

DOI: [10.55643/fcapter.1.66.2026.5043](https://doi.org/10.55643/fcapter.1.66.2026.5043)

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Received: 27/10/2025

Accepted: 27/01/2026

Published: 28/02/2026

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# FACTOR-ANALYTIC APPROACH TO THE LATENT STRUCTURE OF OBSTACLES TO THE DEVELOPMENT OF UKRAINE'S AGRICULTURAL SECTOR

## ABSTRACT

The research problem is that a component-wise list of barriers (insufficient demand, financial constraints, weather conditions, shortages of materials/equipment, and labor) does not yield an integrated understanding of the hidden dimensions through which these obstacles manifest, interact, and change in intensity under shocks.

The principal result is a stable two-factor configuration that captures two substantively distinct dimensions of obstacles. The first market institutional aggregates signals of insufficient demand and organizational/regulatory uncertainty and moves in antiphase to responses of “nothing constrains.” The second resource climatic financial accumulates shortages of materials/equipment, financial constraints, and the influence of weather conditions. The “labor shortage” indicator exhibits a transitional (cross-loading) position, with meaningful loadings on both dimensions, reflecting the simultaneous influence of organizational and security–resource factors. The temporal dynamics show a regime shift in 2022: dominance of the market-institutional dimension in the pre-crisis period gave way to an elevated role of resource climatic and financial constraints in 2023-2025. Anchored comparison of the factor indicators with aggregate financial outcomes and the share of loss-making enterprises confirms their diagnostic value: strengthening of the resource climatic financial dimension correlates with weaker results and a broader loss zone, whereas attenuation of the market institutional dimension aligns with short-term “windows of opportunity” for particular subsectors.

The scientific novelty lies in a statistically verified map of the “latent geometry” of obstacles that enables a shift from describing symptoms to identifying mechanisms and their links to financial outcomes. The practical significance is the possibility of dual-channel policy targeting: contracting instruments, insurance, and reduction of regulatory uncertainty for the market institutional dimension: resumption of supply logistics, access to working capital, and deployment of climate-resilient technologies — for the resource, climate, and financial dimension.

**Keywords:** Ukraine’s agricultural sector, economic governance, enterprise management, global economy, sustainable development, transformation, barrier structure

**JEL Classification:** Q10, Q12, Q14, C38, O13, P27

## INTRODUCTION

The agricultural sector of Ukraine has traditionally served as one of the pillars of the national economy: it ensures food security, generates a substantial share of export revenues, and sustains employment across extensive upstream and downstream value chains. Over the past decade, however, the sector’s development has unfolded under persistent turbulence. Decision-making and performance outcomes have been simultaneously shaped by geopolitical risks and logistical disruptions, institutional change and regulatory experimentation, fluctuations in energy and fertilizer prices, demographic pressures, and seasonally variable climatic factors (Andriushchenko et al., 2022; Mirzoeva et al., 2024). Amid this confluence of shocks, conventional indicators of efficiency and resilience send mixed signals: alongside positive dynamics in certain subsectors, a

significant share of loss-making enterprises persists, while short-term upswings often fail to translate into durable structural equilibrium.

This ambivalence suggests that the observed problems are driven not only by “surface-level” constraints that are readily captured statistically (insufficient demand, financial stress, shortages of labor or materials, weather-related risks), but also by more complex configurations of mutually reinforcing factors. Existing approaches that describe obstacles component-by-component frequently diffuse attention across a multitude of metrics and obscure their underlying architectonics – namely, the latent dimensions through which heterogeneous barriers “condense” into a limited set of stable, dominant influences. As a result, managerial and policy responses risk addressing symptoms rather than structural causes (Perevozova et al., 2021).

At the same time, both academic and applied discourse on Ukraine’s agricultural sector has already accumulated extensive observational evidence: regular enterprise surveys on business obstacles, time series of financial outcomes by activity, profitability and loss indicators, external trade metrics, and infrastructure measures. Yet these data are seldom analyzed as an integrated system capable of illuminating hidden linkages among the “demand–institutions” nexus, the “resource–supply block,” and “climate–logistics” constraints. The knowledge gap lies precisely in the absence of a synthesized, empirically validated perspective that would enable a shift from a mere inventory of barriers to their statistically grounded taxonomy (Duginets et al., 2023).

## LITERATURE REVIEW

Research shows that Ukraine’s agricultural sector possesses strong growth potential yet operates under multidimensional shocks. Shovkun-Zablotska et al. (2024), Moldavan et al. (2023), and Andriushchenko et al. (2022) determined that the pre-war export-oriented model combined expansion with a need for resilient modernization. Nehrey and Finger (2024) emphasized that after 2022, priorities shifted from expansion to survival and recovery. Ohorodnyk and Finger (2024) drew attention to the role of diversification as a source of regional value added. Regnier and Catallo (2024), Denysiuk et al. (2022), Lupenko et al. (2022), and Kvasha et al. (2019) delineate different farm types (from large exporters to small producers), which shape the heterogeneity of recovery trajectories. Taken together, these findings are important for our study in that they justify aggregating heterogeneous obstacles into a small number of interpretable latent dimensions.

Institutional–market conditions set the “rules of the game” for access to resources and capital. Kvartiuk, Bukin, and Herzfeld (2024) and Ostapchuk et al. (2021) showed that, prior to 2021, the land-lease market was a key mechanism for scaling production, whereas the effects of launching the land sale market are uneven across producer groups. Using evidence from Eastern Europe and Central Asia, Gorgan and Hartvigsen (2022) confirmed the importance of property rights, transparency, and concentration structures for the efficiency of land markets. Ibatullin et al. (2024) underlined the evolutionary character of the liberalization of land relations in Ukraine and the need for institutional safeguards. This implies that institutional barriers may form a common latent cluster with financial constraints.

Resource–technological, climatic, and labor factors remain systemic barriers. Jia et al. (2024) pointed to labor losses, input shortages, and infrastructure destruction as direct channels of output decline. Chen et al. (2024) and Koval et al. (2019; 2023) recorded reductions in sown areas and yields of key crops during the peak of the shock. Together with co-authors, Moldavan et al. (2023) and Bezdushna et al. (2023) further stressed the overlay of environmental and climate risks, necessitating “green” modernization. From a global perspective, Zhang et al. (2023) demonstrated the vulnerability of value chains due to disruptions in grain and fertilizer supplies, which amplifies domestic risks for Ukraine. Methodologically relevant, Yilmaz et al. (2023), Tatenko et al. (2024), Kryzhanivskiy et al. (2020), Zamula et al. (2020), and Hutorov et al. (2018) demonstrate the effectiveness of factor analysis for extracting “bundles” of practical constraints in farming. This suggests the feasibility of collapsing indicators such as “shortages of labor/materials/finance/climate” into several composite factors.

Logistical, trade, and security constraints determine the sector’s ability to monetize harvests. Kormych (2024) described the legal and risk parameters of maritime humanitarian corridors in the Black Sea. From the perspective of transport policy and the food security of import-dependent countries, Ekleme and Yercan (2025) assessed the Black Sea Grain Initiative. Yanovska et al. (2025), Yarmol et al. (2022), and Sirant et al. (2022) showed that land and river alternatives are limited by throughput capacity and regulatory bottlenecks. In a broader inter-market context, Auer et al. (2025) demonstrated how energy shocks cascade into food markets. This indicates the existence of a distinct latent block of logistics–security obstacles, which may correlate with financial outcomes and the loss index.

In sum, recent research on agricultural development identifies four key dimensions: (1) structural trends and the development potential of Ukraine's agricultural sector; (2) institutional–market conditions (land, leasing, finance); (3) resource–climatic and labor constraints; and (4) logistics–security shocks. These blocks are the most informative for factor-analytic identification of the latent structure of obstacles and for subsequent alignment with aggregate financial indicators of the sector.

## AIMS AND OBJECTIVES

The aim of the article is to identify and interpret the latent dimensions of obstacles to the development of Ukraine's agricultural sector and to relate them to the sector's financial outcomes, thereby providing a statistically grounded basis for ongoing monitoring and policy targeting.

To achieve this aim, the article sets the following objectives:

1. To construct a statistically validated map of the latent geometry of obstacles.
2. To identify and provide a substantive interpretation of the latent dimensions.
3. To detect structural breaks and regime shifts in the temporal profile of obstacles.
4. To determine the diagnostic value of the extracted factor indicators.
5. To justify the potential for policy targeting based on the identified latent geometry.

## METHODS

Methodologically, the study unfolds as a sequence of interrelated steps. First, we examined the suitability of the data for factorization: we computed the Kaiser–Meyer–Olkin index (overall and variable-level measures of sampling adequacy) and conducted Bartlett's test of sphericity for the Pearson correlation matrix; we additionally assessed departures from multivariate normality using Mardia's test (skewness and kurtosis) to interpret model fit indices appropriately. Next, the number of latent factors was determined via parallel analysis combined with visual inspection of the scree plot; we retained the minimal set of dimensions whose eigenvalues exceeded simulated means and formed an economically meaningful, parsimonious structure (the Kaiser criterion was used only as a sensitivity check). Estimation proceeded via exploratory factor analysis with oblique promax rotation, allowing for correlated factors; interpretation was based on the pattern-loading matrix with a working absolute loading threshold of  $\geq 0.40$ , taking into account variable uniqueness and derived communalities. Model adequacy was evaluated using a suite of absolute and comparative fit indices (including the standardized root mean square residual, an approximation index with confidence interval, the Tucker–Lewis and comparative fit indices, and the Bayesian information criterion), with interpretation conditioned on deviations from normality, a short battery of indicators per factor, and structural breaks in the 2022–2023 time series. The final step was analytical triangulation: factor scores for each dimension were related to aggregate financial outcomes and the share of loss-making enterprises to interpret the mechanism of uneven recovery and to identify which latent blocks are more strongly correlated with elevated losses in 2025.

The empirical base comprises two complementary datasets. The first consists of seasonally adjusted survey indicators of obstacles for 2015–2025, covering insufficient demand, weather conditions, labor shortages, shortages of materials and equipment, financial constraints, other factors, and statements of no obstacles; this block serves as the initial battery of variables for factor analysis. The second comprises aggregate financial indicators of the agricultural sector for the first half of two adjacent years, including profit/loss before tax, total financial result before tax, and the share of loss-making enterprises; this block is used as an external reference plane for interpreting the extracted factors and for testing the hypothesis of an asymmetric recovery. All computations, rotations, and visualizations were performed in JASP, with prior rescaling of variables to comparable metrics to ensure consistent estimates and reproducible results.

## RESULTS

Ukraine's agricultural sector occupies a system-forming position in the national economy: it generates a significant share of exports, ensures food security, and supports employment in related industries. At the same time, over the past decade, it has evolved under overlapping external and internal shocks – security, logistics, institutional, and climatic. Against a backdrop of short-term improvements in certain financial indicators, the sector continues to exhibit a high share of loss-

making enterprises and marked variability in outcomes across producers. Superficial “symptoms” are compounded by deep-seated, hidden mechanisms of development restraint that cannot be captured by a simple enumeration of barriers (demand, finance, inbound logistics, labor, weather, etc.).

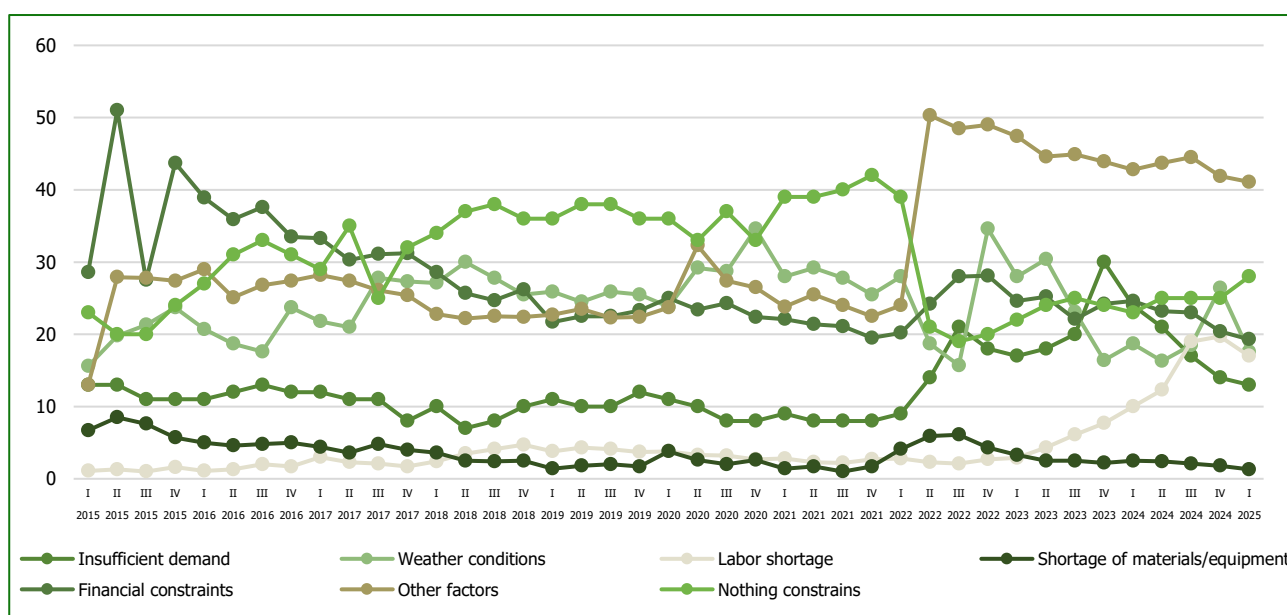
A comparison of the first half of 2025 with the first half of 2024 indicates an improvement in the sector's aggregate financial result alongside simultaneous increases in both profits and losses. This implies that the recovery is heterogeneous: some producers have been able to capitalize on favorable prices and export opportunities, while others remain in the loss zone. The high share of loss-making enterprises in 2025, recorded in Table 1, points to a polarization of recovery effects: access to logistics, working capital, and sales markets is distributed unevenly, and localized shocks (mine hazards, damaged infrastructure, water scarcity) continue to “distort” mean values.

**Table 1. Financial results and Loss Index of the agricultural sector: H1 2025 vs H1 2024.** (Source: created by author based on data from the State Statistics Service of Ukraine (2025))

Type of economic activity	Financial result before tax		Profit before tax		Loss before tax		Share of loss-making enterprises (% of total)	
	Jan–Jun 2025 (UAH million)	% of Jan–Jun 2024	UAH million	% of Jan–Jun 2024	UAH million	% of Jan–Jun 2024	Jan–Jun 2025 (UAH million)	% of Jan–Jun 2024
Agriculture, forestry, and fishing	3737.9	165.1	4193.4	171.6	455.5	253.9	53.1	163.9

Such a divergence between the positive dynamics of aggregate indicators and the substantial share of loss-making firms is consistent with the hypothesis that profitability has shifted in favor of enterprises with stronger institutional and resource capacities. At the micro level, this may be linked to better integration into supply chains, access to credit and forward contracts, geographical advantages with respect to logistical routes, and the ability to restore sown areas and machinery fleets more rapidly. At the macro level, it aligns with the 2024–2025 price cycle, the correction of fuel and fertilizer costs, partial stabilization of export channels, and the effects of government liquidity-support programs.

The long seasonally adjusted time series of obstacles (Figure 1) reveals three distinct phases. During 2015–2021, “softer” market–financial barriers (insufficient demand, financial constraints) dominated, while resource shortages and weather factors displayed a wave-like pattern. At the turn of 2022, a regime shift occurred: constraints related to material and technical supply and logistics rose sharply, labor shortages intensified, and the share of responses indicating “nothing constrains” temporarily declined. In 2023–2025, a partial normalization emerges with a new equilibrium: market barriers are no longer decisive on their own; instead, resource and labor constraints persist, and weather risks more frequently translate into production disruptions due to heightened infrastructure vulnerability.



**Figure 1. Factors constraining agricultural activity, 2015–2025 (seasonally adjusted data).** (Source: created by author based on data from the State Statistics Service of Ukraine (2025)).

Taken together, these observations – the positive dynamics of aggregate financial results (Table 1) and the reweighting of obstacles toward resource–labor factors (Figure 1) – suggest a mechanism of “uneven recovery.” Enterprises with better access to inputs, machinery, storage, and transport infrastructure translate even moderate improvements in external conditions into profit; those with weaker starting positions remain sensitive to supply-chain breaks, seasonal labor peaks, and climatic fluctuations. Consequently, averages improve while the dispersion of outcomes widens.

For subsequent analysis, this matters for two reasons. First, the 2025/2024 comparison reflects the intensity rather than the universality of recovery; hence, indicators of the “share of loss-making enterprises” should be interpreted as a marker of structural heterogeneity rather than a negation of the general trend. Second, the temporal profile of obstacles in 2015–2025 provides a natural basis for factor aggregation: at least two latent blocks are expected to emerge – (i) a market–institutional block (demand/finance) and (ii) a resource–climatic–labor block (materials, equipment, weather, labor). This configuration allows factor indicators to be aligned with financial outcomes and enables a test of which block correlates more strongly with the elevated share of loss-making enterprises in 2025.

To test the above hypothesis of two latent blocks of obstacles, we first assess whether the data are suitable for factorization (Table 2). The KMO/MSA statistics indicate minimally sufficient correlation density for conducting EFA: overall adequacy is at the threshold of acceptability, while individual indices vary substantially across variables. Higher values for variables such as “other factors” and “nothing constrains” imply greater common variance with the remaining indicators, whereas lower values for “labor shortage”, “shortage of materials/equipment” and “financial constraints” signal their specificity and the “localized” nature of shocks. This aligns with field realities: resource–labor constraints are often regionally or seasonally anchored and therefore cohere less readily into a common correlation structure.

**Table 2. Data suitability and factor retention.** Note. The statistic for skewness is assumed to be Chi<sup>2</sup> distributed, and the statistic for kurtosis standard normal; \* - Factor should be retained. Results from PC-based parallel analysis. (Source: calculated by author using JASP)

Kaiser-Meyer-Olkin Test			Parallel Analysis			
Overall MSA	MSA			Real data component eigenvalues	Simulated data mean eigenvalues	
x1 Insufficient demand	0.519		Factor 1*	2.991	1.670	
x2 Weather conditions	0.533		Factor 2*	2.316	1.334	
x3 Labor shortage	0.386		Factor 3	0.793	1.112	
x4 Shortage of materials/equipment	0.409		Factor 4	0.427	0.946	
x5 financial constraints	0.409		Factor 5	0.283	0.793	
x6 other factors	0.866		Factor 6	0.142	0.657	
x7 Nothing constrains	0.763		Factor 7	0.047	0.488	
Bartlett's Test			Chi-Squared Test			
X <sup>2</sup>	df	p		Value	df	p
199,477	21.000	< .001	Model	31.950	8	< .001
Mardia's Test of Multivariate Normality						
	Value	Statistic		df	p	
Skewness	36.438	248.990		84	< .001	
Small Sample Skewness	36.438	272.067		84	< .001	
Kurtosis	79.442	4.689			< .001	

A significant Bartlett test rejects the hypothesis of a diagonal correlation matrix; therefore, common latent factors are present, and factorization is warranted. Mardia’s tests register departures from multivariate normality (skewness and heavy tails), which is typical for data exposed to exogenous shocks in 2022–2024. Practically, this implies reliance on oblique rotation and interpretation, without expecting a perfect fit under simple normality assumptions. Results of the parallel analysis confirm that the first two latent dimensions carry the substantive information (their eigenvalues exceed simulated means). This aligns with the conceptual scheme outlined above: one factor concentrates market–institutional manifestations (demand/finance), while the other captures resource–climatic–labor constraints (materials, machinery, weather, labor). The next subsection, therefore, presents the factor solution proper and interprets the loadings for these two dimensions.

The pattern matrix confirms a two-block latent structure consistent with the diagnostics (Table 3).

**Table 3. Factor Loadings and Structure Matrix.** Note. Applied rotation method is promax. (Source: calculated by author using JASP)

	Factor 1	Factor 2	Uniqueness	Structure Matrix		
x1 Insufficient demand	0.880		0.225	x1 Insufficient demand	0.876	
x6 other factors	0.841		0.265	x2 Weather conditions	-0.476	
x7 Nothing constrains	-0.831		0.121	x3 Labor shortage	0.463	-0.500
x3 Labor shortage	0.490	-0.525	0.511	x4 Shortage of materials/equipment		0.988
x2 Weather conditions	-0.464		0.717	x5 financial constraints		0.789
x4 Shortage of materials/equipment		0.980	-0.002	x6 other factors	0.830	
x5 financial constraints		0.788	0.378	x7 Nothing constrains	-0.851	-0.436

**Factor 1** primarily aggregates market–institutional manifestations. The indicators “insufficient demand” and “other factors” load strongly and positively, whereas “nothing constrains” shows, as expected, a negative association with the same factor. This indicates that as “soft” sales/organizational barriers intensify, the probability of reporting no obstacles drops sharply.

**Factor 2** represents the resource – supply contour: “shortage of materials/equipment”, “financial constraints” and “weather conditions” dominate – i.e., bottlenecks in input logistics, liquidity, and climate risks.

“Labor shortage” exhibits cross-loadings: substantively, it resides between demand–organizational disturbances and resource-side disruptions (seasonality, migration, mobilization, and logistical constraints), which yields a bidimensional anchoring. The uniqueness statistics suggest that the indicator of material–technical constraints is only weakly specific (it is explained almost entirely by Factor 2), whereas the others retain a notable idiosyncratic component – consistent with the heterogeneous origins of the shocks.

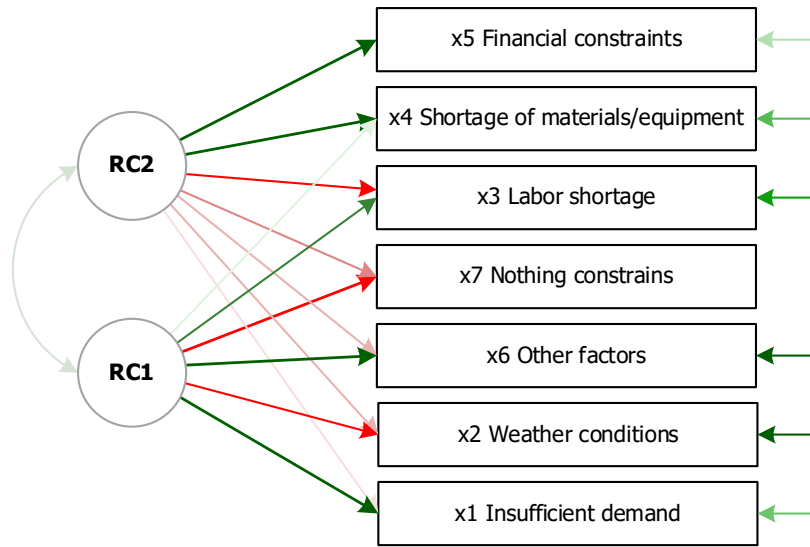
The structural matrix mirrors this picture: variables with the largest pattern loadings display the highest correlations with their “own” factor, while “nothing constrains” persistently moves in antiphase to the demand–institutional core. Taken together, Tab. 3 provides a basis for naming the factors as follows: F1 – market–institutional; F2 – resource–climatic–financial.

In terms of variance characteristics, the two-factor solution is parsimonious and informative: a majority of the variance in the indicators is explained in aggregate, and the contributions of the two factors are commensurate – well aligned with the notion of the “two arms” of obstacles (sales/institutions vs. resources/climate/liquidity). The inter-factor correlation is low despite the oblique approach, indicating that the latent clusters are conceptually distinct and do not collapse into a single dimension (Table 4).

**Table 4. Solution characteristics and model fit.** (Source: calculated by author using JASP)

	Unrotated solution			Rotated solution			
	Eigenvalue	Proportion var.	Cumulative	SumSq. Loadings	Proportion var.	Cumulative	
Factor 1	2.732	0.390	0.390	2.658	0.380	0.380	
Factor 2	2.056	0.294	0.684	2.126	0.304	0.684	
Factor Correlations	Factor 1			Factor 2			
Factor 1	1.000			0.052			
Factor 2	0.052			1.000			
RMSEA	RMSEA 90% confidence			SRMR	TLI	CFI	BIC
0.269	0.178 – 0.376			0.053	0.633	0.866	2.241

The global fit indices are mixed: residual variance is relatively small (acceptable SRMR), whereas indices such as RMSEA/TLI/CFI signal underfit. This is to be expected given the deviations from multivariate normality, the short battery of indicators per factor, and structural breaks in 2022–2023. Having confirmed the parsimony of the two-factor solution and its acceptable coherence, it is appropriate to visualize the network of associations and facilitate interpretation of factor content (Figure 2).



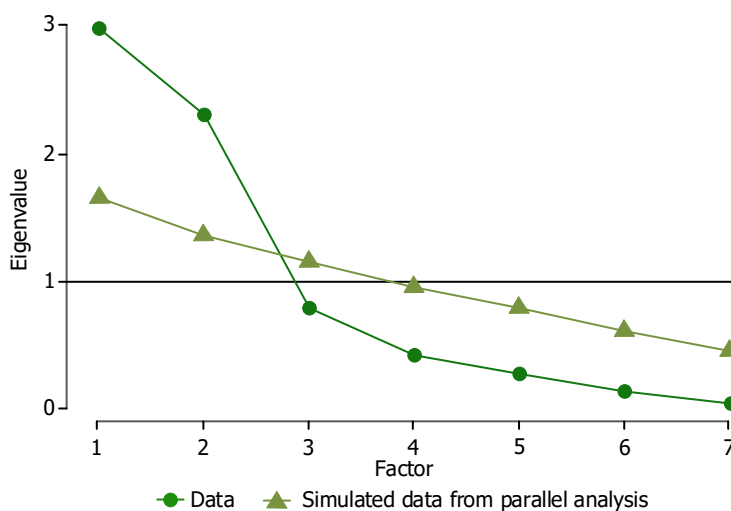
**Figure 2. Path Diagram.** (Source: calculated by author using JASP)

Node RC1 aggregates market–institutional barriers: strengthening of this core is accompanied by rising sales/organizational problems and a symmetric negative association with the “nothing constrains” indicator. This is consistent with periods of external-demand volatility, regulatory uncertainty, and revisions of contracting practices.

Node RC2 represents the resource–supply core: the strongest ties point to financial constraints and shortages of materials/equipment, with weather conditions close by. This configuration is explained by the post-war fragmentation of input logistics, resource price volatility, and frequent weather extremes that heighten production risk.

Labor shortage has a transitional character – its links extend to both cores. In practical terms, this reflects the simultaneous influence of organizational factors (work planning, demand expectations) and resource–security constraints (migration, mobilization, seasonality, access to machinery).

Finer “cross” arrows indicate partial overlaps between the cores; overall, however, they remain relatively autonomous: market disturbances do not reduce to mere input scarcity, and resource–climatic problems are not reducible to demand decline. Accordingly, subsequent policy targeting should be dual-channel: on the one hand, instruments for sales/contracting and reducing institutional uncertainty; on the other, input infrastructure, access to working capital, and climate-resilience technologies.



**Figure 3. Scree plot.** (Source: calculated by author using JASP)

Figure 3 aligns with the preceding results: the correlation structure of the data is governed by two dominant dimensions (market–institutional and resource–climatic–financial), while the remaining variation is local and specific (including seasonality, regional differences, and the shocks of 2022–2024).

The resulting two-factor solution makes it possible to describe the field of obstacles as a plane with two axes:

- F1 – market–institutional axis (demand, organizational uncertainty),
- F2 – resource–climatic–financial axis (input logistics, liquidity, weather).

The low inter-factor correlation implies near-orthogonal dimensions: the forces operate in parallel but are relatively independent.

Within this plane, variables are grouped in a systematic way. Near F1, “insufficient demand” and “other factors” concentrate, whereas the indicator “nothing constrains” lies in antiphase to F1 – when market–institutional barriers intensify, the share of enterprises reporting no constraints declines. Along F2, “shortage of materials/equipment”, “financial constraints,” and “weather conditions” are concentrated – the core of “hard” production bottlenecks. “Labor shortage” occupies a transitional position with cross-loadings, reflecting the simultaneous influence of organizational factors (work planning, demand expectations) and resource–security factors (migration, mobilization, seasonality).

This geometry is consistent with the time series (Figure 1) and the retention criteria (Figure 3): until 2021, the F1 “arm” predominated; after the 2022 shock, F2 became dominant; and in 2023–2025, a new equilibrium emerges with an elevated role for resource–climatic and financial constraints. This shift explains the observed unevenness of recovery: enterprises with better access to inputs, storage, credit, and routes move more rapidly into the region of the plane with low F2 and convert improvements in external conditions into profit, whereas others “stick” in the high-F2 quadrant.

A practical interpretation of the plane is as follows:

- High F1, low F2 – sales and institutional coordination problems under relatively stable resources;
- Low F1, high F2 – input/liquidity deficits and weather risks under normal demand;
- High F1 and F2 – compound crisis (simultaneous market and production barriers);
- Low F1 and F2 – a situation without significant obstacles.

At the policy level, this picture suggests dual-channel targeting: contracting, insurance, and reduction of regulatory uncertainty for the F1 domain; input-logistics infrastructure, access to working capital, climate-resilient technologies, and repair of logistics for the F2 domain. Despite mixed global fit indices (expected given structural breaks and deviations from normality), the parallel analysis, loadings, and path visualization jointly support a parsimonious two-factor model.

The two-factor pattern obtained in the analysis yields not only an analytical but also a clear financial and economic logic of how obstacles are structured. The first domain captures phenomena that directly increase the riskiness of production decisions. Volatile rules, weak contract guarantees, and high regulatory unpredictability materialize as elevated transaction costs, a higher risk premium embedded in the cost of capital, and suppressed investment activity. Under such conditions, producers shorten planning horizons, limit long-term commitments, and shift toward shorter trading cycles. Financial results deteriorate not only because of direct losses but also due to the rising cost of insurance, hedging, and liquidity buffers. Policy measures aimed at reducing uncertainty within the F1 domain, therefore, have a precise economic rationale: they lower the risk premium, stabilize cash flows, and restore the capacity to invest in productive assets.

The second domain reflects constraints that generate working-capital shortages, increase operating-cycle costs, and lead to the loss of part of the value added due to disruptions in logistics. When supply, transport, and storage infrastructure operate with interruptions, producers must accumulate excessive inventories, pay for more expensive alternative routes, or reduce output. This creates substantial pressure on liquidity and worsens profitability, as the share of non-productive expenditures increases. Access to short-term finance becomes a critical survival factor, while climate-resilient technologies partially offset yield losses and enhance operational stability. Policy instruments aligned with the structure of the F2 domain should therefore support working-capital availability, restore logistical nodes, and decrease the financial burden on producers during periods of heightened risk.

The financial and economic rationale for dual-channel targeting follows from the fact that the two domains generate distinct mechanisms of inefficiency. F1 acts through risk and expectations regarding future income, whereas F2 operates through actual operating costs and interruptions in value-creation chains. Their differentiation enables policy tools to match the concrete points of loss, reduce dispersion of resources, and increase the effectiveness of interventions. Even though the global fit indices are mixed – an expected outcome for data characterized by temporal breaks and structural shifts – the combination of parallel analysis, loading stability, and structural topology confirms the internal economic coherence of the two-factor solution, in which each domain exhibits its own logic of influence on the financial condition of the sector and the prevalence of loss-making enterprises.

## DISCUSSION

The results of the factor analysis of the latent structure of obstacles to the development of Ukraine's agricultural sector confirm and substantially extend existing scholarly approaches that acknowledge the multidimensional nature of shocks. Previous studies emphasized the importance of geopolitical risks, logistical disruptions, institutional volatility, price fluctuations, demographic pressures, and climate-related factors as the key constraints for the sector (Andriushchenko et al., Mirzoeva et al.). However, as noted earlier, these approaches often described the problems in a fragmented manner, which dispersed analytical focus and obscured the architecture of their interdependence.

The two empirically identified latent axes – the market-institutional domain (F1) and the resource-climate-financial domain (F2) – align with the four major blocks outlined in the literature review: institutional and market conditions, resource-climate and labour constraints, and logistics-security shocks. The F1 factor captures demand-side and organizational uncertainties, corresponding to research that highlights institutional barriers such as land governance, leasing, and financing (Kvartiuk et al., Ostapchuk et al., Gorgan & Hartvigsen, Ibatullin et al.). The F2 factor combines shortages of materials and equipment, financial constraints, and adverse weather conditions, reflecting the systemic barriers reported by Jia et al. (labour losses, resource deficits, infrastructure destruction), by Chen et al. (reduced sown areas), and by Moldavan et al. (climatic risks).

The detected regime shift in 2022 – from the dominance of F1 to the stable predominance of F2 in 2023–2025 – provides empirical grounding for the conclusions of Nehrey and Finger (2024), who argued that the sector's priorities after 2022 shifted from expansion and modernization toward survival and restoration. This suggests that, unlike in the earlier period when financial-market "soft" barriers were decisive, the full-scale shock made "hard" production and resource constraints the determining factors.

The study clearly links the strengthening of F2 with the deterioration of aggregate financial outcomes and the high share of loss-making enterprises in 2025. This supports the hypothesis of heterogeneous recovery: enterprises with better access to logistics, working capital, and sales channels convert even moderate improvements in external conditions into profit more quickly, while others remain highly sensitive to supply-chain disruptions, which underscores structural asymmetry within the sector.

Unlike a simple classification of labour shortages as merely a resource-related issue, the calculations show that this indicator has a transitional, cross-loading character. This means that labour deficit is amplified by both organizational-market factors (planning, demand) and security-resource pressures (migration, mobilization, seasonality). This finding refines the understanding of the multifactor nature of labour constraints, which cannot be reduced solely to material losses (Jia et al.).

The main distinction of this article compared with existing research lies in the shift from describing isolated symptoms to developing a statistically verified taxonomy (latent geometry) of obstacles. Although the methodological relevance of factor analysis for identifying clusters of constraints in agriculture had been demonstrated earlier (Yılmaz et al., Tatenko et al., Zamula et al., Hutorov et al.), this work is the first to apply this approach to an integrated time-series system of obstacles in Ukraine's agricultural sector under wartime and economic shocks.

The novelty of the study is that it empirically shows for the first time how heterogeneous barriers condense into two relatively independent, nearly orthogonal latent axes, forming a holistic understanding of structural drivers rather than merely surface-level limitations. The low inter-factor correlation (0.052) indicates that market and resource forces operate in parallel but remain conceptually distinct – an aspect not clearly established in earlier research.

Furthermore, the diagnostic value of the factor scores was demonstrated by linking them to aggregated financial outcomes and the share of loss-making enterprises. This makes it possible not only to inventory obstacles but also to quantify which structural block – F1 or F2 – is more strongly associated with deteriorating economic performance, particularly the heightened role of F2 in 2023–2025.

The practical contribution lies in the ability to design dual-channel policy targeting. Unlike responses to isolated problems, the proposed latent geometry makes it possible to develop precise tools: contract-based instruments, insurance mechanisms, and reduction of regulatory uncertainty for F1; restoration of supply logistics, access to working capital, and climate-resilient technologies for F2.

Taken together, the results shift the discourse from symptom-level description to the identification of underlying mechanisms, offering a statistically grounded basis for strategic monitoring and policy decision-making.

## CONCLUSIONS

The aim of the article was to identify and interpret the latent structure of obstacles to the development of Ukraine's agricultural sector and to relate it to the sector's current financial outcomes. This aim has been achieved: an exploratory factor analysis based on survey indicators for 2015–2025 revealed a stable two-factor configuration, confirmed by diagnostics (KMO/Bartlett), parallel analysis, and the scree plot.

The main results are as follows:

1. Two substantively distinct latent dimensions were identified: F1 – market–institutional (dominated by “insufficient demand” and “other factors”, with a negative association to “nothing constrains”) and F2 – resource–climatic–financial (“shortage of materials/equipment”, “financial constraints”, “weather conditions”). The inter-factor correlation is low, indicating the relative independence of the blocks.
2. “Labor shortage” has a transitional character with cross-loadings; that is, it intensifies via both organizational–market and resource–security channels.
3. The temporal profile of obstacles shows a regime shift in 2022: from F1 dominance in the pre-crisis years to a sustained predominance of F2 in 2023–2025.
4. A comparison of financial outcomes for H1 2025 vs. H1 2024 indicates an improved aggregate result alongside a persistently high share of loss-making enterprises, consistent with the mechanism of “uneven recovery”: producers with better access to inputs, logistics, and finance convert improvements in external conditions into profit faster than others.

The two-factor “latent geometry” implies dual-channel policy targeting: for F1, instruments of contracting and risk insurance, reduction of regulatory uncertainty, and support for sales and exports; for F2, restoration of input logistics and storage infrastructure, access to working capital, and climate-resilience technologies. Labor shortages should be addressed separately (mobility, workforce training, and mechanization).

In sum, the proposed factor-analytic approach provides a statistically grounded map of obstacles to Ukraine's agricultural development, explains the nature of uneven recovery in 2025, and offers a concrete basis for targeted public and corporate decision-making.

Prospects for further research follow from the identified latent structure of obstacles and the dynamics of their influence. Particular attention is required for the phenomenon of labour shortage, which, in the conducted analysis, demonstrated a transitional character. Its cross-loadings on both factor domains indicate that the shortage of workers arises not only from resource losses but also through organizational and market mechanisms.

Further work should also clarify the mechanisms of structural heterogeneity in recovery, which became particularly visible during the post-2022 shift in sectoral priorities. A micro-level analysis will make it possible to identify groups of enterprises and subsectors that remain vulnerable to logistical disruptions and resource constraints despite improvements in aggregated financial indicators, and thus operate within the zone of strong F2 influence. Understanding which specific characteristics determine the adaptability of enterprises or, conversely, keep them in a state of persistent vulnerability will enable the development of more targeted policy solutions and refine the concept of recovery under prolonged shocks.

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## ADDITIONAL INFORMATION

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### AUTHOR CONTRIBUTIONS

*All authors have contributed equally.*

### FUNDING

*The Authors received no funding for this research.*

### CONFLICT OF INTEREST

*The Authors declare that there is no conflict of interest.*

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## ФАКТОРНО-АНАЛІТИЧНИЙ ПІДХІД ДО ЛАТЕНТНОЇ СТРУКТУРИ ПЕРЕШКОД РОЗВИТКУ АГРАРНОГО СЕКТОРА УКРАЇНИ

Проблема дослідження полягає в тому, що покомпонентний перелік бар'єрів (недостатній попит, фінансові обмеження, погодні умови, нестача матеріалів / обладнання та робочої сили) не дає цілісного розуміння прихованих вимірів, через які ці перешкоди проявляються, взаємодіють і змінюють свою інтенсивність під впливом шоків.

Основним результатом є стабільна двофакторна конфігурація, що відображає дві змістово різні виміри перешкод. Перший — ринково-інституційний — об'єднує сигнали недостатнього попиту та організаційно-регуляторної невідповідності й рухається в антипазі до відповідей «ніщо не заважає». Другий — ресурсно-кліматично-фінансовий — акумулює нестачу матеріалів / обладнання, фінансові обмеження та вплив погодних умов. Показник «нестача робочої сили» займає перехідну (з перехресними навантаженнями) позицію, маючи суттєві навантаження на обидва виміри, що відображає одночасний вплив організаційних і безпеково-ресурсних чинників.

Часова динаміка демонструє зміну режиму 2022 року: домінування ринково-інституційного виміру за докризового періоду поступилося підвищеній ролі ресурсно-кліматичних і фінансових обмежень протягом 2023–2025 років. Порівняння факторних показників із сукупними фінансовими результатами та часткою збиткових підприємств підтверджує їх діагностичну цінність: посилення ресурсно-кліматично-фінансового виміру корелює зі слабшими результатами та ширшою зоною збитків, водночас ослаблення ринково-інституційного виміру відповідає короткостроковим «вікнам можливостей» для окремих підгалузей.

Наукова новизна полягає в статистично підтвердженій карті «латентної геометрії» перешкод, що дозволяє перейти від опису симптомів до ідентифікації механізмів і їхніх зв'язків із фінансовими результатами. Практичне значення полягає в можливості двоканального політичного таргетування: контрактні інструменти, страхування та зниження регуляторної невизначеності — для ринково-інституційного виміру; відновлення логістики постачання, доступу до оборотного капіталу та розгортання кліматостійких технологій — для ресурсно-кліматично-фінансового виміру.

**Ключові слова:** аграрний сектор України, економічне управління, управління підприємством, глобальна економіка, сталий розвиток, трансформація, структура бар'єрів

**JEL Класифікація:** Q10, Q12, Q14, C38, O13, P27