

COMPETITIVENESS OF UKRAINIAN AGRICULTURAL EXPORTS AND ENVIRONMENTAL EXTERNALITIES

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Abstract. Agricultural exports plays a pivotal role in shaping Ukraine's foreign trade specialization; however, the predominance of primary commodities intensifies challenges related to long-term competitiveness and environmental sustainability in conditions of European integration. The strengthening of environmental requirements within the EU Common Agricultural Policy necessitates a reassessment of the structural characteristics of Ukraine's agricultural exports with explicit consideration of environmental externalities. The purpose of this study is to evaluate the competitive position of Ukraine's agricultural sector using the revealed comparative advantage (RCA) index and the product complexity index (PCI), interpreting the results through the lens of economic externality theory. The object of the research is the structure of Ukraine's agricultural exports, while the subject is the relationship between comparative advantages, product complexity, and environmental external effects. The methodological framework integrates international trade analysis tools with concepts from institutional and environmental economics. The empirical basis of the study is formed by international trade statistics for 2023. The research employs index analysis, comparative statistical methods, and theoretical interpretation of the obtained results. The findings indicate that Ukraine's highest revealed comparative advantage (RCA) values are concentrated in product groups with low product complexity index (PCI) scores, reflecting the predominance of a resource-oriented model of export competitiveness. Although this model supports short-term export performance, it is associated with the accumulation of negative environmental externalities that remain largely non-internalized within the existing institutional framework. The scientific novelty of the study lies in the integrated application of RCA and PCI indicators in conjunction with externality theory to assess the sustainability of agricultural competitiveness in the context of Ukraine's European integration. The practical significance of the results consists in substantiating policy recommendations aimed at developing financial and economic support mechanisms to stimulate higher value-added agricultural production and to mitigate the adverse effects of intensive natural resource use.

Keywords: revealed comparative advantage (RCA), product complexity index (PCI), environmental externalities, institutional framework, European integration, sustainable development.

JEL Classification: Q17, Q56, F14

1. Introduction

The transformation of agricultural systems in the context of globalization and European integration necessitates a rethinking of the principles of competitiveness and sustainable development of national economies. For Ukraine, the agricultural sector is a key source of export revenues and plays a strategic role in ensuring food security and macroeconomic stability, which has been repeatedly emphasized in scientific studies of the development of

agricultural economies in countries with a transitional type of economy (Borodina, 2016; Shkuratov et al., 2019; Leonov & Brychko, 2022; Kondratiuk & Stoianenko, 2022). At the same time, the dominance of primary agricultural products in export flows raises the issue of long-term competitiveness, environmental sustainability, and approximation to the regulatory standards of the European Union (EU).

The European Union's Common Agricultural Policy (CAP) has evolved from an income support

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instrument to a comprehensive policy, within which the role of environmental requirements, climate objectives and institutional internalisation of negative externalities is increasing (EU Parliament Research Service, 2024). Within the CAP, environmental conditionality, agri-environmental payments and support for sustainable land use have become key regulatory instruments that directly affect the structure of agricultural production and exports of EU member states. In contrast, Ukraine's agricultural policy remains predominantly focused on short-term economic results, with limited consideration of the environmental and social consequences of agricultural production, which creates a persistent structural asymmetry between Ukraine and the EU (Kaneva, 2021).

Modern international research emphasizes that export competitiveness is not identical to economic sustainability if it is based on products with a low level of complexity and intensive use of natural resources. Studies show that countries with more complex export structures have better opportunities for green and environmentally responsible products, as well as less pressure on natural resources compared to economies focused on resource-intensive goods (Mealy & Teytelboym, 2022; Caldarola et al., 2024; Ul-Durar, 2023). In this context, the concept of product complexity allows us to assess the qualitative characteristics of the export structure and its potential to create added value, while the economic theory of externalities explains the gap between the private benefits and the social costs of agricultural production (Pigou, 1920; Coase, 1960).

Despite a significant amount of research on the problems of agricultural policy and foreign trade, empirical work combining indicators of revealed comparative advantages, product complexity and environmental externalities in the agricultural sector remains limited, especially for countries with economies in transition and in the context of European integration (Manta et al., 2024). It is this circumstance that forms the scientific niche of this study.

The problem statement is that the export competitiveness of the agricultural sector of Ukraine is formed without due consideration of the qualitative characteristics of products and environmental externalities, which undermines its long-term sustainability. In this regard, the article poses the following research question: how is the structure of revealed comparative advantages of the agricultural sector of Ukraine related to product complexity and environmental externalities in the context of European integration? The working hypothesis is that Ukraine's competitive advantages are concentrated in industries with a low level of product complexity and significant negative environmental externalities.

The aim of the article is to assess the competitive position of the agricultural sector of Ukraine using the

revealed comparative advantage index (RCA) and the product complexity index (PCI), as well as to interpret the results obtained through the prism of the theory of externalities and institutional economics.

The methodological basis of the study is a combination of international trade analysis tools with the provisions of institutional and environmental economics. The empirical basis of the study is formed on the basis of international trade statistics for 2023, obtained from the Harvard Laboratory for Economic Growth database, which ensures comparability of results between countries and methodological consistency of calculations.

Export competitiveness was assessed using the revealed comparative advantage index (RCA), which reflects the level of specialization of the country in the production of individual product groups by comparing their share in national exports with the corresponding share in world exports. The value of the RCA index exceeding 1 indicates the presence of comparative advantages. To take into account the qualitative characteristics of competitiveness, the product complexity index (PCI) was used, which reflects the amount of productive knowledge and technologies embedded in the production of a particular product and is determined on the basis of the diversity and prevalence of producing countries. The analytical procedure of the study includes three stages. At the first stage, the RCA index values were calculated for the main groups of agricultural products in the structure of Ukrainian exports. At the second stage, these product groups were compared with the corresponding values of the PCI index in order to identify the relationship between comparative advantages and the level of product complexity. At the third stage, the results were analyzed from the standpoint of the theory of environmental externalities based on the conceptual provisions of A. Pigou and R. Coase, with special attention to the role of the institutional environment in the process of internalizing social and environmental costs.

The proposed integrated approach makes it possible to assess not only the level of competitiveness of the agricultural sector of Ukraine, but also the compliance of the formed model of competitive advantages with the principles of long-term sustainable development and the strategic goals of agricultural policy focused on the European Union.

2. Institutional and Political Determinants of Export-Oriented Competitiveness of the Agricultural Sector of Ukraine

Creating a favorable institutional environment for doing business in the agricultural sector is a guarantee of increasing the competitiveness of agricultural enterprises and ensuring their sustainable development.

In Ukraine, program documents regulating the regulatory and legal support of agrarian policy mostly contain general provisions, principles and goals. At the same time, state support mechanisms aimed at stimulating environmentally friendly land use are currently practically not implemented.

Analysis of the prerequisites and factors of sustainable development of enterprises is an important tool for the effective use of their resource and production potential. The key factors for ensuring competitive development and environmental responsibility of commodity producers are the flexibility of management decisions and the ability to quickly adapt to external challenges. Agrarian development, as the production dominant of the national economy, plays a leading role in the process of European integration, in particular by ensuring the competitiveness of agricultural products in accordance with European safety and quality standards.

In the context of European integration transformations, the EU Common Agricultural Policy (CAP) has undergone a long evolution, forming key guidelines for Ukraine's agricultural policy, which in the future may provide new incentives for the development of agriculture, increasing its competitiveness and the quality of life of the rural population.

The analysis of the correspondence between the goals and key indicators of the Strategy for the Development of Agriculture and Rural Areas in Ukraine until 2030 and the EU Common Agricultural Policy for 2023–2027 demonstrates the dominance of domestic state regulation, oriented mainly on economic results. In particular, Ukraine's program documents focus on indicators of the share of production and exports in the global volume, labor productivity and the level of profitability of agricultural enterprises (Cabinet of Ministers of Ukraine, 2024).

Domestic statistics do not fully cover social and environmental parameters, while modern European agricultural policy is increasingly focusing on assessing sustainability. The EU Long-term Vision for Rural Development Strategy (European Commission, 2021) highlights the importance of comprehensive monitoring of the social, environmental and economic components of agricultural production. It is on this basis that the EU agricultural sector development forecast for 2024–2035 was made (European Commission, 2023), which, in turn, became the basis for the adoption of Regulation 2023/2674. In 2023, in order to support the accounting of agricultural sustainability within the EU CAP, an amendment to Regulation No. 1217/2009 was adopted to transform the accounting data network into a sustainability data network – Regulation (EC) 2023/2674 (Council of the European Union, 2009). Thus, the existing unified information system on agricultural producers – the Farm Accountancy Data Network (FADN) – has

been supplemented with a requirement to collect data on economic, environmental and social aspects of agricultural production in order to analyze and use its results to adapt the CAP to the challenges of modern agriculture and the development of rural areas in the EU.

Thus, the analysis of the comparative provisions of the Strategy for the Development of Agriculture and Rural Areas of Ukraine until 2030 and the Common Agricultural Policy of the EU for 2023–2027 indicates the need for significant improvement of approaches to determining the goals and indicators of sustainable development of the agricultural sector in Ukraine. While the EU CAP takes into account the factor of externalities and is aimed at the sustainable development of agriculture, the Ukrainian Strategy focuses mainly on achieving economic indicators without taking into account the impact of externalities. Natural resources, in particular land, are intensively used in domestic agriculture without taking into account the long-term perspective and social costs. Due to the underestimation of the externality factor in Ukrainian legislation and the lack of a clear mechanism for compensating for negative externalities, agricultural enterprises do not include their cost in their own expenses.

As shown on Fig. 1, in a situation where the producer takes into account only private costs, the price and quantity of the product produced are set at the level of $MPC = MSB$.

If agricultural enterprises cause significant environmental pollution and other manifestations of its degradation, due, for example, to excessive use of pesticides or soil depletion, the classic problem of negative externalities (externalities) arises, which have a harmful effect on the health and well-being of the population. The economic activity of such enterprises does not take into account the social costs associated with pollution, which leads to inefficient allocation of resources and a decrease in overall social welfare. From the perspective of welfare theory, such an equilibrium is not optimal, since in the presence of negative externalities, the socially optimal price and output are determined at the level $MSC = MSB$ (Nicholson & Snyder, 2017).

Arthur Pigou's concept involves state intervention by introducing special taxes (so-called Pigou taxes) that are imposed on the production or consumption of goods with negative externalities. In the case of pollution, this means establishing a tax equivalent to the amount of external social costs. Such a tax encourages the enterprise to take social losses into account in production decisions, which contributes to reducing the level of pollution and optimizing production volumes.

At the same time, the effectiveness of the tax mechanism largely depends on a clear definition of property rights. The formalization of property rights

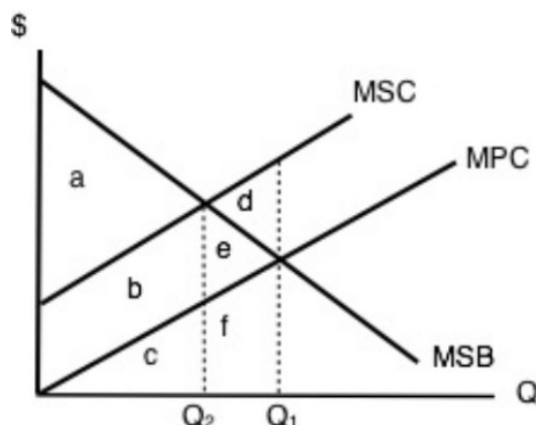


Figure 1. Social cost of negative externalities

Note:

- MSC – marginal social cost;
- MPC – marginal private cost;
- MSB – marginal social benefit.

Source: developed by the authors based on Pigou (1920) and Nicholson & Snyder (2017)

creates a legal basis for establishing responsibility for pollution (environmental degradation) and ensuring the protection of the interests of affected citizens. Under the conditions of properly secured and protected property rights, the victims have the opportunity to demand compensation or initiate a ban on harmful production. Ron Coase's theorem indicates that in the absence of significant transaction costs, the parties can reach an effective compromise through negotiations, however, in the case of a large number of victims, the transaction costs of negotiations increase significantly, which complicates the application of the relevant Coase mechanisms. In such situations, a more effective tool is state intervention through the introduction of Pigou taxes (Pigo tax) or other regulatory mechanisms. At the same time, the state must guarantee a clear definition and reliable protection of property rights to environmental resources, which is a necessary prerequisite for further effective economic regulation.

Calculations based on international trade statistics published by the Growth Lab at Harvard University

(The Growth Lab at Harvard University, 2025) indicate that in 2023 the Ukrainian economy remained competitive according to a two-digit index of revealed comparative advantage (RCA), mainly in industries with a low level of technological complexity of products. Table 1 presents the five industries with the highest RCA values for Ukraine and their level of economic complexity as of 2023.

The index of revealed comparative advantages is calculated by the formula:

$$RCA_{cp} = \frac{\frac{X_{cp}}{X_c}}{\frac{X_p}{X_w}}$$

where: X_{cp} – export of goods (industry) from country;

X_c – total export of country;

X_p – world export of goods;

X_w – total world export.

Thus, the index of revealed comparative advantages reflects the ratio of the share of a particular good

Table 1

Industries with the highest values of the index of revealed comparative advantage (RCA) of Ukraine and the level of product complexity (PCI), 2023

Category	Share in Ukraine's export, %	Share in world export, %	RCA	PCI
Food industry, its residues and waste; prepared animal feed	3,38	0,49	6,94	-1,08
Oil seeds and fruits; grains, seeds and fruits of industrial or medicinal plants	6,81	0,66	10,33	-1,13
Vegetable plaiting materials; other vegetable products	0,11	0,01	14,02	-1,57
Animal or vegetable fats and oils and their cleavage products	12,64	0,64	19,79	-0,69
Cereals	19,96	0,72	27,71	-0,72

Source: calculated by the authors based on data from The Growth Lab at Harvard University (2025)

(industry) in national exports to its share in world exports; an index value exceeding one indicates the presence of comparative advantages. The analysis shows that the industries with the highest RCA values in Ukraine belong mainly to the agricultural sector and at the same time are characterized by the lowest values of the product complexity index (PCI). This indicates a structural asymmetry of export competitiveness, in which quantitative advantages are not accompanied by an increase in the technological and knowledge-intensive complexity of products. In view of this, there is a need for a comparative analysis of the relationship between comparative advantages, product complexity and environmental externalities of agricultural exports of Ukraine and the European Union countries, which determines the logic of further research.

3. Comparative Advantages, Product Complexity and Environmental Externalities of Agricultural Exports of Ukraine and the European Union

In contrast, agri-food exports in the European Union countries are characterized by a more even distribution of comparative advantages between product groups with higher values of the product complexity index (PCI). This reflects the significant role of food processing, innovation and regulatory standardization within the framework of the EU Common Agricultural Policy. In particular, such product categories as dairy, meat and ready-made food products combine relatively high RCA values with increased technical complexity, which is a characteristic feature of knowledge-intensive exports.

To systematize the results and provide a comparative interpretation of the export competitiveness of Ukraine, the European Union and Poland, taking into account the level of product complexity and environmental externalities, the generalized characteristics are presented in Table 2.

The data in Table 2 confirm that Ukraine's export competitiveness is formed mainly in product groups with a low level of product complexity and significant negative environmental externalities that are not compensated by effective institutional mechanisms

of regulation. Such a structure of export indicates the resource-oriented nature of competitive advantages and limits the long-term potential for creating added value.

The structural difference between Ukraine and the EU is largely due to the difference in the technological equipment of the agricultural sector, the level of development of food processing, as well as the degree of integration of standardized production technologies and EU regulatory requirements, which stimulate the growth of the share of processed products in the export structure of the Union member states.

Indicative in this context is the comparison with Poland as a Central and Eastern European country, which at the initial stages of European integration had an export structure close to that of Ukraine. Empirical studies show that, while maintaining comparative advantages in basic agricultural goods, Poland has gradually increased RCA values for processed food products with higher PCI indicators. This dynamics was the result of institutional adaptation to the requirements of the EU Common Agricultural Policy and targeted support for the food processing industry (Matkovski et al., 2021). Poland's experience confirms the possibility of transitioning from a resource-oriented model of export competitiveness to a model based on the creation of higher added value, provided that agricultural and environmental policies are combined, effective internalization of externalities and structural modernization of the agri-food sector (Rac et al., 2024).

The Product Complexity Index (PCI) ranks products by the level of diversity and complexity of production knowledge and technologies required for their production. The calculation of the PCI is based on information on the number of countries capable of producing a particular product, as well as on the level of economic complexity of these countries. Thus, PCI reflects the volume and complexity of know-how embedded in the production of a particular product.

The highest PCI values are characterized by products that can be produced only by a limited number of countries with a high level of economic complexity, in particular mechanical engineering, electronics and the chemical industry. In contrast, agricultural products, in particular cereals and oilseeds, belong to

Table 2

Relationship between export competitiveness (RCA), product complexity (PCI) and environmental externalities in the agricultural sector of Ukraine, the EU and Poland

Country/ commodity group	Level		Dominant environmental externalities
	RCA	PCI	
Ukraine: cereals	High	Low	Soil degradation, erosion, biodiversity loss
Ukraine: vegetable oils	High	Low	Water pollution, pressure on land use
EU-27: dairy products	Medium-high	High	High Greenhouse gas emissions, waste management
EU-27: meat products	Medium	Medium-high	Emissions, animal welfare
Poland: processed food products	Growing	Medium-high	Energy consumption, packaging waste

the group of products with the lowest PCI values, since their production is technologically less complex and accessible to most countries in the world.

As shown in Figure 2, Ukraine's agricultural exports are concentrated in the zone of high values of the revealed comparative advantage index (RCA) and low values of the product complexity index (PCI). This configuration of export specialization is accompanied by a high intensity of negative environmental externalities, in particular soil degradation, crop rotation violations and excessive use of agrochemicals.

Eurozone countries, on the contrary, demonstrate a shift in the export structure towards products with higher PCI values and lower levels of unregulated environmental losses. This is the result of the institutional internalization of externalities through the instruments of the EU Common Agricultural Policy, in particular environmental conditionality, targeted subsidies and support for innovation in the processing agri-food sector. Poland occupies an intermediate position, illustrating a gradual transition from a resource-oriented model of competitiveness to a model based on the creation of added value.

The experience of the European Union countries shows that combining export competitiveness with environmental sustainability is possible with the presence of effective institutional mechanisms capable of internalizing negative externalities through a system of regulation, financial incentives and support for technological modernization. In Ukraine, despite the presence of significant production and resource potential and sustainable comparative advantages in the

agricultural sector, the imperfection of the institutional environment limits the possibilities of transition to a more complex and environmentally oriented export structure.

Currently, the domestic agricultural economy remains the most competitive in the export of products with a low level of product complexity. This raw material nature of exports creates risks of losing the potential for the formation of products with high added value and deepens dependence on the extensive use of natural resources.

Limited state support for the agricultural sector in Ukraine, in contrast to EU countries, where the instruments of the Common Agricultural Policy play a significant role, leads to a short-term orientation of production decisions of agricultural enterprises. This is manifested in the desire to maximize profits within one marketing year, in particular through the intensive use of pesticides and neglect of the principles of crop rotation, which reduces the ecological and economic efficiency of production.

In the context of globalization and intensification of European integration processes, the convergence of domestic legislation with the European regulatory framework and the development of long-term state support programs aimed at the development of processing industries and complementary sectors of the economy are of particular relevance. The insufficient level of development of mechanical engineering, processing industry and bioenergy hinders the formation of effective value added chains, while their activation could significantly strengthen both the

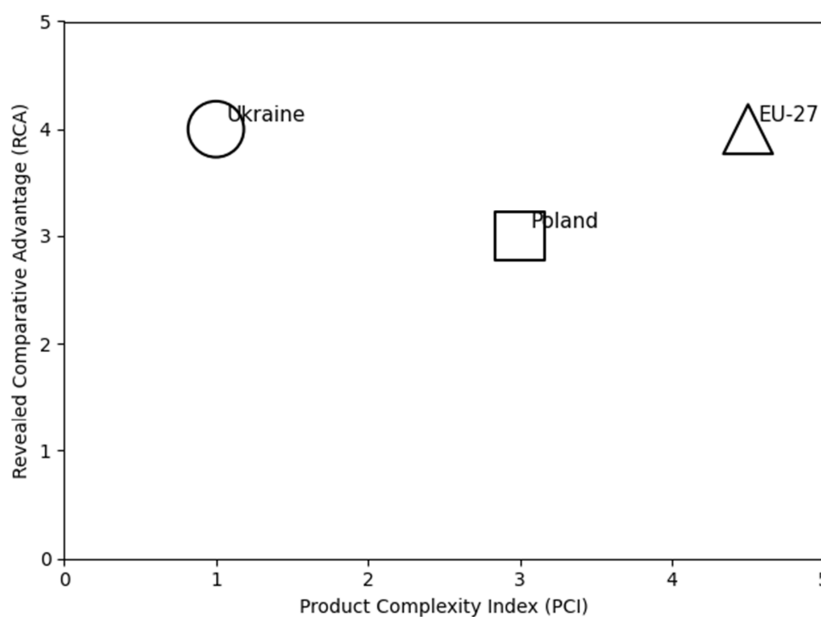


Figure 2. Relationship between the revealed comparative advantage index (RCA), the product complexity index (PCI) and environmental externalities

Note.

○ Ukraine; □ Poland; △ EU-27

internal and external competitiveness of the agricultural sector of Ukraine.

4. Conclusions and Recommendations on the Formation of Sustainable Agricultural Development

One of the key problems of Ukrainian environmental legislation remains the insufficient level of consideration of environmental externalities in the process of forming economic incentives, which leads to excessive use of natural resources in the case of negative externalities and insufficient encouragement of producers in the case of positive ones. Such institutional asymmetry causes distortion of market signals and strengthens the resource-oriented nature of agricultural competitiveness. Internalization of externalities through a system of regulation, economic instruments and environmental standards is a necessary condition for the approximation of national agricultural policy to the practices of the European Union and the formation of a favorable institutional

environment for the sustainable development of the agricultural sector.

Ukraine's competitiveness in sectors with low product complexity requires strategic rethinking in the context of long-term structural modernization. The dominance of products with low product complexity index (PCI) values in the export structure is largely due to the country's natural resource advantages and geographical location, but in the long term, this model limits the possibilities of creating added value and increasing the technological level of agricultural production. In the context of European integration, state policy in the field of agriculture and rural development requires a reorientation from short-term responses to the formation of a system of clearly defined priorities and long-term institutional mechanisms. This involves creating conditions for the development of a competitive, environmentally sustainable and diversified agricultural sector capable of ensuring food security, reducing negative externalities and gradually integrating into the production and regulatory chains of the European Union.

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