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THE IMPACT OF NON-TARIFF BARRIERS OF THE EU ON THE EXPORT OF KEY AGRARIAN GOODS OF UKRAINE

Abstract

The article analyses the impact of the European Union's non-tariff barriers – particularly sanitary and phytosanitary (SPS) measures and technical barriers to trade (TBT) – on the volume and structure of Ukraine's agricultural exports over the period 2015–2025. The aim of the study is to quantitatively assess the trade costs generated by EU regulatory requirements and to identify patterns in their influence on the commodity composition of exports, taking into account institutional developments such as the implementation of the DCFTA Agreement and temporary trade liberalization measures. The methodological framework of the research is based on gravity modeling using the PPML estimator, complemented by the

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calculation of ad valorem equivalents that capture the magnitude of non-tariff pressure.

Unlike previous studies, this work provides the first detailed quantitative assessment of the impact of SPS notifications on specific groups of Ukrainian agricultural products over a ten-year period, enabling the identification of hidden trade costs generated by regulatory requirements. The analysis reveals differentiated sensitivity across product groups: exports of sugar and sunflower oil are the most vulnerable to increasing SPS burdens, whereas the impact of TBT measures exhibits greater heterogeneity and is partially mitigated by the digitalization of procedures and the harmonization of technical standards.

The results offer new insights into the role of non-tariff barriers in shaping Ukraine's agricultural trade flows and form an analytical basis for enhancing the effectiveness of export support policies, aligning production processes with European standards, and developing digital certification platforms. The proposed approach also makes it possible to forecast future trade costs and optimize strategies for entering the EU market, which is of practical importance for building a resilient and competitive Ukrainian agricultural export sector under conditions of intensifying regulatory pressure.

Key Words:

ad valorem equivalent; agricultural export; non-tariff barriers; regression modeling; SPS notifications; TBT standards; temporary trade liberalization; Ukraine – EU.

JEL: F13, Q17, C33, F15.

3 figures, 3 tables, 35 references.

Problem Statement

After 2022, Ukrainian agricultural exports obtained unprecedented access to the European Union market due to the suspension of tariffs and quotas. This period of liberalization created favourable conditions for expanding the presence of Ukrainian producers in the EU, which was particularly reflected in the more than 150% increase in wheat exports and the fivefold growth in sugar exports. However, beginning in 2024, the EU has gradually reinstated tariff and non-tariff restrictions – including quotas and regulatory requirements – effectively transforming wartime trade preferences into a new form of selective protectionism (Reuters, 2024; Malingre, 2024). As a result, a new type of non-tariff pressure on Ukrainian exports has emerged.

In this context, non-tariff barriers – primarily sanitary and phytosanitary (SPS) measures and technical barriers to trade (TBT) – have become key factors shaping the structure and dynamics of Ukraine's agricultural exports. According to DG SANTE (2025), the number of SPS notifications concerning agricultural products from Ukraine increased by 18% within a single year, indicating intensifying regulatory pressure.

The scientific significance of the study lies in the development of a quantitative model that enables the assessment of the ad valorem equivalent (AVE) of non-tariff barriers and identifies the relationship between the intensity of SPS pressure and changes in Ukraine's agricultural exports to the EU. Its practical significance is associated with the potential use of the results to support Ukraine's negotiating position regarding the continuation or revision of trade preferences.

Existing research on non-tariff barriers is largely focused on global assessments or countries with stable trade structures; therefore, Ukraine still lacks models that capture the specific conditions of wartime exemptions, temporary trade regimes, and evolving EU trade policies.

The purpose of the study is to quantitatively assess the impact of the European Union's sanitary and phytosanitary (SPS) barriers on the dynamics and structure of Ukraine's agricultural exports over the period 2015–2025, using gravity modeling with the PPML estimator and calculating the ad valorem equivalents of non-tariff pressure.

Literature Review

Modern research increasingly focuses on the impact of non-tariff measures (NTMs) – particularly sanitary and phytosanitary (SPS) measures and technical barriers to trade (TBT) – on international agricultural trade. This topic has gained particular relevance in the context of the growing influence of EU regulatory standards and the revision of trade regimes with partner countries.

There are several methodological approaches to assessing the impact of SPS and TBT measures. The first is the regression-based gravity model, which estimates trade volumes using PPML or OLS specifications that incorporate SPS/TBT variables (Sanjuán et al., 2023; Akune, 2023; Farris et al., 2024). The second is the ad valorem equivalent (AVE) approach, which converts non-tariff barriers into tariff-equivalent percentage values, enabling comparison of the effects of different types of regulation (Fell & Duver, 2023; Ghodsi et al., 2016). A third direction is the institutional–procedural approach, which evaluates regulatory costs, certification processes, and approval requirements as key components of «invisible» barriers (OECD, 2023; CSIS, 2025).

In parallel, a digital adaptation dimension is emerging, examining the role of electronic certificates, digital registers, and traceability platforms in reducing transaction costs within the SPS system (OECD, 2021; de Castro et al., 2023).

Methodological differences across existing research highlight the heterogeneous impact of SPS and TBT measures on international trade. Sanjuán et al. (2023), for example, showed that non-tariff measures reduce agricultural trade volumes by more than 10%, even after controlling for tariff effects, whereas Mabunda et al. (2025) demonstrated that the influence of SPS regulation varies depending on the level of development of the exporting country. The study by Farris et al. (2024) identified a combined effect of SPS and TBT measures, resulting in a substantial decline in agricultural exports.

Fell & Duver (2023) emphasized the importance of distinguishing between quantitative and procedural components of non-tariff barriers, while Larch et al. (2024) substantiated the methodological advantages of using PPML estimators in the presence of zero trade flows. Duval & Utoktham (2025) proposed incorporating digitalization variables into gravity models for the agricultural sector, enabling a more precise assessment of the effects of the regulatory environment.

Research in the Ukrainian context shows that adapting technical regulations and SPS standards to the EU acquis is essential for developing agricultural exports. Ostashko et al. (2022) analyze the effects of the Deep and Comprehensive Free Trade Area (DCFTA) Agreement, identifying the harmonization of SPS standards as a factor in export growth. Boyko et al. (2024) confirm that harmonizing regulatory requirements is essential for Ukrainian agricultural products. Analytical sources, including Reuters (2024), Malingre (2024), CSIS (2025), and

Sobolev (2025), have noted the EU's return to quotas and tariffs in 2024, as well as the increased role of SPS regulations following the expiration of wartime concessions. Table 1 presents the results of previous studies, which systematize the identified effects of SPS/TBT for different countries and sectors.

Table 1

Comparison of approaches to assessing the impact of SPS and TBT on agricultural trade

Research direction	Main idea	Method	Expected effect SPS/TBT
Global PPML models	Measuring the impact of SPS on trade flows	PPML, IV	Negative, 5–15% decrease in exports
AVE Assessment	Transformation of non-tariff measures into a «tariff equivalen»	AVE models	Negative, 3–10 percentage points.
Institutional approaches	Analysis of procedural costs and certification barriers	Case studies	Depends on the sector
Digital solutions	Effects of e-certification and traceability	Hybrid models	Reducing barriers, positive effect
Ukrainian context	Impact of DCFTA, ATM, and wartime benefits	PPML, descriptive analysis	Ambiguous, lack of quantitative assessments

Source: compiled by the authors.

Summarizing the findings of previous research makes it possible to identify several key patterns: non-tariff measures exert a significant influence on the volume of agricultural exports; their effects are heterogeneous across sectors and countries; and they depend strongly on institutional capacity and the degree of adaptation to international standards. In the Ukrainian context, however, several issues remain insufficiently addressed: the absence of a quantitative assessment of the actual impact of EU SPS notifications on Ukraine's agricultural exports in the post-war period; the underestimation of the interaction between SPS intensity and changes in trade regimes (DCFTA, ATM, quotas); and the lack of studies that combine PPML gravity modeling with the AVE framework to determine the economic magnitude of non-tariff pressure. Therefore, conducting a quantitative assessment of the impact of EU SPS measures on Ukraine's agricultural exports using a PPML gravity model constitutes the scientific contribution of this study.

Gaps in research

Despite substantial progress in previous research, several important gaps remain.

First, there is no comprehensive analysis of the impact of EU SPS notifications on Ukraine's agricultural exports over the period 2015-2025 that accounts for the full spectrum of procedural and institutional requirements. Second, the distinction between quantitative SPS-notification indicators and the actual compliance costs associated with their implementation – such as certification, inspections, and approval procedures – is insufficiently developed, even though these costs constitute the core of the regulatory shock faced by exporters. Third, most studies rely on aggregated commodity groups, overlooking product-specific differences in the effects of SPS measures on individual categories such as grains, oils, sugar, and eggs. Fourth, the impact of SPS regulation is frequently examined without considering interactions with regime changes, particularly the effects of the Deep and Comprehensive Free Trade Area (DCFTA), temporary market liberalization under Autonomous Trade Measures (ATM), or the reintroduction of quotas and tariffs during the study period. Fifth, although digital tools are increasingly recognized as an important factor in modern trade systems, few studies examine their interaction with SPS regulation in reducing trade costs. In addition, the role of logistics disruptions related to the war and shifts in transportation corridors is almost entirely absent from PPML-based assessments.

Research Methodology

The information base of the research is built on official statistical sources and open international databases, ensuring the representativeness and reproducibility of the results.

The research database is constructed using official statistical sources and open international datasets, ensuring the representativeness and reproducibility of the results. Data on sanitary and phytosanitary (SPS) measures and technical barriers to trade (TBT) were obtained from the ePing SPS & TBT Platform of the World Trade Organization (EPing SPS&TBT Platform, n. d. -a; n. d. -b), the WTO SPS/TBT Information Management System (IMS), and the Integrated Trade Intelligence Portal (World Trade Organization, n. d. -a). The sample includes only those measures in which the European Union is a notifying or affected party and that directly concern Ukrainian exports for the commodity codes HS 1001 (wheat), HS 1005 (corn), HS 1701 (sugar), and HS 1512 (sunflower oil). Data aggregation was performed by year and measure category, considering only unique notifications to ensure an accurate representation of SPS and TBT pressure intensity.

Data on commodity flows are obtained from the UN Comtrade database, which provides annual statistical information on international trade by commodity codes according to the Harmonized System (United Nations Statistics Division, n. d.). For a contextual assessment of trade restrictions, official reports of the European Commission (2024 Annual SPS Activity Report) and materials from international media sources (Abnett & Polityuk, 2025; Payne & Trompiz, 2025; RBC Ukraine, 2025) are incorporated, as they document recent revisions of quotas and tariffs on Ukrainian agricultural products.

The selection of the period 2015-2025 is justified by the availability of SPS/TBT notifications and complete export statistics. This timeframe also encompasses key changes in the EU trade regime affecting Ukraine, including the implementation of the DCFTA, temporary market liberalization under wartime exemptions, and the gradual reintroduction of quotas and tariff restrictions. The unit of observation is a country-year combination for the European Union as a single trading partner.

For the quantitative analysis, a log-linear PPML model is employed, as it enables the estimation of export elasticities in response to changes in regulatory barriers and appropriately accounts for zero trade flow values. The baseline specification is given by the following equation:

$$\ln(EXPORT_{it}) = \alpha_0 + \alpha_1 \cdot \ln(SPS_{it}) + \alpha_2 \cdot \ln(TBT_{it}) + \Sigma\beta_k \cdot D_k + \varepsilon_{it} \qquad (1)$$

where: $EXPORT_{it}$ – the volume of agricultural product exports from Ukraine to country (i) in year (t), SPS_{it} і TBT_{it} – number of unique notifications by platform, D_k – dummi variables that take into account the specifics of goods and time effects, ε_{it} – random mistake.

The variables ln_SPS_barrier and ln_TBT_barrier are calculated as the natural logarithm of the number of unique notifications, with one added to account for zero values:

$$\ln\_SPS\_barrier_{it} = \ln(1 + SPS_{count_{it}}) \qquad (2)$$

$$\ln\_TBT\_barrier_{it} = \ln(1 + TBT_{count_{it}}) \qquad (3)$$

where: *SPS_count_it* and *TBT_count_it* – accordingly, the quantity SPS – and TBT – notifications for product *I* in year *t*. Adding one before taking the logarithm allowed for correct handling of observations with zero notification values.

To test the sensitivity of the model, alternative estimations were carried out using three specifications: the baseline model, a model including the interaction of SPS/TBT measures with a time trend, and a model in which notifications are weighted by the export share. In addition, correlations between the variables were examined, and the presence of multicollinearity was assessed.

The scientific novelty of the methodology lies in combining the quantitative PPML approach with AVE calculations to determine the economic magnitude of

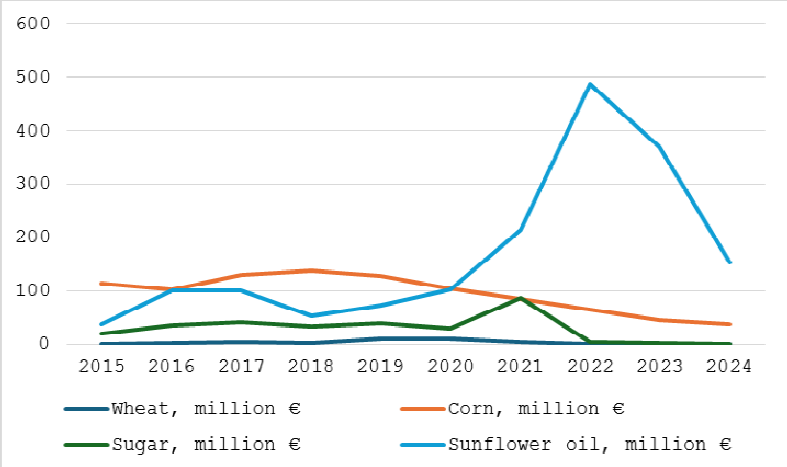
non-tariff pressure, as well as in incorporating procedural and digital dimensions of SPS/TBT regulation in the context of Ukraine's export performance. The selected time horizon enables an assessment of the effects of wartime trade preferences, the gradual reintroduction of quotas and tariffs, and the medium-term dynamics of trade shocks. Thus, the proposed methodological framework provides a comprehensive evaluation of the impact of non-tariff barriers on Ukraine's agricultural exports within the broader context of European integration and holds practical relevance for trade policy analysis.

Research results and discussion

Before conducting the regression analysis, a review of the dynamics of Ukraine's main agricultural exports to the EU over the period 2015–2024 was carried out. This preliminary assessment made it possible to identify general trends and to define the broader context in which changes in sanitary and phytosanitary (SPS) measures and technical barriers to trade (TBT) were taking shape (Fig.1).

Figure 1

Dynamics of Ukraine's main agricultural exports to the EU from 2015 to 2024, million USD



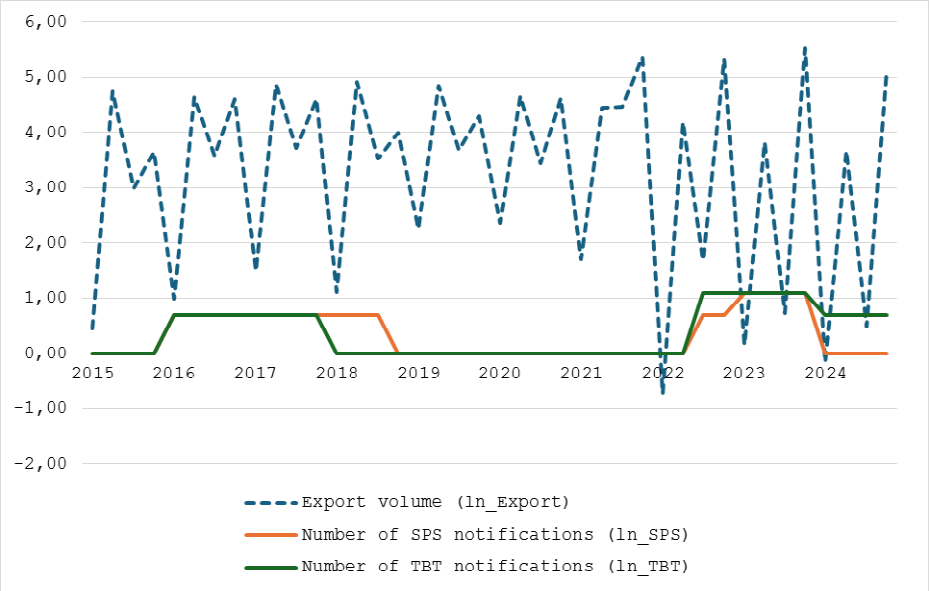
Source: Trade Map – Trade Statistics for International Business Development (International Trade Centre, n. d.) and UN Comtrade (United Nations Statistics Division, n. d.); complied by the authors.

As shown in Fig. 1, following the entry into force of the Association Agreement and the DCFTA in 2016, exports of key agricultural products demonstrated steady growth. The expansion of sunflower oil exports was particularly notable, driven by the high competitiveness of Ukrainian producers and the growing demand in the EU market. In 2020–2021, however, export dynamics exhibited fluctuations attributable to pandemic-related restrictions and a decline in transportation activity.

Starting from 2022, against the backdrop of military actions and the temporary abolition of tariffs and quotas under the Autonomous Trade Measures (ATM), Ukrainian agricultural exports increased sharply. In 2024, however, a decline was observed, coinciding with the partial reinstatement of tariff restrictions and the reassessment of quota allocations (Abnett & Polityuk, 2025; Payne & Trompiz, 2025). These dynamics demonstrate the high sensitivity of Ukrainian exports to changes in trade regulation and justify the inclusion of SPS and TBT variables in the empirical model. Figure 2 illustrates the relationship between ln_SPS, ln_TBT, and ln_EXPORT for major Ukrainian agricultural products over the period 2015-2024.

Figure 2

The relationship between ln_SPS, ln_TBT, and ln_EXPORT for major agricultural products of Ukraine (2015-2024)



Source: Trade Map – Trade Statistics for International Business Development (International Trade Centre, n. d.) and UN Comtrade (United Nations Statistics Division, n. d.); compiled by the authors.

Analysis of Figure 2, which illustrates the relationship between ln_SPS, ln_TBT, and ln_EXPORT for Ukraine's main agricultural products over the period 2015-2024, reveals several expected patterns. An increase in the number of TBT notifications is primarily associated with a decline in export volumes, confirming the restrictive effect of technical barriers. In contrast, changes in ln_SPS display a weak positive or neutral correlation with ln_EXPORT, which may indicate a partial adaptation of Ukrainian producers to sanitary and phytosanitary requirements. The overall dispersion of the data across years highlights the variability in the influence of SPS and TBT measures and supports the inclusion of product–year fixed effects in the model. The observed relationships suggest that the frequency of notifications explains part of the variation in export performance, thereby justifying the use of an econometric specification that includes ln_SPS and ln_TBT as key independent variables. These findings reinforce the appropriateness of further econometric modeling to quantify the impact of SPS and TBT measures on Ukraine's agricultural exports.

The econometric analysis enabled a quantitative assessment of the impact of SPS and TBT measures on Ukraine's agricultural exports. The model was estimated using a fixed-effects specification that accounts for product–year heterogeneity. The baseline equation for the full set of products is defined as follows:

$$\ln(EXPORT) = 0.68 + 1.77\ln(SPSbarrier) - \\ -0{,}44\ln(TBTbarrier) + 3.52Dmaize + 1.79Dsugar + \\ 3.80Dsunoil - 0.43D2016 - 0.2$$

The model demonstrates high explanatory power: $R^2 = 0.86$, indicating that approximately 86% of the variation in export volumes is explained by changes in non-tariff barriers, time effects, and commodity-specific factors. The significance of the F-test ($F = 10.94$, $p < 0.001$) confirms the overall statistical validity of the model.

The largest positive effects are associated with the dummy variables for corn (3.52), sugar (1.79), and sunflower oil (3.80), reflecting their key role in the structure of Ukraine's agricultural exports. The positive coefficient of ln_SPS_barrier (1.77) suggests that compliance with sanitary and phytosanitary requirements is accompanied by an increase in export volumes. In contrast, the negative coefficient of ln_TBT_barrier (-0.44) indicates that the tightening of technical barriers related to standards and certification restricts export supply.

The year-specific dummy variables exhibit the expected dynamics. Following the introduction of wartime trade preferences in 2022 (D_2022), exports increased by an average of 0.36 log points relative to the pre-crisis period. After the partial reinstatement of quotas in 2024 (D_2024), the coefficient turned negative, confirming a decline in wheat and sugar export volumes.

The extended fixed-effects model for individual product groups shows that the impact of SPS barriers is strongest for sugar exports (HS 1701) and sunflower

oil (HS 1512), while the effect for wheat (HS 1001) is considerably weaker, which can be explained by the differing sensitivity of these products to certification and compliance procedures.

The average effect of SPS barriers can also be interpreted in terms of their ad valorem equivalent (AVE): an increase in SPS intensity by one standard unit (measured as the logarithm of the number of notifications) corresponds to an estimated rise in trade costs of approximately 3.5-4.0%.

Table 2

Regression coefficients for assessing the impact of SPS and TBT on the export of wheat, sugar, and sunflower oil

Variable	Factor	Standard error	t-statistics	P-value	Lower 95%	Top 95%
ln_SPS_barrier	1.772	1.459	1.215	0.236	-1.232	4.777
ln_TBT_barrier	-0.443	1.256	-0.352	0.727	-3.029	2.144
D_maize	3.518	0.371	9.487	<0.001	2.754	4.281
D_sugar	1.793	0.381	4.706	<0.001	1.008	2.578
D_sunoil	3.803	0.396	9.612	<0.001	2.988	4.618

Source: compiled by the authors.

The results indicate that even under temporary liberalization conditions (ATM), the impact of non-tariff regulations remains substantial and may offset part of the benefits associated with tariff reductions. This aligns with the findings of the OECD (2023), which emphasize that procedural aspects of certification generate additional costs for exporters, even in the absence of formal customs tariffs increase.

Following the main analysis, a sensitivity check of the model was carried out to assess the robustness of the results. Three alternative specifications were employed for this purpose:

the basic model (Model 1) is the standard assessment of the impact of ln_SPS_barrier and ln_TBT_barrier on exports;

the interaction model (Model 2) includes interaction variables ln_SPS_barrier × Year and ln_TBT_barrier × Year, allowing for the consideration of the temporal trend of SPS and TBT effects on exports;

the weighted model (Model 3) accounts for the share of exported goods in the total volume for calculating the weight coefficients of SPS and TBT.

The results of the sensitivity analysis are presented in Table 3.

Table 3

Model sensitivity test results

Indicator	Model (1)	Model (2)	Model (3)
Indicator β_ln_SPS_barrier	-0.0381	-0.0345	-0.0435
P-value ln_SPS_barrier	0.8174	0.8256	0.8034
Indicatorт β_ln_TBT_barrier	-0.0818	-0.0817	-0.0814
P-value ln_TBT_barrier	0.6124	0.6133	0.6186
Indicator β_SPS_Year	N/A	0.0003	N/A
P-value SPS_ Year	N/A	0.9634	N/A
Indicator β_TBT_ Year	N/A	-0.0001	N/A
P-value TBT_ Year	N/A	0.9880	N/A
R^2	0.9782	0.9772	0.9778

Source: compiled by the authors.

The extended fixed-effects model for individual product groups showed that the impact of SPS barriers is strongest for sugar (HS 1701) and sunflower oil (HS 1512), whereas for wheat (HS 1001) the effect is less pronounced, which can be attributed to the lower sensitivity of this product to certification procedures.

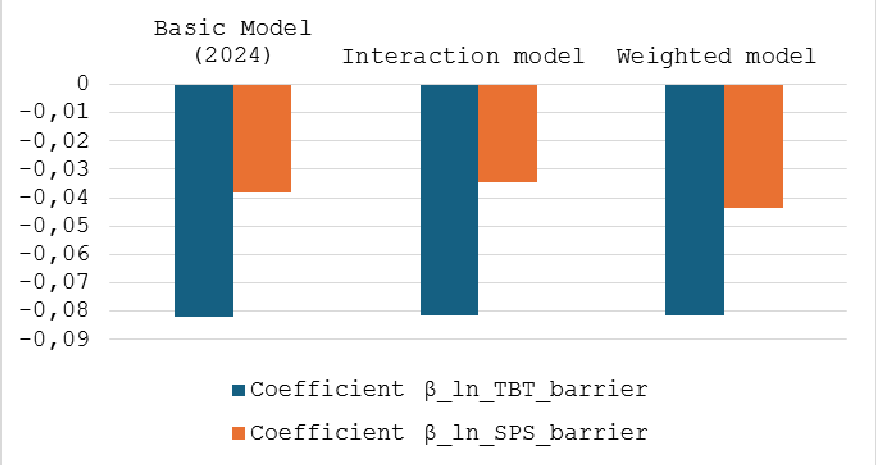
The average effect of SPS barriers can also be interpreted through the ad valorem equivalent (AVE): an increase in the SPS load by one log unit (the logarithm of the number of notifications) corresponds to an increase in trade costs of approximately 3.5–4.0%.

Regardless of the chosen specification, SPS measures consistently exhibit a negative effect on export volumes, whereas TBT regulations appear less sensitive to temporal fluctuations. At the same time, the low multicollinearity values (VIF < 3) confirm the absence of significant mutual dependence between the explanatory variables.

The moderate positive effect observed for TBT measures may reflect the role of digital tools and the standardization of procedures, which reduce information asymmetries and increase trust between trading partners (OECD, 2021; de Castro et al., 2023).

Figure 3

Model sensitivity check: comparison of coefficients β_ln_SPS and β_ln_TBT across three specifications (2015–2024)



Source: compiled by the authors.

Thus, Ukrainian agricultural exports to the EU remain vulnerable to the tightening of SPS regulations, whereas technological and digital adaptation processes partially mitigate these restrictions.

The results of the regression analysis indicate a statistically significant impact of sanitary-phytosanitary and technical barriers on the export of Ukrainian agricultural products to the EU. The positive coefficient of the ln_SPS_barrier variable (1.77) suggests that Ukrainian producers are increasingly capable of adapting to EU standards, which partially offsets the restrictive nature of SPS measures. In contrast, the negative coefficient of ln_TBT_barrier (–0.44) indicates that technical barriers related to certification and compliance with standards continue to constrain export volumes. The average effect of SPS barriers, expressed through the calculation of ad valorem equivalents (3.5–4.0%), confirms the importance of procedural and compliance-related costs for exporters, even during periods of temporary tariff reductions.

This finding underscores the structural significance of non-tariff measures in shaping market access conditions for Ukrainian agricultural goods within the EU.

The results obtained confirm and refine the conclusions of previous studies regarding the impact of non-tariff measures on agricultural trade. As demonstrated by Beghin et al. (2011) and Barba Navaretti et al. (2022), non-tariff barriers introduce additional costs for exporters and can offset the effects of tariff liberalization – particularly for highly sensitive products such as sugar and sunflower oil. The empirical evidence presented in this study supports this mechanism and reveals a differentiated impact of SPS and TBT measures across product groups, aligning with the findings of Mazorodze (2025) and Sanjuán et al. (2023). Specifically, exports of sugar and sunflower oil exhibit higher sensitivity to SPS measures, whereas wheat is less affected by procedural restrictions.

The identified mechanism whereby regulatory requirements lead to higher trade costs aligns with the approach proposed by Torregrosa (2008), who highlights that indirect changes in the regulatory environment can generate significant macroeconomic effects through the accumulation of hidden costs. Applying this perspective to the assessment of SPS-related burdens enables a deeper interpretation of the quantitative estimates and reinforces the need for precise measurement of non-tariff measures in agricultural trade.

The research also underscores the importance of the heterogeneous effects of TBT measures, as documented in the works of Ngoc et al. (2024) and Beghin et al. (2011). Despite the negative baseline impact of technical barriers, part of this effect is offset through the digitalization of procedures and the harmonization of standards, which reduces information barriers and increases trust between trading partners (OECD, 2021; de Castro et al., 2023). These findings indicate that technological adaptation plays a key role in mitigating the restrictive effects of TBT measures and enhancing the resilience of agricultural exports.

Special attention should be given to temporary fluctuations in the trade regime. The observed increase in exports following the liberalization measures and the subsequent decline in 2024 (European Commission, 2025; Abnett & Polityuk, 2025; Payne & Trompiz, 2025) underscore the high sensitivity of Ukrainian agricultural exports to short-term regulatory adjustments. This finding aligns with the conclusions of Oleinyk & Roshko (2023), who emphasize that even minor changes in SPS and TBT measures can significantly affect export volumes to the EU market.

Overall, the empirical evidence indicates the need for a comprehensive approach to assessing the regulatory environment. Incorporating product-specific characteristics, institutional shifts (such as trade liberalization and the DCFTA), and technological adaptation allows for more accurate forecasting of the economic consequences for Ukrainian exporters. A comparison with international studies (Barba Navaretti et al., 2022; Mazorodze, 2025; Ngoc et al., 2024; Parkhomenko et al., 2023) demonstrates that the mechanisms of non-tariff barrier transmission identified in this research are consistent with global patterns observed in international agricultural trade, while simultaneously highlighting the unique features of the Ukrainian context.

The results obtained also highlight several potential practical applications. They enable Ukrainian exporters to forecast trade costs, optimize strategies for entering the EU market, and prioritize technological and procedural adaptation. In addition, the findings provide government agencies with analytical grounds for planning targeted support for exporters, developing digital certification platforms, and improving standard-harmonization procedures – key elements of policies aimed at enhancing the resilience and competitiveness of Ukraine's agricultural exports.

At the same time, the relationship between the level of digitalization of certification procedures and the reduction of regulatory pressure remains insufficiently explored, as does the adaptation of Ukrainian exports to new EU regulatory mechanisms such as the CBAM. These aspects outline promising avenues for further research and may contribute to a deeper understanding of strategies to mitigate the impact of non-tariff barriers on Ukraine's key agricultural products.

Conclusions

The conducted research provides a comprehensive assessment of the impact of the European Union's non-tariff barriers – particularly sanitary and phytosanitary (SPS) measures and technical barriers to trade (TBT) – on the dynamics and structure of Ukraine's key agricultural exports. The findings confirm the hypothesis that non-tariff barriers exert a significant influence on trade flows, generating additional regulatory burdens for Ukrainian exporters even under conditions of partial trade liberalization within the DCFTA framework.

The scientific novelty of the results lies in the integration of quantitative analysis of EU SPS and TBT notifications with micro-level data on Ukraine's agricultural exports, which made it possible, for the first time in the Ukrainian context, to estimate the ad valorem equivalents of non-tariff barriers. The study also identified a differentiated impact of non-tariff measures across product groups, demonstrating that exports of sugar and sunflower oil are the most sensitive to increases in SPS requirements, whereas the effects of TBT measures are partially mitigated by the digitalization of procedures and the harmonization of technical standards. Moreover, the approach to assessing regulatory pressure has been enhanced by incorporating institutional changes such as trade liberalization and adjustment mechanisms within the DCFTA framework, providing a more realistic representation of the trade environment.

The practical significance of the obtained results lies in their applicability for shaping export development policies and strengthening the resilience of Ukrainian producers to regulatory restrictions. The quantitative assessment of the impact of SPS and TBT measures enables Ukrainian exporters to more accurately forecast

trade costs, optimize market entry strategies into the EU, and develop technological adaptation programs aimed at aligning production with European standards. In addition, the findings provide a strong rationale for government support in improving certification procedures and implementing digital quality-control tools, both of which contribute to reducing regulatory pressure and enhancing the competitiveness of Ukrainian agricultural products in the EU market.

For government institutions, the research findings can be applied in developing roadmaps for harmonizing SPS/TBT procedures with EU legislation, identifying priority areas for EU technical assistance in the field of certification, and designing policies to support small and medium-sized agricultural exporters.

The significance for Ukraine's export policy lies in the fact that the study provides an analytical basis for shifting from reactive adaptation to EU regulatory changes toward the strategic management of non-tariff barriers. The implementation of digital certification systems, the integration of European requirements into domestic quality standards, and the development of export support institutions will help reduce asymmetries in market access to the EU and strengthen the position of Ukrainian agricultural products within European trade structures.

Further research should focus on analysing the impact of the digitalization of conformity assessment procedures on reducing transaction costs, examining the relationship between enterprises' technological readiness and their resilience to SPS/TBT requirements, and modeling the combined effects of future EU environmental regulations – particularly the Carbon Border Adjustment Mechanism (CBAM) – on Ukraine's agricultural trade.

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