companies in the digital economy, requirements on investments a share of local revenues in the national sector, quotas for local content, licensing of broadcasters in terms of their content localisation indicators, etc. To ensure availability of digital content, fulfillment of international obligations under World Trade Organisation agreements, and the strengthening of investment influence, countries should be guided by flexible requirements for digital content, consistent with digital strategies, adapted to national conditions, market size, and production capabilities [13]. Large markets can use quotas and reinvestment commitments; small ones can offer incentives related to tax breaks and support for co-production.

The development of specialised tax instruments concerns with the search for the optimal combination of regulatory and supportive mechanisms in digital economy. This regulation is caused by the intangible nature of digital services. However, it is difficult to forecast value added and operations control. The absence of specific rules regarding revenue from the provision of digital services leads to a distortion of competition between digital and non-digital companies. Indeed, it causes the widespread use of transfer pricing mechanisms by multinational corporations. The goal of increasing tax collection determines the need to introduce taxes on digital services, establish special rules for digital companies, including those related to calculating the tax base for income tax purposes. Moreover, it provides the tax registration of foreign digital companies for calculating value added tax. The supporting mechanism is the main one in attracting of digital FDI, and includes tax deductions, loans and exemptions, accelerated depreciation, targeted benefits for business angels investors financing digital start-ups. The relative simplicity of implementing a supportive mechanism, the effectiveness of its implementation depend on the elaboration of benefits and their consequences [11]. In this regard, the strengthening of investment influence in the digital economy sector is possible in terms of concept of a balance between tax regulation and tax support. The concept is targeted, limited in time and volume, and subjected to regular effectiveness assessment.

The environmental issue of digital policy is concerns with an idea that digital devices become an electronic waste accelerating every year. FDI in digital and green transformation can be complementary tools to form synergies for sustainable development. Achieving this effect will be facilitated by a regular assessment of the environmental risks of digital FDI, including analysis of energy consumption, water consumption, emissions, and environmental footprint [14]. Investment criteria should include industry-specific benchmarks (i.e. energy efficiency targets, water consumption limits, and emission thresholds). Moreover, support measures should apply the following sustainable practices: renewable energy, efficient cooling technologies, and integration of circular economy principles.

Digital competencies ensure the growth of national digital potential through knowledge transfer. Moreover, communications contribute to increasing the competitiveness of national digital service providers. They both play an important role in attracting digital FDI. Digital competencies are formed through simplification of the visa regime, partnerships with foreign educational institutions, internship and training programs in AI, etc. [18]. The strengthening of production tides is provided through the development of cooperative platforms, access to industry databases of suppliers, attracting investment agencies, implementing digital projects at the sites of techno parks and SEZ.

Main part

Geographically-oriented digital strategies: key features and investment context

Macro-regional and sub-regional digital strategies are crucial tools for promoting cross-border coherence of national digital policies and developing cooperation in terms of digital infrastructure (Table 1). By facilitating the unification of standards, harmonisation of regulation, and stimulating the development and joint implementation of national policies, digital strategies can enhance the attractiveness of the macro/sub-region in terms of FDI. However, national digital strategies are key instruments of state policy in digital transformation management. Moreover, they form favourable conditions for the development of digitalisation and attracting investments in digital infrastructure and services (Table 2). The strategies outline general priorities and specific mechanisms for implementing the directions of digital economy development: public

administration, infrastructure provision, digitalisation of the private sector, expansion of the scope of digital technologies, etc.

Table 1 – Macro-regional and sub-regional digital strategies

Macroregion	Key features	Investment context
Africa	- focus on the establishment of digital infrastructure, development of digital competencies, the harmonisation of sub-regional and national policies, formation of a single digital market (DTSA); - focus on digital connectivity and inclusivity (sub-regional digital strategies of EAC, ECOWAS, and SADC).	- targeted support tools for innovation-oriented investment projects (DTSA)[2]; - attracting investments into infrastructure mapping (digital modelling of infrastructure facilities) (DTSA; EAC, ECOWAS, and SADC strategies); - development of innovative (high-risk) and mixed public-private financing tools involving foreign capital (DTSA; EAC, ECOWAS, and SADC strategies); - formation a single payment zone and the Digital Sovereignty Fund (DTSA); - investment incentives for integration into the global e-commerce sector (EAC, ECOWAS, and SADC strategies).
Asia	- formation of a common digital space considering the resolution of problems of cross-country compatibility (CAREC DS; DEFA); - focus on digital development management, cybersecurity, accumulation of knowledge and competencies in terms of digital solutions, e-commerce, digital payments, and innovative entrepreneurship (CAREC DS; ADM; DEFA).	- development of the public-private partnership tools (CAREC DS); - formation of a portfolio of priority investment projects supporting digital development in various fields and industries (CAREC DS); - harmonisation of investment regulatory tools (ADM); - establishing rules for investors in the field of digital commerce, payments, working with data flows, privacy, Artificial Intelligence (hereinafter – AI), and cybersecurity (DEFA).
Latin America and the Caribbean (ELAC)	- recommendations on the formation and access to advanced digital infrastructure, innovation management, AI, etc.	- development of tools for mixed financing of investment projects and joint use of new infrastructure facilities; - formation of a set of measures to improve the quality of the investment climate.
Western Europe (DC)	- focus on the development of digital competencies and infrastructure in the private and public sectors.	- planning of large-scale public/private investment programs; - implementation of cross-border investment and infrastructural projects.

Source: Author

[2] *DTSA – Digital Transformation Strategy for Africa (2020-2030); EAC – East African Community; ECOWAS – Economic Community of West African States; SADC – Southern African Development Community; CAREC DS – Digital Strategy for Central Asian Regional Economic Cooperation until 2030; ADM – Digital Master Plan Association of Southeast Asian Nations on the period up to 2025; DEFA – the ACEAN Framework Agreement on the Digital Economy; ELAC – The Digital Agenda for Latin America and the Caribbean for the period up to 2026; DC – Digital Compass-2030.*

Table 2 – Certain aspects of national digital strategies

Aspect	Characteristic
Digital inclusion	- provision on digital inclusivity exists in 97% of developed countries strategies, and in 88 % of developing countries strategies; - directions of digital inclusivity cover: the expansion of digital infrastructure (especially in peripheral areas) and the improvement of digital skills (especially among socially vulnerable groups of the population); - expansion of the digital infrastructure includes both the provision of basic access and construction of data centres and computing centres; - improving digital skills consists in the distribution of basic digital competencies among population groups and the development of advanced digital competencies to maintain the efficiency of innovative ecosystems.
Investment context: the focus on digital inclusion in strategies requires increased investment in high-tech sectors (AI, cybersecurity, and data science). However, it contributes to occurrence of a skilled and digitally literate workforce, and increases the overall national investment attractiveness	
Environmental sustainability	- provision on environmental sustainability exists in 86% of developed countries strategies and in 55% of developing countries strategies; - environmental problems related to the development of the digital economy involve depletion of natural resources due to digital devices production, infrastructure development, high energy consumption, water consumption for cooling data centre servers and electronics production, electronic waste; - problem of energy consumption becomes a key one in the formation of digital infrastructure (data centres). Indeed, those energy issues have been developed in the digital strategies of China, Chile, Finland, Qatar, Singapore); - absence of specific indicators and industry-specific measures related to the environmental aspects of the digital economy in most digital strategies.
Investment context: focus on environmental sustainability determines synchronisation of investments in the digital economy with investments in renewable energy. Therefore, the digital transition plays a catalytic role in the energy transition	
Favourable investment environment	- provisions on regulation of investments in the digital economy in 2024 exist in 88% of national digital strategies. Moreover, there is 20% increase compared to 2017; - provisions on standards of attracting investments in the digital economy in 2024 exist in 77% of national digital strategies. Indeed, there is 61 % increase compared to 2017. These provisions are widespread in developed (89%) rather than in developing (71%) countries; - cybersecurity and data privacy are of the greatest importance in digital strategies.
Investment context: provisions on regulation and standards of investments in the digital economy are usually supplemented by provisions on the investments in specific industries and technologies	
Financial support	– national digital strategies contain parameters for using the following sources of financing: programs focused exclusively on the high-tech sector (2017 – 3%; 2024 – 37%), budgetary funds (2017 – 69%; 2024 – 92%), private funds (2017 – 55%; 2024 – 85%), public-private partnership (2017 – 35%; 2024 – 58 %), FDI (2017 – 44 %; 2024 – 48%); – absence of structured approach to stimulate investments in the digital economy due to the insufficient focus in digital strategies on investment promotion agencies (hereinafter – IPAs). However, IPAs are mentioned in 20% of strategies of developing countries and in 11% of strategies of developed countries;

Aspect	Characteristic
	– special attention in digital strategies is devoted to investment promotion measures (electronic company registration services; visa facilitation for highly qualified specialists; acceleration and training programs) (2017 – 37%; 2024 – 87%) infrastructural and cooperative measures (formation of clusters, parks, and special economic zones) (2017 – 32%; 2024 – 7%), and investment incentives (tax and non-tax benefits) (2017 – 56%; 2024 – 72%).
Investment context: digital strategies should define specific investment goals and include a calculation of financing required for their implementation	

Source: Author

Sectoral-oriented digital strategies: key features and investment context

The rapid development of advanced technologies determines the development of targeted strategies and policies in terms of AI, data processing, and semiconductors (Table 3). These strategies play a key role in the process of attracting investments, highlighting national priorities, ensuring regulatory certainty, and demonstrating a long-term commitment to the development of the digital economy sector.

Table 3 – Key areas of sector- and technology-oriented digital strategies

Aspect	Characteristic
Artificial intelligence	- areas of AI's influence on economic development include: catalytic (positive – in the presence of a strategy and regulation) – stimulating innovation, increasing productivity and competitiveness of sectors; restrictive (negative – in the absence of a strategy and regulation) – digital inequality, concentration of market power, ethical and data privacy issues; - acceleration of adopting AI strategies. In 2024, 38% of states have adopted the strategy. There is 36% increase compared to 2017. However, according the geographical distribution, the strategy has been adopted in 76% of developed countries, 34% of developing countries in the Asia-Pacific region, 24% Latin American and Caribbean countries, 17% of African countries; - countries' approaches to AI in terms of digital strategies include: an approach with an emphasis on economic competitiveness and technological leadership; an approach with an emphasis on public service provision, social inclusion and ethical safeguards; a balanced approach with an emphasis on sustainable development and international innovation cooperation.
Investment context: digital strategies in terms of AI define investment, research, and infrastructure priorities, establish ethical and regulatory frameworks to ensure responsible and transparent use of AI. It ensures public trust and provides favourable conditions for attracting targeted investments	
Data processing	- areas of data centres influence on the digital economy include: catalytic (positive – in the presence of placement planning) – stimulating digital connectivity, industrial transformation, and increasing national technological and innovative potential; restrictive (negative – in the absence of placement planning) – excessive load on the energy grid, negative environmental impact, slowing down the digitalisation; - data centre strategies are primarily involved into cloud computing development policies covering the entire value chain from data management, standards, and digital interoperability to interconnections, process management, business practices, and cybersecurity. For example, in 2024 about 50 countries have adopted similar policies;

Aspect	Characteristic
	- examples of successful implementation of data centre strategies include: a) transformation of Guizhou Province (China) into a national data hub, 2016-2024; b) implementation of national and regional strategies to attract sustainable investments in data centres in Canada (Alberta AI-Based Data Centre Development Strategy, 2024), Chile (National Data Centre Plan, 2024-2030) and Singapore (Green Data Centre Roadmap, 2024); an example of problematic implementation of data centre strategies is the situation in Ireland in 2021-2025 – the growth of the sector outstripped the capacity of the energy grid in Dublin.
Investment context: digital data processing strategies should integrate investment incentives in data centre construction (simplification of licensing procedures, tax incentives and targeted marketing) with the competitive advantages of the territory, energy, and climate policy (availability of renewable energy sources, favourable climate), industrial strategy (reliable industrial infrastructure, level of development of industrial cooperation), and regulatory readiness (transparency of relevant norms and standards); data centre construction projects should consider investments in energy infrastructure modernisation at the planning stage	
Semiconductors	- specialised strategies for semiconductor industry development combine financial incentives with investments in infrastructure, training programs, and targeted support for specific segments of the value chain; - focus on individual segments of the value chain – manufacturing, assembly, testing, design or materials. It helps to consolidate the country in a segment corresponding to its capabilities in the digital economy.
Investment context: strategies for the development of the semiconductor industry should ensure national technological sovereignty, increase competitiveness, and diversify national industry in terms of the requirements of sustainable development	

Source: Author

Special economic zones are the cores of digital infrastructure development

An increase of geo-economic and geopolitical tensions, trade, and investment relations transformed under the influence of digitalisation made special economic zones (hereinafter – FEZs) a kind of investors regulator. Worldwide, the numbers of FEZ exceeds 6,300 units[3]. FEZs provide a structured, predictable, and preferential business environment to facilitate the implementation and maintenance of the most effective international business practices.

However, both positive and negative results of zonal functioning within an ecosystem including thousands of FEZs, zonal policy is being transformed. One part of the FEZ follows a model focused on new forms of growing investments, such as digital infrastructure. The other part is a model aligns infrastructural development with the quality of life, offers investors conditions including residential and social infrastructure facilities for employees[4].

Since 2022, the number of greenfield FDI projects in the FEZ in business services has exceeded the number of production projects. It reveals a trend towards the servicification of investments in the FEZ, especially the large–scale transition to intellectual, high-tech, digital investments (Table 4).

[3] *Irwin-Hunt, A. (2025). Global Free Zones Evolve for Rerouted Globalisation. Source: https://www.fdiintelligence.com/content/1e3968cf-4e1e-4be5-87f9-f1a10747ee16. (accessed on 17.11.2025)*

[4] *Global Free Zones of the Year 2025. fDi Intelligence. Source: https://www.fdiintelligence.com/special-report/523230cd-5d1e-46bd-9162-60594cbfdf97. (accessed on 17.11.2025)*

Table 4 – Number of "greenfield" FDI projects in the FEZ by scope

Project scope	2004	2006	2008	2010	2012	2014	2016	2018	2020	2022	2024
Business services	3	21	32	20	21	26	45	41	65	209	245
Production	44	76	79	48	66	127	238	228	122	130	179

Source: Author

Traditional sectors such as renewable energy, chemical industry, and metallurgy still attract the largest amounts of FDI into the FEZ. However, the communications sector includes data centres. It becomes the one of the top ten sectors in terms of announced FDI in 2023 and attracting record investments in 2024 (Table 5). In 2022, the information technology software and services sector also was ranked high.

Table 5 – Top 10 sectors accepting FDI in FEZs

Sector	2022	Sector	2024
	$ USD, bn The USA		$ USD, bn The USA
Renewable energy	64.33	Renewable energy	19.58
Electronic components	8.84	Chemistry	6.74
Metals	2.47	Metals	5.34
Chemistry	1.74	Electronic components	3.89
Transportation and warehousing	1.59	Semiconductors	2.92
Automotive industry	1.38	Transportation and warehousing	2.64
Software and information technology services	1.32	Communications	2.48
Financial services	0.86	Industrial machinery	2.14
Ceramics and glass	0.74	Pharmaceuticals	1.35
Semiconductors	0.60	Food and drinks	1.17

Source: Author

FEZs have the most significant advantages of localising investments in data processing (Saudi Arabia – a virtual FEZ for cloud computing; Great Britain – specialised territories for data centres near free ports; Singapore – the cross-border Johor FEZ), and electronic commerce (the US Foreign Trade Zones program)[5]. Indeed, they are as follows:

- revocation of custom obligations and import duties on expensive data centre equipment reduce the cost of investment projects related to training and application of AI models;
- existing energy infrastructure provides capacity redundancy and allows energy and water-intensive data centres to support operation;
- FEZs are logistics and infrastructure hubs. They help the companies to achieve the required level of efficiency, scalability, and customer orientation in the e-commerce.

Based on the Global Free Zones of the Year 2025 rating, we will[6] highlight the best practices for regulating and supporting digital FDI within the FEZ at the global and at the macro-regional levels.

Global level (Dubai Multi Commodities Centre (DMCC), UAE; Cayman Enterprise City (CEC), UK (Cayman Islands)). The DMCC operates an artificial intelligence center, a sustainable development hub, a

[5] *The Investment Dimension of Digital Strategies. (2025). UNCTAD. Source: https://unctad.org/system/files/official-document/diaepcbinf2025d3_en.pdf (accessed on 17.11.2025)*

[6] *Global Free Zones of the Year 2025. fDi Intelligence. Source: https://www.fdiintelligence.com/special-report/523230cd-5d1e-46bd-9162-60594cbfdf97. (accessed on 17.11.2025)*

cryptocenter, and a corporate dispute resolution center. DMCC develops initiatives to strengthen corporate governance, transparency, and investment incentives. They include income tax benefits, subsidised support packages for company registration, leasing for start-ups and small and medium-sized businesses in technology, AI, game industry, and blockchain. In CEC, investors are guaranteed complete neutrality with respect to taxes on profits, income, and capital gains. CEC offers resident companies consulting and marketing support, internship programs, and advanced digital infrastructure.

The macro-regional level.

Middle East Macroregion (DMCC; Dubai Commerce (DCC), UAE). Nowadays DCC automated and digitalised its business processes to simplify and accelerate logistics for residents. DCC provides the investors with flexible work and warehouse spaces, information technology infrastructure, and digital marketing services, including real-time analytical data on residents' products.

European Macroregion (Zona Especial Canaria (ZEC), Spain; Consorcio de la Zona Franca de Cádiz (CZFC), Spain). A special feature of ZEC strategy is cooperation with scientific and educational institutions. It allows FEZ to form and develop a talent pool adapted to the needs of residents. The rating experts also highlight credit programs and tax incentives specifically designed for digital industries. They include reduced corporate tax rate and tax deductions to cover part of companies' variable costs and R&D expenses. CZFC is the centre of the "blue economy" – the concept of sustainable use of oceans, seas, and coastal zones. CZFC develops technology start-ups in the shipbuilding and aerospace sectors in cooperation with the University of Cadiz and the institutes of the National Maritime Cluster.

African Macroregion (Eko Atlantic City (EAC), Nigeria). EAC implements the smart city concept, a range of special investor support measures, registration and protection of intellectual property rights, simplified processing of visas, and work permits for qualified professionals. According to the experts, EAC improves corporate governance and transparency standards through regular independent audits of the zone's impact on the environment and social sphere.

Asia-Pacific Macro Region (Port City Colombo (PCC), Sri Lanka; Tanjung Lesung SEZ (TLSEZ), Indonesia). A special feature of the PCC is a combination of incentives, including the following: a zero personal income tax rate for foreign resident employees, tax incentives for developers and investment companies, centre's services for resolving corporate disputes. TLSEZ actively collaborates with universities and research institutes to support talent development and R&D. TLSEZ operates an advanced digital permit and license system.

Macroregion of the Americas (CEC; Zonamerica (ZA), Uruguay). ZA operates as a technology park to form an ecosystem of companies by stimulating cooperation. ZA successfully implements strict sustainability standards in its business processes.

Conclusions

Therefore, we develop the principles to ensure the investment potential of digital strategies. They are as follows::

– firstly, the formation of a clear investment concept to identify the priority sectors, investor profiles, and strategic infrastructure needs for various purposes.

– secondly, the alignment of digital strategies with the goals of sustainable, investment, and industrial development to ensure the development of human capital, necessary regulatory reforms, and infrastructure planning.

– thirdly, integration of sustainability criteria into digital strategies to address the problem of the environmental footprint of investments into digital infrastructure.

– fourth, investment planning, including assessment of the infrastructure gap, forecasting demand, and determining the strategic location of data and innovation centres, etc.

– fifth targeted implementation of measures to promote digital transformation and structural modernisation.

– sixth, strengthening the coordination of digital strategies at different levels to achieve economies of

scale, promote cross-border integration, and ensure regulatory consistency.

– seventh integration of digital development into the special economic zones to build a comprehensive preferential policy in the digital sector.

FUNDING

The work was done on a personal initiative.

CONFLICT OF INTEREST

The author declares no conflict of interest.>

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Received 05.11.2025
Revised 10.12.2025
Accepted 13.12.2025

Jraic.com
JOURNAL OF REGIONAL AND INTERNATIONAL COMPETITIVENESS 2025; 6(4):53-61

The features of the development of the local healthcare services market: analysis of demand for paid service

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ORIGINAL ARTICLE

Abstract. Healthcare sector is a key indicator of socio-economic development and the population quality of life. Healthcare organisations traditionally play a significant role, providing both access to the healthcare services and improving public health. The sector is a special area of economic relations. Indeed, on this market, the healthcare services is a good. An analysis of the healthcare services market dynamics shows a steady increase in the volume of paid services. Recently, there is an increase in the share of paid healthcare services in the total volume. It indicates a growing demand for high-quality medical services. The formation and development of the healthcare services market in Russia is a complex and multifaceted process. It requires an integrated approach. The successful development of this sector depends on addressing existing problems and implementing management decisions. However, the market of paid healthcare services is currently developing in Russia. Its further development includes improving the quality of care, increasing the availability of modern medical technologies, and ensuring the competitiveness of Russian medical institutions. Meanwhile, the share of commercial medical organisations is growing with every passing year. Nevertheless, the development of paid healthcare services market is quite slow due to a reduction in effective demand and a shortage of qualified specialists. The purpose of the research is to define the ratio of supply and demand in this market: the need for health ensures demand for medical services. The major method of an empirical study is a sociological survey. According to the research results, demographic changes, technological innovations, and the level of government support determine the development of the private healthcare services market. The trends identified indicate a natural transition towards the use of paid healthcare services.

Keywords: healthcare; paid services market; quality of life; health capital; effective demand; need for health

JEL codes: A14

DOI: 10.52957/2782-1927-2025-6-4-53-61

For citation: Irina V. Popova, Anna N. Zhilina, Alexey V. Zorin. (2025). The features of the development of the local healthcare services market: analysis of demand for paid service. *Journal of regional and international competitiveness*, 6(4), 53.

Introduction

Nowadays, healthcare is the basis of social vital activity and one of the leading sectors of the national economy. Healthcare sector is a key indicator of socio-economic development and the population quality of life. Healthcare organisations traditionally play a significant role, providing both access to the healthcare services and improving public health. Therefore, it is crucial in the conditions of pandemics, climate change, chronic diseases, etc. First, healthcare organisations are responsible for the development and implementation of healthcare policies aimed at improvement of the population quality of life. It includes disease prevention, vaccination, anti-addiction programs, healthy lifestyle promotion, etc. Healthcare

organisations develop strategies to overcome the challenges, such as the increasing number of infectious or chronic diseases. Secondly, healthcare organisations actively participate in research and scientific activities. They often provide effective solutions and new technologies in the field of medicine and healthcare. It allows one to respond to emerging threats and improve methods for diagnosing and treating diseases. Thirdly, an important aspect is the coordination of actions of various sectors of society. Healthcare organisations work in the cooperation with various government agencies, non-governmental organisations, the business sector, etc. Such collaboration helps to address not only medical issues, but the issues of poverty, education, and access to clean water. Fourth, education and training of personnel is an essential task. Modern healthcare organisations train medical personnel, providing them with the necessary knowledge and skills to work in a rapidly changing environment. In addition, they disseminate information about health and disease prevention. It could significantly improve public health in the long term. Therefore, healthcare organisations play multifunctional and vital role in modern society. Society's ability to adapt to changes, manage emerging threats, and ensure an improved quality of life for all citizens depends on them. It requires constant attention, resources, and innovative approaches to cope with new diseases and challenges facing humanity in the 21st century [1, p. 224].

The existing market of private medical services in the Russian Federation can be assessed as developing one. Therefore, it is exposed to various factors of macro- and meso-economic levels. In this market, there is quite fierce competition. It regulates supply and demand. An important condition for balancing demand is the expansion of economic opportunities for potential consumers, an increase in their incomes, etc. It leads to increased activity in the specified market, the volume of paid healthcare services, and the average service fee.

In the healthcare services market, as in any economic activity, one of the main factors determining the successful development of relationships is the preservation and maintenance of a competitive environment. Competition is a marker of market relations development. It is an independence in the choice of healthcare services providers, the ability to make contracts between buyers and service providers. Competition is one of the most important economic laws of the development of society, a stimulator of production activity, and improvement of the quality of products and services. It promotes the development of the economy, search for effective solutions, development of advanced technologies, and provides consumers free choice. The role of the state as a moderator and supervisor of antimonopoly legislation is important for the development of competition in the healthcare services market. In accordance with Article 4 of the Federal Law "On Protection of Competition", competition is the rivalry of economic entities; their independent actions exclude or limit their ability to unilaterally influence the general conditions of circulation of goods in the relevant commodity market[1]. Consequently, in terms of competition in the provision of healthcare services, medical organisations should not unilaterally influence the general conditions for the provision of services. This mechanism ensures the containment of rising prices for healthcare services, introduction of innovative technologies, provision of high-quality medical services by attracting qualified specialists to a medical organisation, customer-oriented approach, etc. Also, it stimulates a cost reduction.

Methods

The most important characteristic of competition is the rivalry between business entities. It is the behaviour characterised by the desire to gain an advantage over other subjects in a particular area of the economy in conditions of material goods shortage [2, p.18]. Indeed, these norms of law regulate the behaviour of competing entities, rules of competition, and guarantee the competition within certain limits. The establishment of such rules and guarantees is necessary for the existence of competition itself. In conditions of limited resources and growing needs, without legal regulation and control of competition, the process of competition between subjects will result in monopolisation or widespread violation of consumer rights, primarily in the field of quality of goods and services. The most important issue for consumers in the field of paid medical care is the quality and cost. Competition ensures the most significant interests and needs of patients against the background of public healthcare financing problems through the mechanisms of a

[1] *Federal Law No. 135-FZ on Protection of Competition. (2006, July 26). ConsultantPlus. (as amended on 08.08.2024)*

market economy. Therefore, such competition optimises the cost of healthcare services, improves social well-being, and reduces mortality [3, p. 67].

However, in the scientific literature there is another view on competition in the provision of healthcare services. According to it, healthcare is an industry of health protection. Moreover, there is also non-price competition in the healthcare services market, as the competitiveness of a medical organisation increases due to its development (acquisition of new equipment, attraction of highly qualified specialists), improvement of the quality of medical care, and accessibility of medical services (opening new branches, departments of a medical organisation, increasing types of care, and reducing waiting times). Meanwhile, researchers often attribute the paid healthcare services market to markets with imperfect competition, since it is dominated by a small number of individuals; entry of new organisations into the industry is limited by high barriers and significant financial investments. As a result, the features of an oligopoly appear. Imperfect competition is a rivalry in terms of control the prices of the products fabricated by the individual manufacturers. Indeed, imperfect competition causes difficult market interactions and limited access to information. Perfect competition is an idealised state of the commodity market. It characterised by a large number of independent entrepreneurs (sellers and buyers), opportunity to free market interactions, equal access to information and a homogeneous product. Therefore, market participants should have an appropriate high-tech base, ensure licensing of activities, professional growth of employees, and successfully pass the accreditation. Otherwise, private medical organisations cannot expect high profits. According to the research on the competition in the healthcare services market, it has seasonal demand for medical services, insufficient development of commercial services in severe cases of diseases, expensive high-tech equipment, asymmetry in the provision of services, high barriers to entry for new manufacturers, and a multi-level consumer system. Therefore, the concept of competition in the healthcare services market is a process of interaction between consumers of medical services (patients), suppliers (medical institutions), and intermediaries (insurance companies), aimed at achieving the common and personal needs. The purpose of competition in the healthcare services market is to increase the value of receiving a service for the consumer. Value refers to the quality of medical care and the amount of money spent for the service received. Indeed, a constant or slight increase in the price of services for consumers, and the quality of services and should be improved. It stimulates and expands the market [4, p. 33].

An analysis of the healthcare services market dynamics shows a steady increase in the volume of paid services. Recently, there has been an increase in the share of paid healthcare services in the total volume. It indicates a growing demand for high-quality medical services (Figure 1).

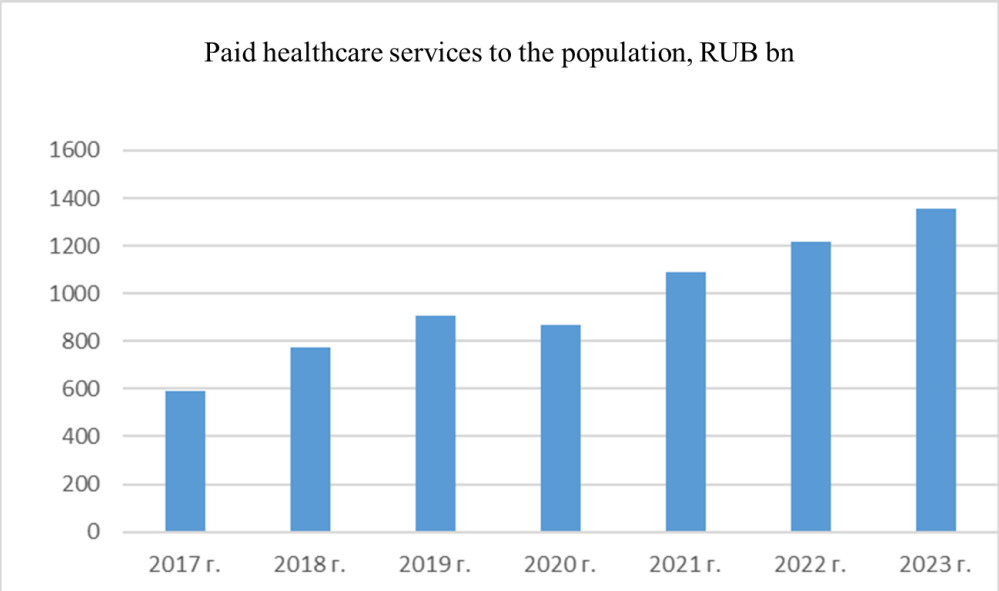

Figure 1. Dynamics of volume of paid healthcare services, 2017-2023

Source: Rosstat

The main factors of healthcare services market development are as follows:
- expanding the range of healthcare services;
- integration of small clinics into the large medical networks;
- opening of multidisciplinary medical centres;
- introduction of digital technologies into medical practice;
- development of the VHI (Voluntary Health Insurance) system [5-8].

The main competitive advantages of private medical institutions include the following:
- high reputation of the healthcare organisation;
- high quality of healthcare products and services provided, effective treatment of diseases (the structure of completed cases according to the purpose of the visit);
- qualification of medical personnel (% of doctors with the highest category);
- sufficient material and technical base, availability of modern diagnostic medical equipment (% of the equipment under 5 years);
- the uniqueness of the healthcare products and services;
- reasonable prices do not exceed the similar ones for healthcare products and services from other market participants.

New medical equipment significantly affects the treatment process. The need for a constant increase in investments of commercial medical institutions in equipment determines the specifics of the demand for healthcare services [9-13].

The identified main limitations of the market development are as follows:
- lack of qualified medical personnel;
- uneven development of regions;
- high costs of equipment and technology;
- the need for constant updating of the material and technical base [13-15].

Therefore, we conditionally identify the main types of medical institutions corresponding to the sectors of the modern economy; each has its own specific management: a) state and municipal medical institutions; b) commercial medical institutions. Public medical organisations include subordinated to the bodies of the state health system, medical, preventive, and scientific research institutions, pharmaceutical organisations, pharmacy institutions, etc. Municipal medical institutions include medical, pharmaceutical, and pharmacy organisations subordinated to the municipality. The private healthcare system includes medical institutions and pharmacies subordinated to the individuals engaged in private medical practice and pharmaceutical activities.

Therefore, the main aspect of the market mechanism is competition. Studying competitors and highlighting their strengths and weaknesses is extremely important for gaining a certain share of the healthcare services market. By comparing services with those of competitors, there could be determined the competitive advantages and market positions. They are unique, special features of medical organisations distinguishing them from others. They make higher profits. When determining competitive advantages, it is important to focus on patients and their needs, and to be sure these advantages are perceived by them. Competitive advantages are the basis of the strategy of participants' behaviour in the market of healthcare products and services [16].

Results

The formation of a post-industrial economy requires increased attention to the factors determining the quality of human capital. It includes the level or capital of health available to individuals. At the micro level, increased interest in health capital is evident in new trends such as telemedicine, healthcare digitalisation, medical tourism, or MedTech (a fusion of advanced medical and information technologies). At the macro level, healthcare services is the area with a high proportion of government intervention due to the social importance of public health, and market failures in the relevant markets.

The healthcare services market has specific features. Its main goal is to provide high-quality medical

care to the population and the patient's health.

However, in the literature, there is a different interpretation of healthcare services in terms of the specifics of payment. It depends on the provision of the service: for a fee, expense of compulsory insurance, or the state budget. Also, it depends on demand because assistance, unlike services, is provided for objective reasons; it is not advertised and offered a choice. This classification is not operational in the framework of this research. For instance, a person has objective indications for a planned medical operation; he or she can study information about providers offering this service and choose the best one; it is quite possible within the framework of the Russian compulsory medical insurance system. In details, the specifics of the healthcare services market are described in the economic literature [17-19]. Synthesising the available approaches, the following characteristics can be distinguished:

1. The uncertainty of demand. Despite a number of medical procedures, such as regular medical checkups or vaccinations, are planned, most of them are surprising for the consumer. It results in consumers being unable to plan their medical expenses. Moreover, these costs may be disproportionately high compared to income.

2. Information asymmetry. The healthcare services are one of the traditional examples of trust-based goods (the quality of these goods is often impossible to assess after their consumption). Consumers are not sufficiently informed to make a rational choice of the healthcare services they require. As a result, they cannot assess the quality of the service provided and rely on subjective impressions. For instance, they believe a certain manipulation with less discomfort for the patient provides a better service [20, p. 17].

The empirical base is the data of a standardised sociological survey conducted based on the program and the author's methods. The starting point of our research was quantitative indicators of improvement of the population quality of life in the Yaroslavl region, Russia. To assess satisfaction with the quality of life, a survey was conducted through a Google form for various categories of citizens of Yaroslavl, Russia. The sampling included: 77.3% of women and 22.7% of men. Age: 51.7% of respondents are under 30 years old; 23.4% – 31-40 years old; 15.4% – 41-50 years old; 7.0% – 51-60 years old; 2.5% over 60 years old. Education: 70.1% of respondents have higher education; 22.4% – secondary vocational education; 7.5% – secondary general education. Marital status: 42.3% of respondents are married for the first time; 28.9% – not married; 8.5% – divorced; 8.0% – remarried after divorce; 10.4% – in a civil union; 2.0% – widowed. Living conditions: 56.4% of respondents live in their own flats; 13.5% – private house; 19.0% – rent apartments; 6.5% – state apartments; 4.5% – communal apartments. Employment: 64.5% of respondents are working; 19.0% – working and studying; 5.0% – studying; 4.0% – retired and working; 7.5% – not working or studying. Sector of employment: 23.9% are government, administrative authorities; 19.8% – trade, services; 14.2% – education, medicine, culture; 11.2% – production; 5.1% – private enterprise; 6.1% – transportation; 19.7% – other. All these socio-demographic characteristics are related to the assessment of people's quality of life.

In accordance with the purpose of this research, we use the results to test some particular hypotheses related to health capital and consumer behaviour in the paid medical sciences market.

The ratio of supply and demand in this market is as follows: the need for health ensures a demand for medical services. To describe the health capital of the population, the research contains the question: "How would you rate your health?". The following results were obtained:

I have good health; I suffer only from seasonal colds – 54.0%;

Generally good, I have one chronic disease – 36.5%;

I have poor health; I have several chronic diseases – 9.5%.

The object of our research is the population distributed by age groups: 51.7% of respondents are under 30 years old; 23.4% – 31-40 years old; 15.4% – 41-50 years old; 7.0% – 51-60 years old; 2.5% over 60 years old.

In recent years, the privatisation of enterprises has formed a steady trend towards ignoring such a problem as occupational morbidity. Confirmation of this hypothesis is the answers to the question: "Do you have an occupational disease?" according to the option "I do not know what occupational disease is" – 13.0% and 11.5% answered they have. The results obtained allow us to conclude low quality of health capital. However, it is factor of increasing demand for paid healthcare services.

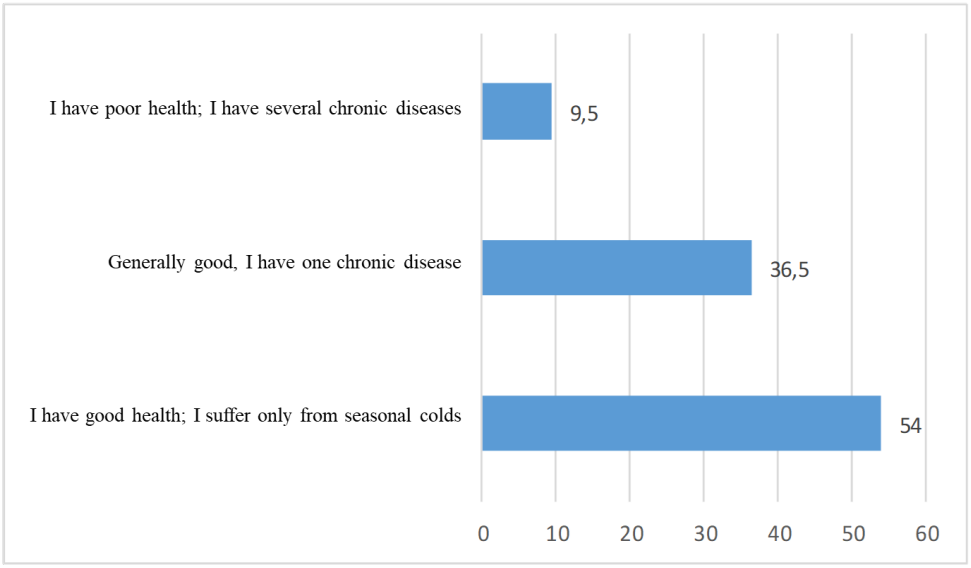

Figure 2. Health capital (% of respondents)

Source: Authors

To determine the proportion of users of paid healthcare services, the question was asked: "Do you use paid healthcare services?"

The results are as follows (Fig. 3):

Yes, sometimes – 47.8%

Yes, more often than free of charge – 45.8%

Free of charge only – 6.4%

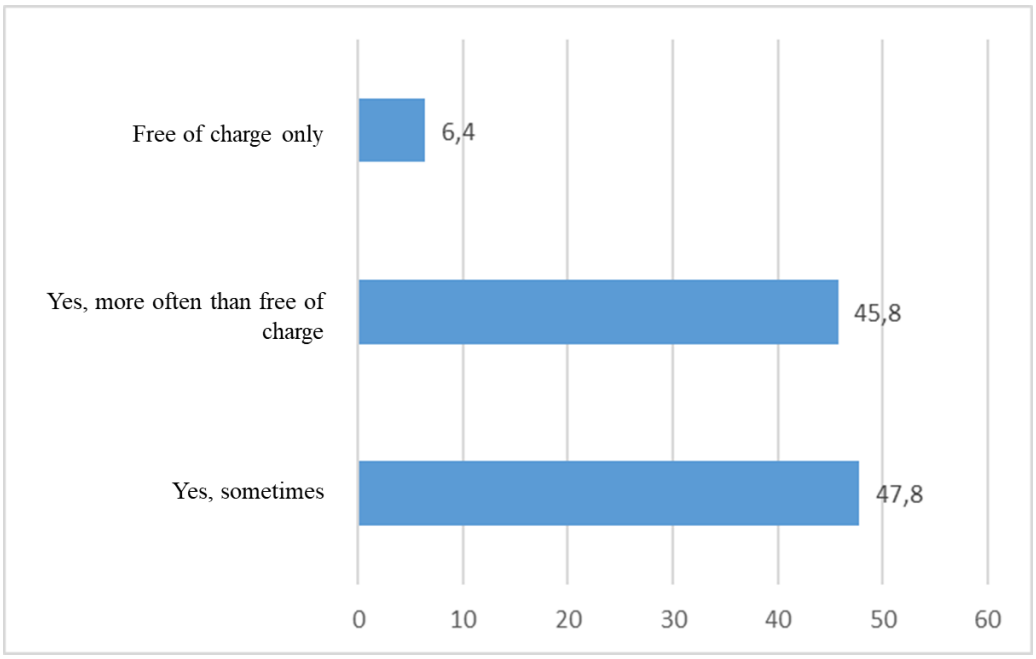

Figure 3. Proportion of healthcare services users

Source: Authors

The main part of the sampling consists of the working people; they can use paid services. But the result itself allows us to extrapolate it to the unemployed population. They are forced to use free medicine, which has serious disadvantages.

The motivation of patients is formed by the quality of service, pricing policy, recommendations, and convenience of receiving services. Understanding these factors allows medical organisations to effectively build a development strategy and improve the quality of services provided. Identifying the reasons for

accessing paid healthcare services was the purpose of the study. It helps to develop recommendations for improving public administration and the population quality of life. Question: "What are your reasons for paying the medical centres?" There were several possible answers; amount is more than 100%; result is arranged in descending order:

62.2% – due to time savings, it is not possible to spend much time on free medicine;
47.8% – due to the lack of opportunity to receive this service for free;
46.8% – due to the higher quality of service;
22.4% – due to the opportunity to choose a doctor by my own.

To overall assessment of the organisation of medical care in Yaroslavl, Russian Federation respondents were asked the following question: "How would you rate the medical care for Yaroslavl residents?" Mark all the options that suit you; amount is more than 100%; result is arranged in descending order:

- negatively, there is always a problem of getting an appointment with a specialist – 55.0%;
- negatively, there is always a problem getting an appointment with a local therapist – 44.0%;
- poorly organised appointment at the local clinics – 39.0%;
- it is difficult to get free dental care – 31.0%;
- poorly organised ambulance service – 27.5%;
- positively, we have no problems receiving medical care – 23.5%;
- it is difficult to get to the hospital for treatment – 10.5%;
- poorly organised child care – 9.5%.

According the research results, public reorganisation of the healthcare system has a negative effect on its condition. People are forced to use paid healthcare services. It reduces the ability to meet people's needs to maintain their health, life expectancy, increases morbidity. Indeed, it negatively affects all indicators of quality of life and capital of health related to the public administration of the health system.

Conclusion

As a result, demographic changes, technological innovations, and the level of government support determine the development of the private healthcare services market. The trends identified indicate a natural transition towards the use of paid healthcare services in healthcare. The entrepreneurs adapted to these changes can expect to thrive in this fast-growing sector of the economy. At the same time, small and medium-sized businesses play a significant role in the healthcare sector. They ensure the availability and quality of healthcare services, introduce innovations, and contribute to economic development. Their active involvement in the health of society highlights the need to form an enabling environment for further growth and development of this sector. It ultimately benefits society as a whole. However, economic activity, tax preferences, and public support measures are necessary for healthy development of the private healthcare services market and the segment of small and medium-sized businesses. Indeed, paid healthcare services market is currently undeveloped in Russia. Meanwhile, the share of commercial medical organisations is growing with every passing year. An effective combination of market mechanisms and government participation will have a positive effect on this sector development. Nevertheless, the development of paid healthcare services market is quite slow due to a reduction in effective demand and a shortage of qualified specialists.

Therefore, modern economics has well-developed terminological basis for describing the major categories of the healthcare services market. The economists define the goal of the healthcare system as an increase of health capital. As a set of healthcare services, those are investments both through non-medical expenses, for example, the purchase of a gym membership or water filtration equipment, and through medical care.

FUNDING

The work was done on a personal initiative.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHORS' CONTRIBUTION

Irina V. Popova – writing – original draft.
Anna N. Zhilina – data curation, formal analysis, validation.
Alexey V. Zorin – conceptualization, project administration, writing – review & editing.

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Received 05.11.2025
Revised 10.12.2025
Accepted 13.12.2025

EU automotive production chains: country-specific features in terms of regional integration development

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ORIGINAL ARTICLE

Abstract. The article considers the specifics of the current production chains of the automotive industry, the degree of specialisation, assessment of changes in geographical disparities in the production of goods by levels of commodity movement in the European Union. The hypothesis of the research concerns with the proportional and equitable participation of individual countries and regions in the European automotive industry in terms of deep regional integration. The methodology presented for modelling the production chains of the automotive industry confirms the general hypothesis of the research. Indeed, the production of simple nodes has become more evenly distributed across Europe. The research reveals a decrease in geographical disparities in the production of complex integrated modules. Finally, it resulted in the increased concentration of the main assembly facilities in a limited number of locations. The results obtained indicate a more even development of Europe's knowledge-intensive production base against the background of deepening integration processes. Those are useful in the development of measures to support the automotive industry in the BRICS and EAEU. It is important to support the expansion of the geography of integrated modules production to contribute the strengthening of the technological base of the regional association member countries.

Keywords: automotive industry; European Union; uneven spatial development; export specialisation; production chains

JEL codes: F18, F63, L62

DOI: 10.52957/2782-1927-2025-6-4-62-73

For citation: Elena V. Sapir, Ilya A. Gorshkov. (2025). EU automotive production chains: country-specific features in terms of regional integration development. *Journal of regional and international competitiveness*, 6(4), 62.

Introduction

At the present stage, the automotive industry of the European Union is facing a number of challenges on the leadership in the global automotive industry. The automotive industry and industries directly or indirectly related to it account for about 7% of Europe's GDP and employ about 13.8 mln people[1]. In 2019, the European Union (consisting of 27 countries) (hereinafter – the EU) dominated the global automotive market. It has 10 of the world's 20 largest suppliers of automotive components and 4 of the 10 largest manufacturers of finished vehicles by revenue[2]. During the same period, Europe's share in the total global production of passenger cars was 21.6%. However, by 2024, the share of finished car production in the EU countries had decreased to 17.4%[3]. It is justified by the technological lag in the region's automotive industry and the slow response to changes in market conditions.

[1] *Automotive industry. European Commission. Source: https://single-market-economy.ec.europa.eu/sectors/automotive-industry/policy-and-strategy_en (accessed on 06.05.2025)*

[2] *Deubener H. et al. European automotive industry: What it takes to regain competitiveness. McKinsey. 2025. Source: https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/european-automotive-industry-what-it-takes-to-regain-competitiveness# / (accessed on 06.05.2025)*

[3] *Production statistics 2024. International Organization of Motor Vehicle Manufacturers. 2024. Source: https://www.oica.`net/category/production-statistics/2024-statistics/ (accessed on 06.05.2025)*

At the current stage, European automakers are facing the challenges of radical changes in engine technology, growing consumer demand for unique cars, an accelerated transition from hardware-defined vehicles to software-defined ones, etc.[4]. Previously, European automakers, especially German companies, were provided with skilled labour, automated production, etc. Therefore, the companies themselves received significant economies of scale. Combined with low energy prices, this allowed companies to produce local products competitive on the global market. However, these advantages are currently under threat due to the active use of industrial robots and the general automation of production in the United States and China. Companies in these countries have flexible cost structure. Moreover, the trade unions have limited influence on company management.

China has an increasingly important role in the global automotive industry. It has currently established the production of internationally competitive electric vehicles [1, p.67]. In opposition to the rapidly advancing Chinese automotive industry, the EU states reduce the dependence of regional production chains on supplies abroad, especially from China[5]. There is a gradual process of reindustrialisation and regionalisation of value chains within the framework of the association. Indeed, the transfer of the most complex and capital-intensive passenger car production processes to the EU countries. Nowadays, the automotive industry production network of the EU has developed a stable system of relationships between suppliers, automotive companies and countries. Therefore, the majority of car assembly plants and factories for the production of parts and components are located in the Western European countries (hereinafter – WE). At the same time, there are several countries forming a core of this system. They accumulate the most knowledge-intensive and profitable stages of the car manufacturing process [2]. Meanwhile, the one of European integration tasks is levelling of the cross-country differences in the technical and production base [3, p. 51].

Therefore, there is an issue of a decrease in the unevenness in the geographical structure of countries' specialisation at the EU certain stages of passenger car production in terms of the economic internationalisation and the development of a Single Market. Indeed, the countries with the peripheral economy should correlate with the central European economies and in terms of the level of production development and technical base of the automotive industry.

Review of literature and research

The problem of uneven development of production chains in the European automotive sector has become the subject of research by a lot of domestic and foreign scientists, consulting agencies and international organisations.

The Russian researchers consider the issues of self-sufficiency of the European automotive industry, export specialisation, and export structure of European economies. They also deal with the specifics of the institutional regulation and the trends towards reducing asymmetry in the development of Eastern European and Western European countries[6] (hereinafter – EE and WE) [4, p. 124; 5, p. 96; 6, p. 562]. The EE countries are actively attracting foreign investment due to cheap labour. However, they risk to lose their advantage in terms of automation [7]. There is a gradual reduction in the technological gap in the levels of development of the countries of the Eastern and Western macroregions [8, p. 50]. The advantages of cooperation are considered as a driver of technological development: the formation of a model of open innovation, joint work in terms of non-competitive research [9]. Mechanisms of state support and administrative regulation play a special role in the European automotive industry [10]. The segment of electric vehicles (EV) and hybrids is actively gaining a foothold in the European automotive market, and EV production volumes are increasing [11, p. 236]. There is a change in the sectoral structure of the WE countries towards an increase in the share of high-tech information services in the cost of products [12].

The works by foreign scientists are devoted to two central groups of problems: the first is the sustainability

[4] *Waas A. et al. European Auto Industry is at a Crossroad. Boston Consulting Group. 2023. Source: https://www.bcg.com/publications/2023/european-auto-industry-is-under-pressure (accessed on 06.05.2025)*

[5] *Updating the 2020 New Industrial Strategy: Building a stronger Single Market for Europe's recovery. European Commission. Brussels. 2021. COM (2021) 350 Final. P. 11.*

[6] *Western Europe: Germany, Austria, Belgium, Sweden. Eastern Europe: Poland, Hungary, Slovakia, Czech Republic, Romania*

and self-sufficiency of production chains; the second one is the uneven participation of countries in certain stages of European automotive chains [14-17; 18, p. 177]. Special attention is paid to the growing dependence of European battery production on the supply of Chinese raw materials [13]. It also concerns with the gradual increase in the degree of integration of production processes within the region [25]. There is a loss of global market share by European automakers due to competition with Asian companies. Moreover, there is a shift in production focus to sustainable development and digital services [19; 20, p. 25]. In the automotive industry of the EU there are imbalances in the distribution of countries by stages of the value chain [21]. The relocation of factories to Eastern European countries allows automakers with the strong economies to supply themselves with cheaper components and increase their competitiveness [22]. Pavlinek [23] notes an increase in the degree of involvement of peripheral EU states in the regional automotive industry. At the same time, it is expected to strengthen the territorial specialisation of production, change in the geographical distribution of automotive enterprises in the EU. Moreover, the author identified a key advantage and time of significant vulnerability of the automotive industry in the integrated periphery of Eastern Europe. They are as follows: attracting foreign direct investment due to low production costs, especially cheap labour [24].

Reports from international organisations and consulting agencies examine the current state of the EU automotive industry and its risks. The agencies note the instability of the current situation in the automotive industry, the technological lag in the production of electric vehicles, and dependence on imports of critical raw materials for the production of batteries of the EU[7,8], . The report of the European Automobile Manufacturers Association[9] (ACEA) for 2023 and 2022 identifies the leaders in car assembly among European countries: Germany, Spain, the Czech Republic, and Slovakia. Countries are experiencing an increase in production volumes caused by a gradual decrease in the impact of supply chain disruptions.

Therefore, the following issues have been widely studied in the scientific literature: the increasing dependence of the EU automotive industry on foreign investors and their products; decline in competitiveness relative to the US and Chinese automakers in the electric vehicle segment; increase in imbalances in the level of development of the automotive industry of the European automotive industry. At the same time, the issue of country-specific aspects of export specialisation at certain stages of the production chain is understudied. This research examines the extent of the discrepancy in the nature of specialisation of individual countries and regions, the course of the development of European integration.

Methods

During the research the following hypotheses were put forward:

H1: a decrease in geographical (cross-country) imbalances in the production of simple nodes.

H2: a reduction in the disparity in the production of integrated modules.

H3: the imbalances in the localisation of assembly plants increasing.

To test the hypotheses, an analysis of the European automotive industry production chain was conducted. It corresponds to the following categories of goods: the product movement; intermediate goods used in car assembly (simple components); enlarged modules: (1) curb chassis and (2) body for passenger cars); ready-made cars of various types. This specification of the levels of product movement is necessary to further determine the specialisation of countries at certain stages of the car creation chain (Table 1).

Table 1 – Classification of goods by levels of movement in the automotive industry in Europe

The level of product movement	Customs Tariff Number (CTN)	Product Name
Simple components	870840	Transmission box

[7] *Deubener H. et al. European automotive industry: What it takes to regain competitiveness. McKinsey. 2025. Source: https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/european-automotive-industry-what-it-takes-to-regain-competitiveness# / (accessed on 06.05.2025)*

[8] *Waas A. et al. European Auto Industry is at a Crossroad. Boston Consulting Group. 2023. Source: https://www.bcg.com/publications/2023/european-auto-industry-is-under-pressure (accessed on 06.05.2025)*

[9] *Economic and market Report Global and EU auto industry: full year 2023. ACEA. 2024. Source: https://www.acea.auto/files/Economic_and_Market_Report-Full_year_2023.pdf (accessed on 10.05.2025)*

The level of product movement	Customs Tariff Number (CTN)	Product Name
	870880	Amortisation System
	8507	Battery accumulators
	840820	Diesel engines
	840734	Engines with a cylinder capacity exceeding 1 litre
	8501	Electric motors and generators
Enlarged modules	8706	Chassis equipped with an engine
	870710	Bodywork for passenger cars
Ready-made cars	870323	Cars with gasoline engine capacity from 1.5-3 litres
	870332	Cars with diesel engine capacity from 1.5-2.5 litres
	870340	Diesel cars with electric motor
	870380	Electric vehicles

Source: composed by the authors based on T. Sturgeon et al., 2016[10]

Stage 1. Determination of the specifics of commodity movement at the level of individual goods

The empirical verification of the research hypothesis was conducted in several stages. At the first stage, the coefficients of the export specialisation of the European Union countries for the main components, integrated modules, and finished cars (Formula 1) were calculated.

$$RCA_{ip} = \frac{(X(M)_{ipw}/X(M)_{itw})}{(X(M)_{prw}/X(M)_{tw})} \quad (1)$$

Where RCA is the coefficient of export specialisation (according to the method of B. Balash),
X (M) is the export (import) flow,
p is the product of interest according to the CTN code,
i is the country under study, w is the worlds' flow,
r is intercountry flows in the European Union (27 countries),
t is the total volume of exports (import).

The numerator is the share of exports or imports of goods in the total exports or imports of the country under study. The denominator is the share of exports or imports of the studied product in the total exports or imports of EU countries.

The RCA coefficients were calculated for the EU. According to the results, two countries with the highest RCA scores for each of the products were selected. To assess the specialisation of individual economies at a particular stage of the production chain, 9 countries most involved in international trade in automotive products were considered and divided into two macroregions: Western Europe – Belgium, Germany, Austria, Sweden; Eastern Europe – Romania, Slovakia, Czech Republic, Poland, Hungary.

Stage 2. Determining the location of individual economies at the stages of the production chain

The assessment of the location of individual countries at specific stages of the passenger car production chain was conducted by calculating the weighted average coefficient of export specialisation for a group of goods proposed by the authors (Formula 2).

[10] *Sturgeon T. et al. (2016). The Philippines in the Automotive Global Value Chain. The Duke Centre on Globalization. Governance & Competitiveness Centre on Globalization. Source: https://gvcc.duke.edu/wp-content/ uploads/2016_Philippines_Automotive_Global_Value_Chain.pdf (accessed on 10.05.2025)*

$$ARCA_{ik} = \sum_{p=1}^{Pk} (RCA_{ip} * d_{ipk}) \quad (2)$$

Where ARCA is the RCA indicator weighted by the share of exports of goods in the commodity movement group, RCA is the coefficient of specialisation for a particular commodity item within the commodity movement group, p is the product of interest according to the CTN code,

i is the country under study,

k is the level of commodity movement (according to Table 1),

pk is the number of product items in group k (for simple components – 6 items, for enlarged modules – 2 items, for ready made vehicles – 4 items),

d is the share of exports of goods by a country within the commodity distribution group.

The higher the weighted average coefficient of export specialisation of countries for a certain group of goods, the more significant the country's role in the production of group k goods. The coefficient provides the country's strategic role in the automotive production chains of the EU. The indicator is calculated for nine countries for three groups.

To detail analysis of the distribution of European countries by individual stages of the production chain, a graphical method based on the construction of bell curve has been applied. Traditionally, the concept of a bell curve shows the relationship between a stage of the production chain and its added value. Their initial stages are represented by research and development with high added value. However, in our work the bell curve has been modified: three stages have been postponed on the abscissa (X) axis according to the distribution scheme: components, assemblies, and readymade cars. The values of the ARCA coefficients are on the ordinate (Y) axis. The resulting graph allows us to assess the degree of participation of countries in a specific part of the production chain and draw conclusions about the role of the economy in the automotive industry of the region.

Stage 3. Assessment of the uniformity of the distribution of production capacities in the EU

At the final stage of the study, to determine the degree of uniformity of capacities distribution in the EU automotive sector, the indicators of the standard deviation of the export specialisation coefficients of the countries for 2010 and 2023 were calculated. The choice of the initial period is due to the restructuring of production chain and recovery of the global economy in 2010 to the level preceding the global financial crisis. The standard deviation indicator (Formula 3) shows the imbalances in the production and technological potential of the EU countries in the automotive industry in the post-crisis period.

$$\sigma_{gk} = \sqrt{\frac{\sum (ARCA_{ik} - (\overline{ARCA})_k)^2}{(n-1)}} \quad (3)$$

Where σ_{gk} is the standard deviation for the group of countries,

g at the level of commodity movement k,

g is the group of countries,

$\overline{ARCA}$ is the arithmetic mean of the weighted average coefficients of countries at the level of commodity movement k, n is the number of analysed countries.

To assess changes in the degree of participation of EU macro-regions in the production process, the value of the average standard deviation for the enlarged regions of the European Union (Western Europe and Eastern Europe) is used (Formula 4).

$$\overline{\sigma}_{gks} = \frac{\sigma_{gk1s} + \sigma_{gk2s} + \sigma_{gk3s}}{ns} \quad (4)$$

Where $\overline{\sigma}_{gksis}$ the average value of the standard deviation for the countries of Western / Eastern Europe,

s is the macroregion (Western / Eastern Europe),

σ_{gkis} the standard deviation of the weighted average coefficient of export specialisation of goods for the group of countries g at the level of commodity movement k (1, 2, 3).

The obtained indicator estimates the overall change in the imbalances in the distribution of production chain stages in the geographical regions of the EU. Based on a comparison of the average standard deviation at the beginning and end of the period, the structure of the distribution of production capacities of the automotive industry in WE and EE has changed.

Results

1 The level (state) of specialisation of EU countries in the automotive industry

According to the results of the calculations in the first stage, the countries with the highest value of the coefficient of export specialisation for individual goods were identified (Table 2). Two countries with the highest specialisation rates in terms of selected product line and product group were included in the Table 2.

Table 2 – Values of the highest indicators of export specialisation (RCA) of the EU-27 countries for selected goods

Product Name	Country	RCA	Product Name	Country	RCA
Transmission box	Romania	5.16	Electric motors and generators	Hungary	3.54
Amortisation System	Slovakia	4.72	Battery accumulators	Hungary	9.99
Diesel engines	Slovakia	5.81	Engines, V[11] > 1L	Hungary	9.11
Bodywork	Czech Republic	5.64	Chassis	Sweden	11.59
Cars with petrol engine, V 1.5-3L	Slovakia	5.81	Cars with diesel engine, V 1.5-2.5 litres	Czech Republic	3.02
Diesel cars with electric motor	Slovakia	8.57	Electric vehicles	Belgium	2.21

Source: developed by the authors according to UN Comtrade data

According to research results, the following positions of EU countries in the automotive industry were determined: centres for (1) the production of highly processed components (Hungary); (2) the assembly of components into integrated modules (Czech Republic); (3) the integration of imported goods into a single unit and the production of a finished car (Slovakia, Czech Republic, Germany); (4) the role of manufacture and export of curb chassis (Sweden) in the segment of intermediate and consumer goods of the international automotive market.

We have compiled a general scheme for the distribution of automotive components in production chains in the EU (Fig.1).

Eastern European countries specialise in internal combustion engines. The production of enlarged modules is concentrated to a greater extent in Germany, Sweden, the Czech Republic, and Poland. The main assembly plants of the European automotive industry are located in the countries of Central Eastern Europe; individual capacities are localised in Germany; electric vehicles are also assembled in Belgium.

[11] *Note: V – engine cylinder capacity*

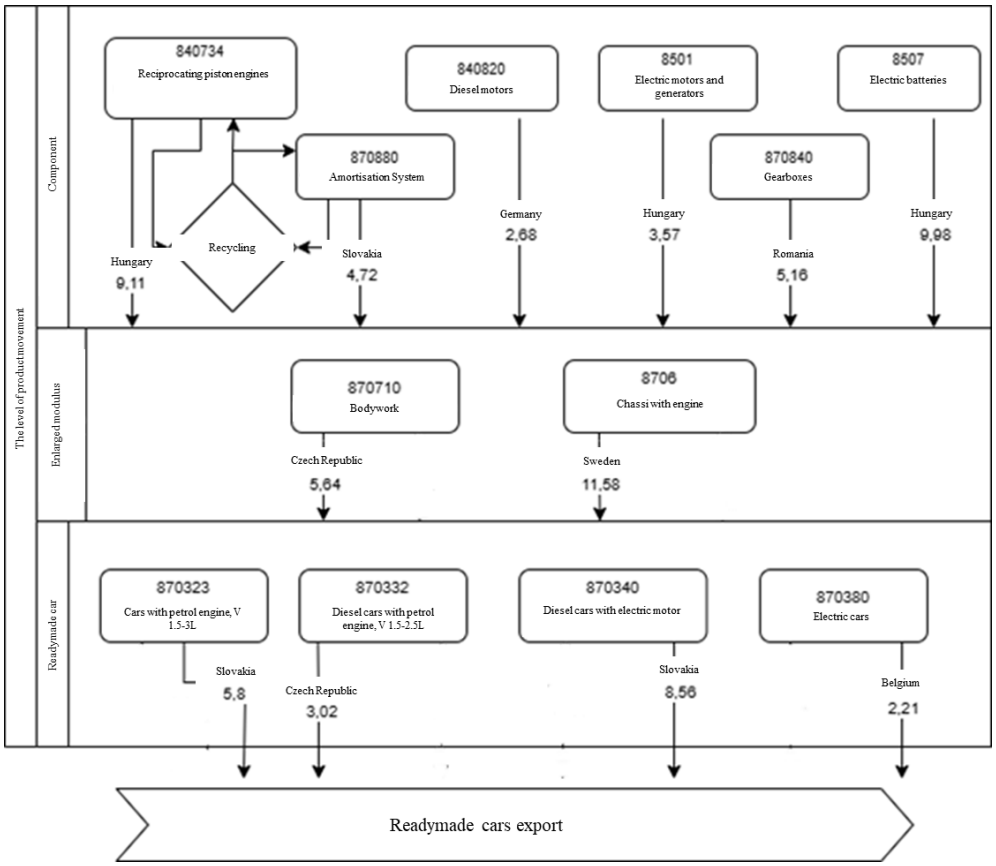


Figure 1. A product distribution scheme focused on the EU's leading countries in terms of RCA[12]
Source: developed by the authors according to UN Comtrade data

2 Modern configuration of production chains in the EU automotive industry

At the second stage, the weighted average indicators of export specialisation (ARCA) by levels of commodity movement for the selected countries were calculated (Table 3).

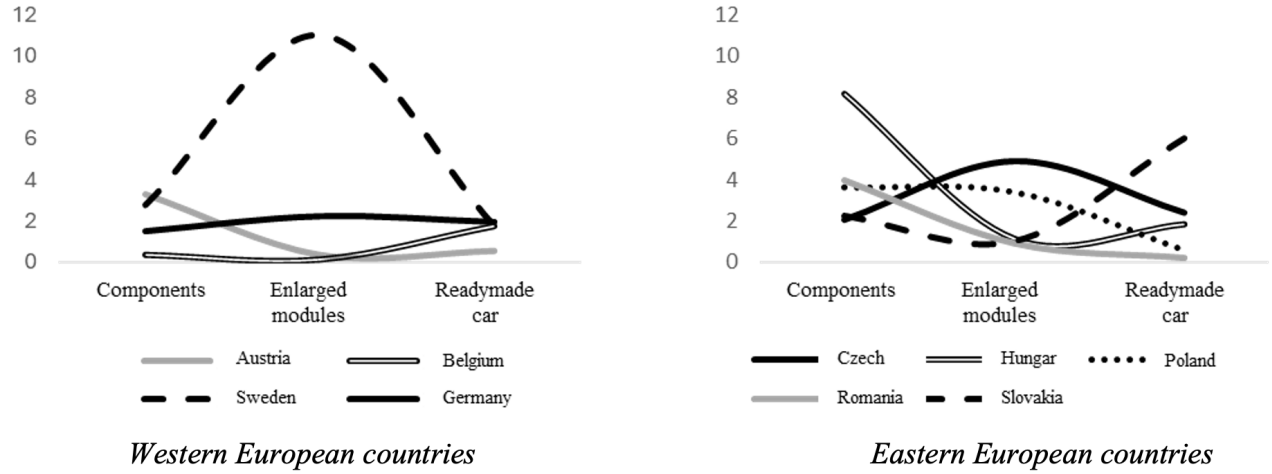
Table 3 – Matrix of ARCA indicators by levels of product movement

Country	Simple components	Enlarged modules	Readymade car
Austria	3.313	0.330	0.524
Belgium	0.369	0.141	1.758
Czech Republic	2.039	4.911	2.387
Finland	1.951	0.150	0.265
Germany	1.523	2.213	1.951
Hungary	8.157	1.132	1.834
Poland	3.610	3.377	0.567
Romania	3.956	0.923	0.224
Slovakia	2.247	1.023	5.992
Sweden	2.787	11.041	1.761

Source: developed by the authors according to UN Comtrade data

Based on the weighted average coefficients of specialisation, we constructed graphs to show the degree of participation of the countries of the eastern and western parts of the EU at certain stages of the value chain (Fig. 2). The results of the second stage clarify and expand the provisions obtained in the first one.

[12] *Note: The value under the country name is the coefficient of export specialisation*



Western European countries *Eastern European countries*

Figure 2. The values of the ARCA coefficient of the EU countries for individual stages of the automotive production chain

Source: developed by the authors according to UN Comtrade data

According to Figure 2, there are imbalances in the specialisation of individual countries of Eastern and Western Europe at the stages of the production chain. Indeed, the countries of Eastern Europe mostly are focused on simple stages of the production chain do not require high qualification skills. Slovakia, the Czech Republic, and Hungary are actively involved in the final assembly of cars. At the same time, Hungary also has a high degree of specialisation in the components trade. Poland and Romania do not specialise in exporting of the readymade cars. However, they are one of the main suppliers of shock absorption systems and gearboxes. In addition, Poland produces and exports of equipped automobile chassis.

The countries of Western Europe (Austria, Germany, Sweden) are focused on the production of components and assemblies. Nevertheless, they are also specialising on the assembly of cars. Some Western European countries (Germany, Belgium, Sweden) mainly assemble the electric cars are, actively promote a "green" policy, and stimulate demand for environmentally friendly vehicles.

3 Imbalances in the geographical distribution of automotive capacity in the EU

The changes in the structure of countries' specialisation in the production of goods at different levels of the production chain across the enlarged regions of the European Union and the union as a whole were analysed. Table 4 estimates the deviations of country specialisation levels from the average values for individual stages, macro-regions across the EU and automotive industry chain.

Table 4 – Indicators of the standard deviation of ARCA coefficients by levels of product movement and country groups, 2010 and 2023

The level of product movement	Simple components		Enlarged nodes and modules		Ready-made cars	The whole chain	Ready-made cars	The whole chain
Region	2010	2023	2010	2023	2010	2023	2010	2023
EU	2.65	2.10	10.90	3.37	0.60	1.70	1.89	1.39
EE	3.61	2.71	15.11	1.82	0.57	2.36	1.58	1.50
WE	1.67	1.60	6.26	4.71	0.69	0.95	2.12	1.25

Source: developed by the authors according to UN Comtrade data

In the EU there is a tendency to reduce the imbalances in the distribution of production capacities of the automotive industry by country. At the same time, there is a gap in the component manufacturing segment; the largest change is in the disproportion in the location of assembly plants. There is also an increase in imbalances in the assembly of readymade cars.

In the analysed Eastern European countries, the imbalances in the component manufacturing segment decreased during the study period. The production processes to design complex nodes have acquired a more uniform geographical distribution across the world countries. There is a decrease in differences in the distribution of the final assembly of readymade cars in the macroregion.

The Western European countries under study have a reduction in the asymmetry in the level of specialisation of countries by stages of the production chain. There is a decrease in imbalances in the production and trade of components and enlarged assemblies against the background of a reduction in the number of assembly plants in Western European countries.

Therefore, the results of the third stage show a reduction in the overall disparities in the geographical location of individual stages of passenger car production across the EU regions. At the same time, in the Western, Central, and Eastern parts of Europe there is an increase in imbalances in the distribution of carmaker assembly plants. For both regions and the Union as a whole, there is a tendency to move towards a more even distribution of the production links of components and assemblies.

Conclusions

Hence, all three formulated hypotheses were confirmed during the research. Firstly, the geographical imbalances in the production of simple components and components of the automotive industry have decreased over the period under study. Secondly, the production of enlarged technologically complex modules has become more evenly distributed across the Europe. A number of countries have managed to strengthen their own technological base of the industry and integrate into the production chain in its more knowledge-intensive segments. Thirdly, the geography of localisation of assembly plants in Europe has become more limited. There is a formation of a limited pool of countries that control the main capacities of the final assembly of readymade cars.

The study revealed the country-specific features of the automotive industry production networks of the European Union. Among the countries of Western Europe, Germany is of particular interest. The country has an identified export specialisation at each of the levels of commodity movement. Moreover, despite ARCA's low performance in comparison with other countries in absolute terms, Germany is the leader in exporting components, integrated modules and readymade vehicles, surpassing the production scale of other economies in the region by several times. Assembly and manufacturing plants of both European and non-regional automakers are concentrated in Germany. Its automotive industry is characterised by technological leadership among the EU countries in the development of diesel, gasoline engines, hybrid systems, and electric vehicles. The main importing countries of German components are the USA, Poland, China, Turkey, the Czech Republic, Austria, and Slovakia. Some of the products produced are aimed at non-regional exports. However, the significant volumes of components are still supplied to enterprises in the EU member states. Most European automakers depend on the supply of German-made components. The German automotive sector features underline the country's status as a leading one in regional value chains and a major player in the international automotive market.

Sweden's atypically high level of specialisation at the assembly production stage in 2023 can be recognised as a natural consequence of the active expansion of national automakers into foreign markets. Swedish companies supply equipped chassis for vehicle assembly in other countries. This method significantly reduces the costs associated with customs formalities. The main markets for the enlarged modules of Swedish manufacturers are Mexico, Egypt, Spain, Israel, Australia, and Brazil. Indeed, the largest flow of loaded chassis belongs to the segment of commercial vehicles, represented among others by trucks of the Scania and Volvo brands, Sweden.

The automotive industry in Slovakia is focused on assembling of ready-made cars of different brands, design of ready-to-install automotive components, commissioning work, etc. [26]. Moreover, the assembly plants of the Korea company KIA and its first-order suppliers – Mobis – are located in the country. More than 35% of gasoline car shipments are to Germany; about 30% of hybrid car exports are to the United States; a third of diesel cars are exported to Italy. The main volume of deliveries of finished Slovak-made cars concerns

with the countries of Europe and North America.

Among the Eastern European countries, Hungary is the most actively produces the components. For instance, Continental's Hungarian plants in Vaca, Debrecen and Gyor produce braking and electronics systems; ZF Friedrichshafen provides assembly plants with transmission elements, suspension, and control systems. A significant share of Hungarian components is imported by European countries specialising in the final assembly of car s (Germany, Belgium, Slovakia, Czech Republic). About 7% of the country's battery exports is to the United States, about 51% to Germany, and 10% to Belgium[13].

According to the results of the analysis of the dynamics of the imbalances in the export specialisation of countries at the stage of production of simple components, minimal change was revealed among Western European countries. However, the geographical distribution structure of automotive component manufacturing enterprises in Eastern Europe became more homogeneous. The distribution of component production capacities in Eastern European countries was achieved due to an increase in the volume of exports of components by Romania and Slovakia. It increased by 6.4 and 2.9 times, respectively. The largest share of the supplied products of the countries is accounted for by the European leaders of the automotive industry: Germany, the Czech Republic, Hungary, Sweden, and Poland.

At the stage of production of enlarged modules, there is a high level of concentration of production within individual countries. The high deviation rate in 2010 for Eastern European countries is explained by Slovakia's particularly large annual exports of passenger car bodies, which amounted to about $ 1.1 bn USD. However, the country's total exports in 2010 were $ 65.3 bn USD. The share of exports of body parts accounted for 1.8% of total exports; the main supplies of these goods were to Germany (~59%) and the Russian Federation (~41%). In 2023, exports of the commodity item under study decreased by 99.5%. It was caused by the cessation of body supplies to the Russian Federation and the relocation of German assembly plants to Slovakia.

Finally, at the stage of final assembly, there is a slight change in the localisation of car assembly plants in the countries of the western macroregion of the Union and a concentration of assembly facilities in a limited number of Eastern European countries. Slovakia is the most involved in the assembly stage today. It has significantly strengthened its position in the export of passenger cars: its share in the country's total exports increased from 8.0% in 2010 to 16.2% in 2023 due to increased trade in gasoline, hybrid, and electric vehicles. A significant part of the deliveries of passenger cars abroad in the reporting period were made to Germany – 21.3%, the USA – 11.7%, Great Britain – 9.1%. Hungary and the Czech Republic have significantly strengthened their specialisation in the final assembly stage. Since 2010, their car exports have increased by 318% and 215%, respectively. Germany, Sweden, and Belgium specialise in the level of ready-made cars. At the same time, Germany has the largest exports of passenger cars of all types. Germany and Belgium are focused on the production of electric vehicles. Swedish enterprises at this stage are mainly focused on the production of gasoline and diesel cars. However, the production of hybrids and electric cars is not well established.

Therefore, there is a reduction in the imbalances in the distribution of production capacity across regions at the level of simple components. There is also a decrease in asymmetry in the localisation of plants for the production of complex components. However, the concentration of assembly plants in individual countries of the macro-regions is increasing with an emphasis on the economies of Eastern Europe.

In the future, the structure of the geographical distribution of production capacities among the EU countries will result in the homogeneous participation of the countries of the macro-regions in certain stages. At the same time, the concentration of manufacturing enterprises focused on the production of simple and less profitable products in Eastern European countries is expected to increase.

The practical significance of the research is in the possibility of use of the European Union experience in the development of the EAEU automotive industry. With certain assumptions, the most developed members of the Union (the Russian Federation and the Republic of Belarus) can become centres for the concentration of complex and knowledge-intensive stages of the production chain. However, the production of components

[13] *The estimates given here and further in the section are obtained by the authors based on Trade Map data. Source: https://www.trademap.org / (accessed on 07.06.2025)*

and assembly of readymade cars can be localised in Kyrgyzstan, Armenia, and Kazakhstan. However, one of the serious limitations of the automotive network development in the Eurasian Union is the insufficient volume of production and sale of domestically produced passenger cars to establish an international production system within the Union.

FUNDING

The study was supported by the P.G. Demidov Yaroslavl State University scientific project VIP-017.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHORS' CONTRIBUTION

Elena V. Sapir – conceptualization, project administration, writing – original draft.
Ilya A. Gorshkov – investigation, formal analysis.

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Received 22.08.2025
Revised 21.09.2025
Accepted 15.10.2025

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