

Industry Differentiation and Integration Effects in the Border Regions of Russia and Belarus: Results of Cluster Analysis and Spatial Interpretation

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Abstract: The article presents an assessment of border situation impact on Russia and Belarus regions sectoral specialization based on an adapted cluster analysis methodology. The industry profiles of six border regions are compared - Bryansk, Smolensk, Pskov regions of the Russian Federation and Gomel, Mogilev, Vitebsk regions of the Belarus Republic. It is established that integration processes within the Union State form a partial differentiation of functions between regions, manifested in the development of mechanical engineering, chemical industry, logistics and resource processing. At the same time, geographical proximity to the border does not in itself determine the structure of specialization and requires institutional support, a well-developed infrastructure and programmatic support for cooperation. The directions of production and economic chains nodes localization of the Russian-Belarusian border region for optimal placement intermediate goods production are proposed, and spatial planning directions of cross-border clusters are proposed.


1 INTRODUCTION

In modern conditions of the increasing Russian and Belarus integration processes, the spatial organization of economic activity in the border regions is of particular importance. It is here that the effects of interfacing economic systems are most clearly manifested, new channels of interaction are being formed and practices of cross-border cooperation are being developed (Manshin, Siqui, 2023; Plyakin, Orekhova, 2024). As shown in (Kuzavko, 2023), the interstate integration process increases entropy in the border area, while simultaneously providing opportunities for the development of some sectors and creating restrictions for others. However, despite all the institutional saturation of the integration process implemented within the framework of the Union State, the actual degree of economic interconnectedness of the border regions remains uneven (Kuzavko, 2020). In some cases, the border position does not become a factor of accelerated development, but rather reinforces the peripheral status of territories. Thus, barriers to the free movement of capital and labor often lead to a

deterioration of economic and social conditions in border regions and have a negative impact on regional development (Hercegová, Chernova, 2021).

The problem is that geographical proximity does not automatically transform into an economic advantage. In the absence of coordinated mechanisms of specialization and cooperation, border regions often develop according to the inertia of national models, without forming stable interregional value chains. This reduces the effectiveness of integration processes and limits the possibilities of industrial policy. In this regard, it is becoming relevant to study exactly how the border situation affects the sectoral structure of regions, whether it contributes to the formation of production and logistics links, as well as which industries demonstrate the greatest potential for interconnection. Studying these issues requires a systematic approach combining spatial analysis, statistical estimation, and cluster methods.

The aim of the study is to assess the impact of the border situation on the sectoral specialization of the regions of Russia and Belarus using an adapted cluster analysis methodology and to identify patterns of spatial differentiation of production activity.

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2 MATERIALS AND METHODS

The methodological basis of the study is based on the provisions of the new economic geography and the theory of cluster regions development, which consider spatial concentration and industry specialization as key factors for increasing the competitiveness of territories.

A number of researchers analyze the dynamics of regions through the prism of new economic geography and a new theory of international trade, which allows to take into account the effects of agglomeration, clusterization and reduction of trade barriers (Izotov, 2023). These theories suggest that integration creates prerequisites for the concentration of economic activity near borders due to the growth of intra-industry trade, lower costs for the movement of intermediate products and an increase in the density of market interaction (OECD, 2013; Xue-jun et al., 2010). At the same time, the difference in border effects depending on the industry is quite clearly highlighted (Requena, Llano, 2010), which emphasizes the need to analyze the industry context in order to form a conclusion about the impact of the border situation. In turn, the results of the analysis of the experience of Russian cluster initiatives in the context of the main socio-economic indicators of the region (Zayenchkovsky, 2017) show the need to take into account the specifics of production and economic forces location and development.

In this regard, it is proposed in this article to use an enhanced cluster analysis methodology for industry profiles, which also includes an assessment based on gravity models of these regions, to study the Russian-Belarusian border regions. As part of the study, the border regions were clustered based on their industry profiles. The sectoral profiles of the territories were formed based on the methodology of the Higher School of Economics, presented in (Abashkin et al., 2021) according to official statistics from Belstat and Rosstat for 2018-2024. In addition, the method of cross-comparison of regional profiles was used, which made it possible to identify pairs of "mirror specializations" between Russian and Belarusian regions. To interpret the results obtained, expressed in the priority directions of production and economic chains nodes localization of the Russian-Belarusian border region, a tabular form was used to provide visualization.

3 RESULTS AND DISCUSSION

The analysis of Russian and Belarus regions bordering industry profiles has shown that the structure of their industry specialization is characterized by high differentiation, but at the same time, it is possible to identify areas of stable overlap of profiles on both sides of the border.

The most pronounced industries of national importance are noted in: Bryansk and Gomel regions - chemical industry, mechanical engineering, metalworking, production of rubber products; Smolensk and Mogilev regions - processing, logistics, assembly facilities; Pskov and Vitebsk regions - food industry and agro-processing. This distribution allows to talk about the formation of cross-border functional pairs, where one territory specializes in the production of intermediate goods, and the other in their processing and assembly. The Bryansk-Gomel industrial and economic hub is particularly significant, which can be considered as the core of cross-border industrial cooperation. There is a combination of heavy machinery, chemical and energy production, which provides a high potential for the formation of value chains. The Smolensk-Mogilev zone performs the functions of a transport and logistics corridor. Smolensk is the "gateway" to the Russian metropolitan area, and Mogilev is a transit point between the eastern and western regions of Belarus.

The development of warehouse and assembly facilities here will increase the density of inter-regional flows and reduce transaction costs. In turn, the Pskov-Vitebsk Group is forming an agricultural and industrial belt, where the processing of agricultural raw materials, the food industry and the storage of products are actively developing. Despite the relatively low level of industrialization, this sector can become key to the food security of the Union State. The cluster analysis revealed that the greatest potential for industry connectivity is observed precisely where profiles of national importance coincide. Such industries are characterized not only by export orientation, but also by internal cooperative dependence, which forms a cross-border specialization.

The results of the study confirm that the effect of the border position does not manifest itself automatically, but requires institutional and infrastructural prerequisites. Geographical proximity creates opportunities, but does not guarantee the formation of stable ties. Only the presence of industry connectivity and a well-developed logistics

infrastructure can turn border regions into active nodes of cross-border economy.

The results obtained allow to identify three key patterns. Firstly, the border location contributes to the diversification of industries, but does not always enhance their competitiveness. Without coordination at the interstate level (in the form of industrial parks, and joint investment projects), clusters remain fragmented. Secondly, the border effect manifests itself as a factor of functional differentiation: one side is a producer of intermediate goods, the other is a processor or logistics center. This creates the prerequisites for horizontal integration and cost reduction. Thirdly, in some cases, there is an asymmetry effect, when Belarusian regions have a higher concentration of industries of national importance, while Russian regions have a greater territorial diversification. This requires equalizing potentials through the development of joint projects and investment incentives.

A comparison of the results obtained with the conclusions obtained during the construction of gravity models of these regions confirms that distance and transport accessibility remain critical factors, but their impact can be offset by the availability of industrial links and logistics infrastructure. Therefore, spatial integration should be considered as a combination of physical and institutional convergence mechanisms.

Taking into account the criteria of minimizing transport costs for intermediate goods; proximity to the final market and consumer (large cities, transport corridors) and the presence of an industrial cluster or suppliers of components, the following optimal directions can be proposed for the localization of production and economic chains of the Russian-Belarusian border region nodes (Table 1).

Table 1: Directions of production and business chains nodes localization of the Russian-Belarusian border region.

Localization	Industry specialization
Gomel (Belarus)	Production of chemical components, mechanical engineering
Bryansk (Russia)	Component manufacturing, assembly, metalworking
Mogilev (Belarus)	Processing, packaging, logistics
Smolensk (Russia)	Assembly and distribution of products
Pskov (Russia) / Vitebsk (Belarus)	Small-scale production, agro-processing, storage

The directions presented in Table 1 can be used as a basis for spatial justification of production facilities of the Union State location.

4 CONCLUSIONS

The conducted research has shown that the industry profile of the border regions of Russia and Belarus is formed under the influence of a complex factors system in which the border position plays a significant but not decisive role.

The greatest interconnection of industries is observed in the chemical, machine-building and processing industries, where the border regions perform complementary functions. Geographical proximity creates the potential to reduce costs and enhance specialization, but requires institutional support in the form of Union State programmatic mechanisms. Integration effects are increasing in regions with developed industrial and transport infrastructure (Bryansk, Gomel, Smolensk, Mogilev). In less industrialized regions (Pskov, Vitebsk), the potential of the border is realized through agro-processing and logistics, which also increases their role in the food security system.

The obtained analysis results allowed to propose directions for a spatial integration model based on the distribution of functions between regions: production of intermediate goods - Bryansk, Gomel; processing and assembly - Smolensk, Mogilev; agricultural processing and storage - Pskov, Vitebsk.

Thus, the formation of a stable system of cross-border clusters in the Union State is possible only with a combination of sectoral, infrastructural and institutional approaches. The implementation of these directions will ensure not only the economic growth of the border territories, but also the strengthening of industrial and technological interconnectedness between Russia and Belarus.

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