Trade openness, regional economic growth, and crises in transition countries: The case of Ukraine

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A B S T R A C T
Objective: The article aims to explore the impact of trade openness on the economic development of Ukrainian regions in different conditions, with a particular focus on the global financial crisis (2007-2009) and the 'hybrid' stage of the war (2014-2021).
Research Design & Methods: We analysed the influence of trade openness on economic development, considering exchange rate fluctuation and foreign direct investment (FDI). Based on 21 input variables, we created the composite index of economic development using principal component analysis. To verify the hypothesis about the impact of determinants on economic development, we employed this index as a dependent variable in autoregressive dynamic panel models with error correction terms. We used trade openness, exchange rate, and foreign investment as explanatory factors. The article presents the examination of the effects of the mentioned variables across several regional categories, including coastal vs. non-coastal regions, regions with different levels of urbanisation and trade openness, and regions affected by military occupation.
Findings: The findings reveal that trade openness has a significant positive impact on regional development, with its highest influence in the pre-war period. Economic growth of coastal regions is more sensitive to trade openness and FDI, compared to non-coastal regions. Moreover, regions with a higher level of trade openness experience stronger positive effects of FDI. We identified the increased impact of trade openness and FDI on the economic development of coastal regions during the 2007-2009 crisis. On the other hand, their influence decreases in non-coastal regions, compared to pre-crisis years. Furthermore, FDI has a positive effect on economic performance, particularly in non-occupied regions.
Implications & Recommendations: The article's results are important to better understand the interaction between trade openness and the economic development of Ukrainian regions, especially during the crisis and war periods. The findings indicate that higher trade openness should be achieved to ensure the economic stability of the country's regions. That is why it is necessary to develop a strategy for the expansion and diversification of Ukrainian exports. The received results could help improve target programs that aim to promote the economic development of the country's regions. The findings could also serve trade-oriented businesses to understand regional processes in more detail and to enhance decision-making under war conditions.
Contribution & Value Added: The novelty of the article is threefold: (i) practical analysis of Ukraine that can serve as a benchmark in future research for comparative analysis between this country and other economies; (ii) comparison of the impact of trade openness on economic development of regions under crisis and non-crisis conditions; and (iii) the use of several classifications of the country's regions (*i.e.*, the proximity to the war zone, the sea access, and the urbanisation level) to identify peculiarities of the above-mentioned impact during the 'hybrid' stage of the war.
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INTRODUCTION

The economic literature widely investigates relationships between trade openness and economic development (see, *e.g.*, Luangaram & Wongpunya, 2024; Mao Takongmo & Touré, 2023; Mtar & Belazreg, 2023; Roquez-Diaz & Escot, 2018; Garncarz, 2024; Kulińska, 2024). Simultaneously, in recent decades, we witnessed the increasing impact of crises with global repercussions, *i.e.*, the 2007-2009 financial crisis, the COVID-19 pandemic, the war in Ukraine, *etc*. Therefore, it is necessary to explore how crises influence economic and trade relationships and to propose measures that could help reduce their negative consequences. However, only a limited number of studies examine these relationships during crisis periods (for example, Benita, 2019; Hossain *et al.*, 2022; Olechnicka & Kniazevych, 2025). Our research aimed to fill this gap, considering the effect of the openness of trade on regional development in transition economies like Ukraine. This country, located in Eastern Europe, is well known for its agriculture and industry. However, nowadays, the Ukrainian economy is in a very difficult situation due to Russia's full-scale war against the country.

We aimed to investigate the impact of trade openness on the economic development of Ukrainian regions in different conditions, with a particular focus on the global financial crisis (2007-2009) and the 'hybrid' stage of the war (2014-2021). We explored the effect of trade openness on the regional economic growth from various perspectives. Firstly, the country's regions are divided into specific groups according to:

− The proximity to the war zone: (i) regions occupied by Russia and located in the war zone, (ii) regions that have joint borders with regions occupied by Russia and located in the war zone, and (iii) all remaining regions;
− The sea access: coastal and non-coastal regions;
− The urbanisation level: high, moderate, and low urbanisation level.

Secondly, in addition to the whole research period (2003-2021), we examined the following periods separately:

− 2003-2006 (the period before the global financial crisis);
− 2007-2009 (the period of the global financial crisis);
− 2010-2013 (the period after the global financial crisis, the pre-war period);
− 2014-2021 (the war period).

The novelty of this study is threefold: (i) practical analysis of Ukraine that can serve as a benchmark in future research for comparative analysis between this country and other economies; (ii) comparison of the impact of trade openness on regional economic performance under crisis and non-crisis conditions; and (iii) the use of several classifications of regions (*i.e.*, the proximity to the war zone, the sea access, and the urbanisation level) to determine peculiarities of the above-mentioned impact during the 'hybrid' stage of the war. Besides, no empirical articles have been published on the impact of trade openness on the economic performance of Ukrainian regions so far. Thus, our article can contribute to theory and practice in this research field.

The study results could help improve target programs that aim to promote the economic development of the country's regions. The findings could also be useful for trade-oriented businesses to understand regional processes in more detail and to enhance decision-making under war conditions.

The article is organised as follows. The next section presents the literature review and hypotheses development. The section research methodology describes the data and methodology used in this article. The section results and discussion provides the empirical results. The section conclusions present main findings, policy implications, research limitations, and suggestions for future research directions.

LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

There are many publications devoted to the influence of trade openness on the economic development of different countries. For instance, Huchet-Bourdon *et al.* (2018) estimate the impact of trade

openness on the economic growth of 169 developed and developing economies, based on the system GMM estimator. The findings show that countries that have more open trade and larger exports of quality products demonstrate higher growth. However, trade openness can negatively impact economic growth if exports focus mostly on low-quality products. Thus, a certain level of export quality should be achieved to have the positive influence of trade openness on economic performance. It is also determined that export diversification is an essential feature to have a higher contribution of trade to economic growth. Duernecker *et al.* (2022) assessed the interaction between the openness of trade and economic development, employing data for 204 countries. In this study, they considered trade openness from a broader perspective, considering not just the country's direct trade connections with other economies, but also its second-order and higher-order connections. Adopting the Bayesian model-averaging approach, Duernecker *et al*. (2022) revealed significant positive relationships among the used integration measures and the country's economic growth.

Meanwhile, Dorn *et al.* (2022) investigated how trade openness affects income inequality, using the data for 139 countries. Based on the ordinary least squares and two-stage least squares models, they found that the interaction between trade openness and inequality differs substantially in the analysed countries, depending on the level of their economic performance. In the case of emerging and developing economies, disproportional benefits of trade liberalisation are observed for the relative income shares of the very poor. The positive impact of the openness of trade on inequality is identified in most advanced economies. Besides, a strong positive effect of openness on income inequality is determined in China and transition countries from Central and Eastern Europe. Benarroch and Pandey (2012) consider whether there is a causal relationship between trade openness and government size of 119 high- and low-income countries, employing aggregate and disaggregated government expenditure data. Using the dynamic regression equation, scholars find little or no evidence for the interaction between trade openness and government size. The only exception is a significant, positive nexus between the openness of trade and education expenditures in low-income countries.

Kim *et al.* (2010) analysed the impact of trade openness on the financial development of 88 economies, relying on the pooled mean group method. The findings indicate that while there is a positive relationship between the openness of trade and financial development in the long run, their negative interconnection is identified in the short run. However, when countries are divided into groups depending on their income or inflation levels, the same results exist only in the cases of relatively low-income economies or high-inflation countries. Haddad *et al.* (2013) estimated the effect of trade openness on growth volatility, based on data set of 77 developing and developed economies. Applying the system GMM approach and random effects estimates, as well as export concentration measures, scholars proved that openness has a significant negative impact on the volatility of many countries with diversified exports. Eris and Ulasan (2013) examined the influence of trade openness on the long-term growth of 66 countries with different levels of economic development, employing Bayesian model averaging techniques. Findings show that trade openness is not directly connected with economic growth in the long run. They also determined that economic institutions and macroeconomic uncertainties are the main determinants of the countries' long-run economic growth.

Kim *et al.* (2011) explored the effect of trade openness on the economic performance of 61 developed and developing countries, using the instrumental-variable threshold regressions approach. The researchers argue that openness leads to uneven development of countries. It has a positive effect on the growth of high-income economies. Simultaneously, researchers observe the significant negative impact of trade openness in the case of low-income countries. Moreover, while the positive influence of trade openness on investment, productivity growth, and financial development is determined in high-income countries, the opposite situation is seen in low-income ones. Gonçalves *et al.* (2021) assess whether trade openness functions as a channel of knowledge transmission, which affects productivity growth of 58 countries with different levels of economic development, based on the generalised method of moments. The findings confirm that while trade openness does not have a long-run impact on the productivity growth of countries, it has a temporary positive effect on their total productivity. However, with the sample restricted to a group of 33 high- and middle-income countries, researchers

found a permanent impact of the openness level on productivity. In the case of low-income and emerging countries, the research results were opposite, namely, trade openness had a negative effect on productivity growth, considering their domestic knowledge capital stock.

Nannicini and Billmeier (2011) evaluated the influence of trade openness on economic growth in transition countries. Based on synthetic control methods, they identified that trade liberalisation has a positive effect on the real GDP per capita of the analysed economies. Their study also revealed that trade openness constitutes a key factor of the successful transition process, measured in terms of economic growth. Caporale *et al.* (2023) investigated the short- and long-run impacts of trade openness on the financial development of 35 European countries. Applying the pooled mean group estimator, researchers found different results across the countries depending on the income levels, governance, and efficiency of financial institutions and markets. In the case of the middle-income countries, while trade openness has a positive effect on financial development in the long-run period, its short-run influence is negative. On the contrary, its positive and significant short-run impact is revealed for the high-income countries, which have better financial systems.

Sakyi *et al.* (2015) studied the influence of trade openness on the income levels and growth rates of 115 developing countries, using the panel cointegrated model. The results indicate that there is a positive interconnection between trade openness and income level in the long run. They also confirmed the existence of a short-run nexus between trade openness growth and economic growth of the countries. Gnangnon and Brun (2019) examined the effect of trade openness on tax reform in 95 developing economies, employing the two-step system generalised methods of moments. The findings show that the countries with a higher openness have a larger positive impact of tax reform on tax revenue performance in comparison with countries which have a lower level of trade openness. Kacou *et al.* (2022) explore the interaction among trade openness, export structure, and labour productivity in 61 developing countries. Using the panel vector autoregressive and Granger causality approaches, they revealed the trade-led productivity not in all the analysed economies. It is only significant in the case of countries with higher levels of openness. Lin *et al.* (2014) examined the interaction between trade openness and government size of small developing countries based on the Baltic Dry Index. Using different regression specifications, they identified the positive causal relationship between trade liberalisation and government expenditure. Camarero *et al.* (2016) investigated the influence of trade openness on the level of productivity in 26 economies: 12 Latin American and 14 Asian countries. Using the panel co-integration techniques with structural breaks, they identified that openness has a significantly positive significant impact on the productivity growth in both groups of countries. Simultaneously, the researchers argue that the Asian approach to trade openness is more successful in comparison with the Latin American one. According to their opinion, the main reason for this situation was that the export-promoting industrialisation process in Asian was a better strategy than the trade liberalisation approach in Latin American countries.

Nam *et al.* (2024) studied the relationship between trade openness, institutional quality, and income inequality in the countries of the Association of Southeast Asian Nations (ASIAN), applying the fixed effects, generalised method of moments, and method of moments quantile regression approaches. The empirical results show that the inverted U-shaped interaction exists between the openness of trade and income inequality. In the case of a low level of openness, the growth in trade openness causes higher income inequality. However, when the openness of trade exceeds a certain threshold, we notice a decline in income inequality. Besides, the findings highlight the importance of institutional quality not just to encourage the country's economic growth, but also to have a balanced distribution of its benefits across society. Using the data on the ASIAN member states, Nam *et al.* (2023) compared the effect of trade openness on GDP growth and human development, using different models. They confirmed that, while trade openness has a positive influence on economic growth, it has a negative impact on human development. The researchers also mention the importance of governance and FDI to mitigate the unfavourable effect of openness on human development. Khan *et al.* (2021) estimate the effect of trade openness and inward FDI on the income distribution of five South Asian countries, employing the system GMM regressions. The findings

show that while the growth of trade openness initially worsens the income distribution, an improvement in the standard of living is observed later in the countries.

There are some publications in which scholars investigate the effect of trade openness on economic development at the regional level. For instance, Fujii (2017) explored the interaction among the openness of trade, the government size, and output volatility across Japanese prefectures, applying the lagged cross-sectional regression. The results show that regions with a higher level of trade openness have a smaller size of government. Simultaneously, there is limited evidence on the impact of the government size on the output stabilisation of prefectures. Rivas (2007) evaluated the influence of trade openness on regional inequality in Mexican states, based on the regression equation approach. The findings reveal that the openness of trade decreases inequality in regions with a lower educational level. Simultaneously, Rivas observed the increase in inequality in the case of regions with higher levels of income and infrastructure. Because the latter effect exceeds the former, the overall impact of trade liberalisation is that its growth causes an increase in regional inequality. Özyurt and Daumal (2013) studied the impact of the openness of trade and human capital on per capita income in Brazilian micro-regions, employing the spatial Durbin growth model. The results show that, while the higher openness promotes the region's economic performance, it negatively affects its neighbouring regions. At the same time, human capital positively influences both the region and its neighbours.

Kong *et al.* (2021) examined the relationship between trade openness and economic growth of Chinese provinces, considering the exchange rate fluctuation. Using the autoregressive-distributed lag model and the threshold approach, they determined that this openness has a positive impact on regional economic performance in both short and long terms. The effect of trade openness on the quality of economic development is statistically significant and has regional heterogeneity. Findings also prove that the positive influence of openness on regional economic growth has non-linear threshold characteristics. Li *et al.* (2023) consider how trade openness affects the economic recovery of Chinese regions, paying special attention to the renewable energy sector. Applying panel data approaches, the study identified a substantial positive correlation between trade liberalisation and the province's economic revitalisation. Besides, they found a positive relationship between the openness of trade, innovation, and technological development within the renewable energy industry. Zhao *et al.* (2024) assessed the influence of trade liberalisation and the degree of trade openness on foreign direct investment of Chinese provinces, employing the fixed effect, the variable coefficient, and threshold models. They identified that both trade liberalisation and openness have a significantly positive interaction with FDI. However, the influence of trade liberalisation on FDI is quite heterogeneous across regions. Moreover, Zhao *et al*. (2024) identified the significant threshold effects of the degree of trade openness on the relationship between trade liberalisation and FDI.

To the best of our knowledge, there are no empirical articles about the impact of trade openness on the economic performance of Ukrainian regions. Few articles were published on the effect of trade on the country's regional development in the pre-conflict and conflict periods (for instance, Horská *et al.*, 2019; Horská *et al.,* 2023). Therefore, our study brings novelty and can contribute to theory and practice in this research field.

Research Aim and Hypotheses

We aimed to investigate the impact of trade openness on the economic development of Ukrainian regions in different conditions, with a particular focus on the global financial crisis (2007-2009) and the 'hybrid' stage of the war (2014-2021). Based on the previous empirical studies, including Benita (2019), Horská *et al.* (2019), Horská *et al.* (2023), Hossain *et al.* (2022), and Kong *et al.* (2021), we verified the following research hypotheses:

H1:   The impact of trade openness on economic development varies significantly between coastal and non-coastal regions.

H2:   The 2007-2009 global financial crisis had a varying influence on the regional economic development, namely, coastal regions experienced a more significant decline in economic

performance compared to non-coastal regions due to their higher dependence on trade openness and FDI.

H3: The effect of exchange rate fluctuations on economic growth is more pronounced in regions with a higher level of trade openness.

H4: The relationship between FDI and economic performance is stronger in regions with a higher level of trade openness.

H5: The impact of trade openness, exchange rates, and FDI on economic growth differs substantially between regions occupied by Russia, neighbouring regions, and non-occupied regions.

H6: The economic development of coastal regions is more sensitive to changes in trade openness and FDI compared to non-coastal regions.

RESEARCH METHODOLOGY

The study used the data on 27 Ukrainian administrative regions from 2003 to 2021. The data came from publications and websites of the State Statistics Service of Ukraine (www.ukrstat.gov.ua, db.ukrcensus.gov.ua/MULT/Dialog/statfile_c.asp), as well as the Ministry of Finance of Ukraine (www.mof.gov.ua), National Bank of Ukraine (bank.gov.ua), and Ukrainian National Office for Intellectual Property and Innovations (www.nipo.gov.ua). The data for 2014-2021 is not available for the Autonomous Republic of Crimea and the city of Sevastopol due to Russia's annexation of these administrative regions. For the same period, there is also no data for the occupied parts of Donetsk and Luhansk regions.

To better understand the impact of trade openness on economic development, we divided Ukrainian regions into specific groups. Firstly, considering the proximity to the war zone, we distinguished the following types of regions:

− Regions occupied by Russia and located in the war zone (Autonomous Republic of Crimea, the city of Sevastopol, Donetsk and Luhansk oblasts);
− Regions that have joint borders with regions occupied by Russia and located in the war zone (Dnipropetrovsk, Kharkiv, Kherson, and Zaporizhzhya oblasts);
− All remaining regions.

Secondly, we split regions into two categories, depending on the sea access: coastal and non-coastal regions. The coastal regions included the Autonomous Republic of Crimea, the city of Sevastopol, Donetsk, Kherson, Mykolaiv, Odesa, and Zaporizhzhya oblasts, while all the rest were non-coastal ones.

Thirdly, we divided regions into the following groups, depending on the urbanisation level:

− Regions which have a high urbanisation level (more than 80%);
− Regions that have a moderate urbanisation level (50-80%);
− Regions which have a low urbanisation level (less than 50%).

Description of Variables and Data Sources

To estimate the economic performance of the country's regions, the indicator of economic development is employed, which is based on the review of articles in the literature review and hypotheses development (*e.g.*, Kong *et al.*, 2021; Horská *et al.*, 2023). This indicator includes variables shown in Table 1.

The selected variables relate to the state of the economy, labour market, income, investment, transport infrastructure, sustainability, and innovation. We recalculated the values of variables in Ukrainian hryvnias (UAH) into US dollars (USD), employing information from the National Bank of Ukraine on the annual average official exchange rate between the currencies. We used three explanatory variables in this research: trade openness, exchange rate, and foreign direct investment (Table 2).

Table 1. Variables used to create the composite indicator of economic development

No.	Variable	Explanation and units	Source
1.	Industry's ratio	(Output of industry/Total output)/(Population employed in industry/Total employed population)	State Statistics Service of Ukraine
2.	Profitability of the enterprise's operational activity	%	State Statistics Service of Ukraine
3.	Ratio of agricultural and non-agricultural gross value added	(Gross value added of agriculture/Population employed in agriculture, forestry and fishing)/(Gross value added of non-agricultural sectors/Population employed in non-agricultural sectors), ratio	State Statistics Service of Ukraine
4.	Non-agricultural and informal employment	(Non-agricultural and informal employment)/total employment	State Statistics Service of Ukraine
5.	Gross regional product (GRP) per employed person	Gross regional product/Employed population aged 15-70 (USD)	State Statistics Service of Ukraine
6.	Wages to GRP	Wages/Gross regional product, ratio	State Statistics Service of Ukraine
7.	Unemployment	Unemployed population aged 15-70 years old (according to the International Labour Organisation's methodology), %	State Statistics Service of Ukraine
8.	Expenditure on the purchase of goods and services	Population's expenditure on the purchase of goods and services/Gross regional product, ratio	State Statistics Service of Ukraine
9.	Gini index	Index	State Statistics Service of Ukraine
10.	GRP to fixed assets	Gross regional product/Fixed and intangible assets of enterprises (residual value)	State Statistics Service of Ukraine
11.	Capital investment to GRP	Capital investments/Gross regional product	State Statistics Service of Ukraine
12.	Inward foreign direct investment	Inward foreign direct investment, mln. USD	State Statistics Service of Ukraine, National Bank of Ukraine
13.	Loans	Loans provided by depository corporations (with the exclusion of the National Bank of Ukraine) to the corporate sector and households/Gross regional product, ratio	National Bank of Ukraine, State Statistics Service of Ukraine
14.	Deposits	Deposits of the corporate sector and households (with the exclusion of the National Bank of Ukraine)/Gross regional product, ratio	National Bank of Ukraine, State Statistics Service of Ukraine
15.	Revenues to expenditures	Total budget revenues/total budget expenditures, ratio	Ministry of Finance of Ukraine
16.	Roads	Length of hard surfaced roads of general use, thousands km	State Statistics Service of Ukraine
17.	Rail tracks	Operational length of public rail tracks, km	State Statistics Service of Ukraine
18.	General water drain	General water drain/Gross regional product, ths. cub. m/mln. USD	State Statistics Service of Ukraine
19.	Waste generation	Waste generation (I-III hazard classes)/Gross regional product, t/mln. USD	State Statistics Service of Ukraine
20.	Emissions of pollutants to GRP	Emissions of pollutants/Gross regional product, t/mln. USD	State Statistics Service of Ukraine
21.	Protective documents	Number of protective documents (patents) on inventions (national applicants), units	State Statistics Service of Ukraine, Ukrainian National Office for Intellectual Property and Innovations

Source: own study.

Table 2. Explanatory variables in estimated econometric models

Variable	Explanation	Unit	Source
Trade openness	(Export of goods + import of goods)/Gross regional product	ratio	State Statistics Service of Ukraine
Exchange rate	Official exchange rate of the Ukrainian hryvnia to the US dollar	UAH	National Bank of Ukraine
Foreign direct investment	Inward foreign direct investment/Gross regional product	ratio	State Statistics Service of Ukraine, National Bank of Ukraine

Source: own study.

In addition to the whole research period (2003-2021), we analysed the following periods separately:

− 2003-2006 (the period before the global financial crisis);
− 2007-2009 (the period of the global financial crisis);
− 2010-2013 (the period after the global financial crisis, the pre-war period);
− 2014-2021 (the war period).

Methodological Framework

We created the composite index of economic development of Ukrainian regions using 21 input variables in the principal components analysis. We employed the constructed index as a dependent variable in the panel data modelling procedure. It assumes a causal relationship suggested by Kong *et al.* (2021) in accordance with equation 1.

$$ECO_{it} = f(FDI_{it}, TOP_{it}, EER_{it}) \qquad (1)$$

in which:

Eco_{it} - the composite index of economic development;
FDI_{it} - foreign direct investment;
TOP_{it} - trade openness;
EER_{it} - the exchange rate of UAH to USD;
the i index - regions;
the t index - time.

First, there is an estimated long-term relationship between the variables, following equation 2.

$$lnECO_{it} = \beta_0 + \beta_1 lnFDI_{it} + \beta_2 lnTOP_{it} + \beta_3 lnEER_{it} + u_{it} \qquad (2)$$

in which:

$lnEco_{it}$ - the logarithm of the composite index of economic development;
$lnFDI_{it}$ - the logarithm of foreign direct investment;
$lnTOP_{it}$ - the logarithm of trade openness;
$lnEER_{it}$ - the logarithm of the exchange rate of UAH to USD;
$\beta_0, \beta_1, \beta_2, \beta_3$ - the estimated model parameters;
u_{it} - the random error component.

We investigated the cointegration of relationships using the Fisher type unit root test based on Augmented Dickey-Fuller statistics on residuals u_{it} from the long-term relationship model. This relationship would be confirmed if long-term regression residuals were stationary. The Fisher-type unit root test combines p-values from the panel-specific unit-root tests using the four methods proposed by Choi (2001). Inverse-logit transformations can be employed whether N is finite or infinite. The null hypothesis verified by the Fisher test is that all panels contain a unit root. For a finite number of panels, the alternative is that at least one panel is stationary.

We estimated the short-term dynamic of the relationship among variables using the *ARDL (p1, p2, p3, p4)* error correction model in the form of equation 3. Moreover, we determined maximum lag

orders according to the AIC value and obtained model parameters based on the Arrellano-Bond dynamic panel data estimation method.

$$\Delta lnECO_{it} = \gamma_0 \ \sum_{j=1}^{p1} \Delta lnECO_{i,t-j} + \gamma_1 \ \sum_{j=0}^{p2} \Delta lnFDI_{i,t-j} + \gamma_2 \ \sum_{j=0}^{p3} \Delta lnTOP_{i,t-j} +$$
$$\gamma_3 \sum_{j=0}^{p4} \Delta lnEER_{i,t-j} + \delta ECM_{i,t-1} + \mu_{it}$$

(3)

in which:

Δ - the first-order difference;

$ECM_{i,t-1}$ - the error correction term;

$\gamma_0, \gamma_1, \gamma_2, \gamma_3$ - estimated model parameters;

j - the lag order;

p_1, p_2, p_3, p_4 - the maximum lag order;

δ - the coefficient of the error correction term, which measures the speed of adjustment to the long-run relationship;

μ_{it} - the random error component.

Equation 4 presents the threshold model on the impact of different levels of trade openness, according to the definition by Hansen (1999). The considered values for trade openness were 0.5 and 1.

$$lnECO_{it} = \alpha_0 + \alpha_1 lnFDI_{it} + \alpha_2 lnEER_{it} + \alpha_3 lnTOP_{it}.I(TOP < \varphi)$$
$$+ \alpha_4 lnTOP_{it}.I(TOP \geq \varphi) + \varepsilon_{it}$$

(4)

In which:

TOP - the threshold of the trade openness variable;

φ - the threshold value;

ε_{it} - the random error component.

RESULTS AND DISCUSSION

Figure 1 shows the relationship between the economic performance and trade openness of Ukrainian regions. It confirms that regions with larger trade openness tend to have higher economic development.
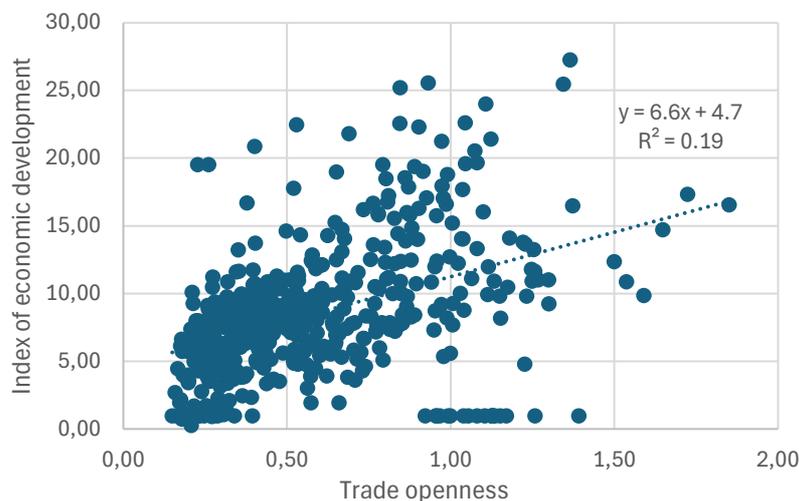

Figure 1. Relationship between trade openness and the index of economic development
Source: own elaboration.

The function may have been biased by some observations with extremely low values of economic performance, but there was still clearly a significant positive interaction. Figure 2 presents the relationship between economic development and foreign direct investment. In comparison to Figure 1, this interaction is weaker. On the one hand, many regions could have a low level of economic development, despite higher FDI. On the other hand, there are some regions with a higher level of economic performance, in spite of a smaller FDI inflow.
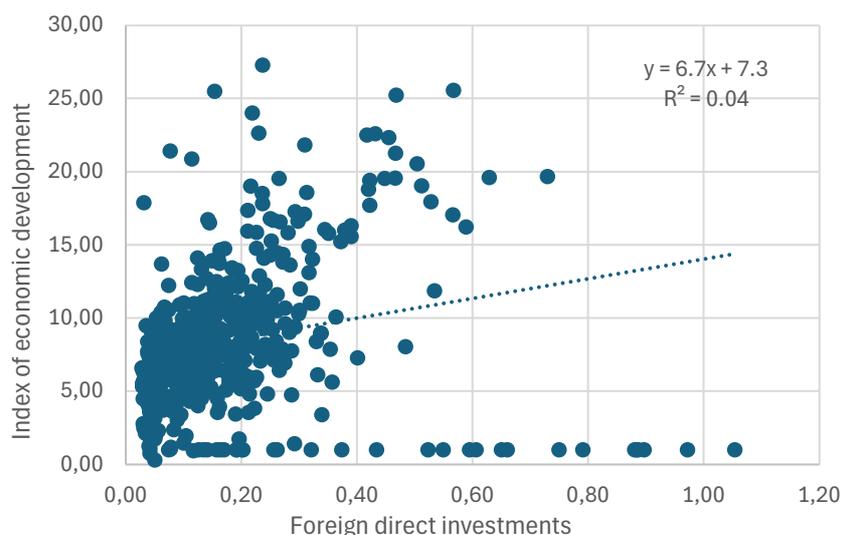
Figure 2. Relationship between foreign direct investments and the index of economic development
Source: own elaboration.

To estimate the economic performance of Ukrainian regions, we constructed the composite index based on 21 input variables as indicators of sustainable economic development (Table 1). We used this index as a proxy variable of economic performance and applied it as a dependent variable in further econometric modelling. We analysed the relationship between the region's economic development and three explanatory factors: the exchange rate, trade openness, and FDI. We employed all variables in the form of the natural logarithm, utilising the data for Ukraine's regions in the period 2003-2021. We examined the interaction between variables from different perspectives, using autoregressive dynamic panel models with the error correction term.

Long-term Relationship Between Variables

Firstly, we explored the overall long-term relationship between the variables. Table 3 provides the econometric model, which analyses this relationship for all regions during the research period. We can consider it as an average interaction between the levels of variables. Despite the smaller R-squared value (0.43), the model was significant with the F value equal to $1.41.10^{-56}$. All presented variables had a substantial impact on the region's economic performance. We determined the highest influence in the case of trade openness with the coefficient value of 0.46, *i.e.*, the 1% change in trade openness led to an average change in economic growth of 0.46%. We found the smaller effect in the case of FDI (0.23%) and, among the three analysed variables, the lowest impact in the case of the exchange rate (0.13%).

Table 3. Long-term relationship between the variables: The overall period

Variable	Coefficient	Standard error	t-stat	p-value	Significance
const	2.55	0.12	21.11	1.07E-69	***
LnEEr	0.13	0.03	3.99	7.68E-05	***
LnTOP	0.46	0.04	10.57	1.55E-23	***
LnFDI	0.23	0.04	6.445	2.91E-10	***

Source: own study.

However, due to the non-stationary nature of most economic variables, we could consider this model as a spurious regression. Moreover, we examined the significance of the long-term relationship using the cointegration test. Hence, we investigated the stationarity of residuals from the previous model, applying the panel Fisher-type unit root test based on Augmented Dickey-Fuller statistics. The mentioned stationarity meant the validation of the stable long-term relationship between economic

development and explanatory factors, which one could use as evidence of cointegration among the variables. Table 4 provides the cointegration test results.

Table 4. Cointegration test results

Indicator	Statistics	p-value
Inverse chi-squared(50) P	173.1732	0.0000
Inverse normal Z	-8.5894	0.0000
Inverse logit t(129) L*	-9.2882	0.0000
Modified inv. Chi-squared Pm	12.73	0.0000

Source: own study.

All p-values suggest the rejection of a unit root in residuals from the panel model presented in Table 3. This confirms that residuals were stationary, and a stable long-term relationship exists between the economic development and explanatory factors in Ukrainian regions in 2003-2021. The model in Table 3 assesses the interaction among the levels of the investigated variables. We could consider it as a long-term equilibrium, whose existence is also proved by employing the cointegration test.

Short-term Relationship Between Variables

To analyse a short-term relationship among indicators, we evaluated a nexus between differenced variables. The results in Table 5 include the model, which estimates the short-term interaction between the analysed variables. We dynamised this model using the lagged value of the dependent variable as the explanatory factor and lagged residuals from the long-term model as the error correction term.

Table 5. Short-term relationship between the variables: The overall period

Variable	Coefficient	Standard error	t-stat	p-value	95% confidence interval	
d_LnECO$_{(t-1)}$	0.112***	0.039	2.74	0.005	0.035	0.191
d_LnEEr	-0.297***	0.093	-3.19	0.001	-0.480	-0.114
d_LnTOP	0.788***	0.090	4.03	0.000	0.610	0.965
d_LnFDI	0.366***	0.055	5.03	0.000	0.258	0.473
ECM$_{t-1}$	-0.894***	0.052	-17.21	0.000	-0.996	-0.792

Source: own study.

We obtained the model parameters by applying the Arrellano-Bond dynamic panel data estimation. The Wald chisq=482.52 and the corresponding p-value of 0.000 confirmed the significance of this relationship. The model assesses the interaction between differenced variables and compares it with the long-term estimation. It has two additional variables: the lagged values of the economic development indicator dECO$_{(t-1)}$ and the error correction term (ECM), which are residuals from the long-term relationship lagged by one period. Similar to the long-term assessment, the interaction was estimated as the average for all regions and years.

The model results prove that the region's development level in the previous year significantly influenced the economic performance. The analysis of explanatory factors reveals that trade openness (0.79) had the highest positive effect on the regional economic performance, followed by FDI (0.37). In contrast to the results of the long-term model, we found a negative value in the case of the exchange rate. We could explain it by the substantial increase in the exchange rate over the analysed period due to events which have an adverse influence on the country's economic growth. This implies the existence of a negative relationship between the difference values of the economic development indicator and the exchange rate.

The last explanatory factor included in the model was the error correction term. Its significance confirmed the evidence of the long-term equilibrium between the variables, as suggested by the cointegration test results in Table 4. The estimated value of the error correction term measures the speed of the recovery of the long-term equilibrium in the case of its interruption. Based on the results in Table 5, we found a significant relationship between economic development and exchange rate, as

well as foreign direct investment and trade openness. The model also proves the existence of a significant long-term interaction among these variables.

Period-specific Analysis

Many events have had a large impact on the economic situation of Ukraine since 2003. Hence, we conducted the analysis also separately for main periods related to the most significant events: (i) 2003-2006 – the period before the global financial crisis, (ii) 2007-2009 – the period of the global financial crisis, (iii) 2010-2013 – the period after the global financial crisis, the pre-war period, and (iv) 2014-2021 – the war period. These events may have had a substantially different impact on regions depending on their characteristics. Table 6 presents the estimated models for the mentioned periods. The influence of trade openness varied over time, with the highest effect on economic development in the pre-war period. However, we found the smallest impact of trade openness on the region's economic performance during the war period. We noticed a similar situation in the case of FDI. While the largest impact of the indicator on the economic state of regions was in the pre-war period, its lowest influence was in the war period. The significance of the error correction term in the whole period provides evidence of the stable long-term relationship between the variables.

Table 6. Models estimated for different periods

Variable	Pre-crisis period	Crisis period	Pre-war period	War period	Overall period
d_LnECO$_{(t-1)}$	0.0126	0.139	-0.025	0.179**	0.160***
d_LnEEr	0.062	-0.355	-0.47	-0.381***	-0.28***
d_LnTOP	0.699***	0.515***	1.024***	0.488***	0.818***
d_LnFDI	0.304***	0.418***	0.518***	0.392***	0.332***
d_LnEEr(t-1)	-0.103	0.249	0.137	0.112	-0.077
d_LnTOP(t-1)	0.207	0.177	-0.436	0.095	0.183*
d_LnFDI(t-1)	-0.019	-0.025	0.062	-0.029	0.011
ECM$_{t-1}$	-0.809***	-0.6***	-0.569***	-0.812***	-1.088***
Const	0.145***	-0.0145	0.0562	0.046*	0.067***
Wald chisq	90.71***	67.73***	61.1***	197.89***	598.84***

Source: own study.

Further, we divided the regions into different groups. Firstly, we explored the war's impact on the analysed relationship separately for occupied regions, neighbours to occupied regions, and non-occupied regions during the war period. Secondly, we examined the interaction between variables, considering whether regions had sea access or not. We investigated it for coastal and non-coastal regions in all periods. The last considered factor was the urbanisation level. We performed the analysis for regions with the high, moderate, and low urbanisation levels during the mentioned periods.

Table 7 shows the relationship between the economic development and explanatory variables of regions divided according to military occupation in the pre-war and war periods. In this case, the autoregressive dynamic panel model also includes all explanatory variables lagged by one period. The obtained results prove that explanatory variables had different effects on economic development depending on the type of region. In occupied regions, trade openness and FDI significantly influenced economic performance during the pre-war period.

We observed the most significant impact in the case of foreign direct investment lagging by one period. However, in the war period, the interaction among the variables changed. The results show that only FDI still had a significant effect, but we saw its decrease from 1.18 to 0.52. Notably, the economic development of occupied regions and their relationship with other influencing variables did not follow any traditional assumptions. On the other hand, the models on the regions neighbouring with occupied oblasts, as well as non-occupied ones, confirmed a more significant relationship between the investigated variables. In the case of neighbours of occupied oblasts, the peculiarity is that trade openness and FDI had a significant negative impact on the region's economic performance. This could be

caused by anticipation of the conflict in the pre-war period, and, as a result, these regions have a spe-cific economic situation. During the war period, the findings differ substantially from the results of the previous period, and they are more in line with economic theory. While trade openness and FDI had a positive effect, the increasing exchange rate had a significant negative impact on the economic devel-opment of regions in this period.

Table 7. Model's results for regions categorised according to military occupation in the pre-war and war periods

Variable	Occupied regions		Neighbours to occupied regions		Non-occupied regions	
	pre-war period	war period	pre-war period	war period	pre-war period	war period
dLnEco(t-1)	-0.539*	-0.014	-0.262***	0.278	0.212***	0.228***
dLnEEr	-3.319	-0.199	0.918***	-0.541***	-0.278	-0.296
dLnTOP	0.898*	0.264	-1.319***	0.717***	0.788***	0.561***
dLnFDI	1.179*	0.517***	-0.903***	0.297***	0.258**	0.413***
dLnEEr(t-1)	-2.56*	-0.184	2.203***	-0.417*	-0.243	0.028
dLnTOP(t-1)	-0.748	-0.478*	-1.11***	0.275	-0.055	0.102
d_LnFDI(t-1)	1.588***	-0.067	-1.375***	-0.154	0.162	0.032
ECM	0.515	-1.017***	-0.415***	-1.225***	-1.427***	-1.094***
const	0.808	0.046	-0.393**	0.0765	0.099	0.0335
Wald Chi2	40.97***	1410.35***	437.26***	1893.84***	53.53***	487.09***

Source: own study.

In non-occupied regions, the findings were more consistent in both periods and corresponded to the expectations according to economic theory. The influence of the exchange rate was not substantial in these regions, but both trade openness and FDI had a strong impact on the region's economic per-formance. Compared to the pre-war period, the effect of trade openness declined slightly in the war period, but at the same time, the impact of FDI increased to a substantial extent. Based on the com-parison of results during the war period, we can conclude that, on the one hand, the economic devel-opment of neighbours of occupied regions was more influenced by trade openness, while, on the other hand, the economic performance of non-occupied regions was more affected by FDI. Besides, the co-efficient values of the error correction term in estimated models suggest that the equilibrium relation-ship between examined variables is restored quicker in non-occupied regions in the pre-war period. However, during the war period, we identified the faster recovery of the long-term equilibrium in ob-lasts, which are neighbours to occupied regions, compared to occupied ones.

Coastal and non-coastal Regions

We conducted a similar analysis for regions with sea access, *i.e.*, coastal and non-coastal oblasts. We estimated the relationship between the region's economic development and its influencing factors in the pre-crisis, crisis, pre-war, and war periods and, for comparison purposes, in the overall research period too. Table 8 presents the findings for coastal regions, which are in accordance with expecta-tions. During the pre-crisis period, trade openness and its lagged value, as well as the lagged values of the exchange rate and FDI, had a significant effect on the economic performance of regions. We also identified that the influence of trade openness increases during times of crisis. Simultaneously, other variables become insignificant. Moreover, the sign of lagged foreign direct investment contrasts with expectations, and the interaction between this investment and the region's economic development does not follow usual patterns during the crisis period.

The interesting finding is that the effect of trade openness is the highest in the crisis time, but FDI has the highest impact on the economic development of coastal regions during the pre-war period. Another interesting result is that the crisis time determines the fastest recovery of the long-run equilibrium relationship between variables. On the other hand, the regional economic perfor-mance is not influenced by its previous level in the crisis and war periods because the lagged value of dLnEco(t-1) is not significant.

Table 8. Model's estimations for coastal regions

Variable	Pre-crisis period	Crisis period	Pre-war period	War period	Overall period
dLnEco(t-1)	-0.512***	0.219*	0.0281**	-0.085	0.016
dLnEEr	-0.039	-0.457	-0.085	-0.443**	-0.098
dLnTOP	0.538***	0.930***	0.789***	0.603***	0.795***
dLnFDI	0.0323	0.115	1.301***	0.371***	0.294***
dLnEEr(t-1)	0.516***	0.216	0.367	-0.269	0.101
dLnTOP(t-1)	0.927***	0.353	-1.301***	0.106	0.198
d_LnFDI(t-1)	0.136*	-0.650***	0.827***	0.087	0.0216
ECM	-0.876***	-1.756***	-0.907***	-0.754***	-0.945***
const	0.132***	0.007	0.101	0.117**	0.084**
Wald Chi2	215.22***	28.06***	106235***	981.14***	547.48***

Source: own study.

Table 9 shows similar results for non-coastal regions. The influence of FDI was stable during the overall research period, and its coefficients varied between 0.4 and 0.5. Besides, the impact of trade openness was significant in all analysed periods. While we identified its highest effect on the economic development of non-coastal regions in the pre-war period, we saw the substantially lower impact of this variable during the war period. Interestingly, in the case of non-coastal regions, we observed the fastest recovery of the long-run relationship among the variables in the pre-war period.

Table 9. Model's estimations for non-coastal regions

Variable	Pre-crisis period	Crisis period	Pre-war period	War period	Overall period
dLnEco(t-1)	0.018	0.155*	0.063	0.231***	0.107
dLnEEr	-0.101	-0.749	-0.674***	-0.314	-0.335**
dLnTOP	0.613**	0.326***	0.916***	0.484***	0.638***
dLnFDI	0.504***	0.404***	0.492***	0.405***	0.355***
dLnEEr(t-1)	-0.344*	0.156	-0.792**	0.144	-0.054
dLnTOP(t-1)	0.099	0.222*	0.055	0.172*	0.107
d_LnFDI(t-1)	0.128	0.027	0.295***	-0.019	0.069
ECM	-0.871***	-0.734***	-1.367***	-1.091***	-1.229***
const	0.178***	-0.061	0.0254	0.016	0.040
Wald Chi2	147.38***	21.26***	469.86***	2423.89***	1052.76***

Source: own study.

Urbanisation Levels

We estimated the same models for Ukrainian regions, depending on the urbanisation level. We used the following intervals for this indicator in the study: the high urbanisation level – more than 80%, the moderate urbanisation level – 50-80%, and the low urbanisation level – less than 50%. Table 10 includes results for regions with a high urbanisation level, *i.e.*, urban areas. We identified the largest impact of trade openness in the pre-war period, and the effect of FDI was the highest in this period, too. During the war period, the influence of FDI on the development of regions with a high urbanisation level was much smaller, and the impact of trade openness was insignificant. Simultaneously, in this period, we observed the quickest restoration of the long-run equilibrium between variables, measured by the estimated coefficient for ECM. The effect of the exchange rate on the region's development was also significant in all periods, except the war period.

Table 11 provides the results for regions with a moderate urbanisation level. The economic performance of these regions is mostly affected by trade openness, and we found the highest impact of this variable in the pre-war period. The influence of trade openness was substantially lower during the crisis and war periods. On the other hand, FDI had the largest impact during the war period. While we saw the fastest restoration of the long-run relationship between variables in the pre-war period, we observed its slowest recovery during the war period. The effect of FDI was lower in this case compared

to regions with a high urbanisation level, and its largest impact was determined in the crisis and pre-war periods.

Table 10. Model's results for regions with a high urbanisation level

Variable	Pre-crisis period	Crisis period	Pre-war period	War period	Overall period
dLnEco(t-1)	-0.38	-0.395	0.047	0.119	0.134
dLnEEr	-0.1456	0.083	-1.537*	-0.786	-0.464
dLnTOP	-0.474	0.0455***	1.173***	0.321	0.733**
dLnFDI	-0.628	0.213	1.013**	0.234**	0.239**
dLnEEr(t-1)	1.939***	1.461***	-2.49***	0.125	-0.237
dLnTOP(t-1)	-1.456*	-0.056	-1.263*	0.109	-0.434*
d_LnFDI(t-1)	-1.066***	-0.512***	0.392	-0.274***	-0.193
ECM	-1.037**	-0.542*	-0.851*	-1.242***	-1.323***
const	-0.239	-0.145***	0.151	0.048	-0.001
Wald Chi2	905.23***	6.6	39.62***	593.48***	240.47***

Source: own study.

Table 11. Model's results for regions with a moderate urbanisation level

Variable	Pre-crisis period	Crisis period	Pre-war period	War period	Overall period
dLnEco(t-1)	0.172*	0.298	0.189***	0.01	0.100
dLnEEr	0.256*	-0.557**	-0.189	-0.407	-0.253*
dLnTOP	0.826***	0.648***	1.14***	0.71***	0.767***
dLnFDI	0.248***	0.371***	0.236	0.409***	0.329***
dLnEEr(t-1)	-0.154	0.629***	0.009	-0.07	-0.169*
dLnTOP(t-1)	0.331***	0.336***	0.272	0.18	0.243**
d_LnFDI(t-1)	-0.075	-0.138*	0.305	0.129*	0.079
ECM	-1.212***	-1.101***	-1.377***	-0.808***	-1.239***
const	0.195***	-0.062	0.154*	0.071	0.099*
Wald Chi2	964.07***	78.23***	851.81***	725***	567.19***

Source: own study.

Table 12 includes results for regions with a low urbanisation level, *i.e.*, rural areas. Interestingly, the effect of trade openness, exchange rate, and FDI on the region's development was not significant in the pre-crisis and crisis periods. On the other hand, trade openness had a substantial impact on these regions during the pre-war and war periods. Moreover, FDI also significantly affected the economic performance of rural regions in these two periods. The current level of the region's development substantially depends on its previous performance, mainly in the pre-war period. Another interesting discovery is that the fastest restoration of the equilibrium relationship among variables was in rural areas compared to regions with moderate and high levels of urbanisation. We observed the quickest recovery of the long-run relationship between the region's economic development and its influencing factors during the crisis period.

We also examined regions considering the degree of trade openness. According to its value, we divided trade openness into three intervals: the low level (smaller than 0.5), the average level (between 0.5 and 1.0), and the high level (higher than 1.0). Table 13 shows threshold effects for the mentioned levels of the variable in different periods. The model's results show the highest impact of trade openness change in regions with its average level. The findings also confirmed that the largest effect of trade openness was in the pre-crisis period. During the crisis and war periods, we saw a similar influence of the variable's change in regions with small trade openness. In regions with average trade openness, its effect is slightly larger in the war period, compared to the crisis period. The interesting finding is that the change in trade openness in regions with its high level did not have any significant impact on economic development during all periods. We found the most significant effect of trade openness in the case of regions with the variable's low and average levels during the pre-war period.

Table 12. Model's results for regions with a low urbanisation level

Variable	Pre-crisis period	Crisis period	Pre-war period	War period	Overall period
dLnEco(t-1)	-0.346	0.205	0.376***	0.277	0.194**
dLnEEr	-0.215	0.733	-0.392	-0.898	-0.032
dLnTOP	0.103	2.112	1.46***	0.440**	0.595***
dLnFDI	0.312	-0.158	0.465**	0.327***	0.384***
dLnEEr(t-1)	0.667*	0.043	0.168	0.309	0.085
dLnTOP(t-1)	0.213	-0.044	-0.085	0.107	0.126
d_LnFDI(t-1))	-0.087	0.013	-0.139	-0.248**	0.047
ECM	-0.468	-2.076***	-1.277***	-1.517***	-1.328***
const	0.060	-0.237	-0.072	-0.016***	0.006
Wald Chi2	138.58***	103.32***	79.52***	4332.54***	751.44***

Source: own study.

Table 13. Results of threshold effects models

Variable	Pre-crisis period	Crisis period	Pre-war period	War period	Overall period
LnECO(t-1)	0.44	0.14	-0.10	0.16**	0.15***
LnEEr	-12.41***	-0.35	1.37	0.16***	0.08**
LnFDI	0.42	0.49*	0.02	0.22***	0.19***
TopSmall	1.14	0.56*	0.80***	0.55***	0.46***
TopMedium	1.47*	0.45	0.85***	0.57**	0.56***
TopHigh	1.93	1.19	0.47	0.74	0.10
_cons	23.08***	3.94***	0.11	2.12***	2.30***
Wald Chisq	11.48**	7.89	61.02***	71.77***	177.06***

Source: own study.

Furthermore, Table 14 presents the estimated models for the subsample of regions with low, average, and high trade openness. It shows that FDI and the exchange rate had the highest impact on the economic performance of regions with a high level of trade openness. The influence of the exchange rate was not significant in regions with the average and low levels of the variable, and, in this case, the effect of FDI was smaller too.

Table 14. Subsample results for high, average, and low levels of trade openness

Variable	High	Medium	Small
LnECO(t-1)	0.26*	0.02	0.14**
LnEEr	0.15*	-0.05	0.06
LnFDI	0.32**	0.25***	0.20**
_cons	2.04***	2.76***	1.88***
Wald Chisq	19.58***	16.6***	21.65***

Source: own study.

The results indicate that coastal regions benefited more from trade openness compared with non-coastal regions, which supports the research hypothesis about the different impact of trade openness on the economic development of coastal and non-coastal regions. The influence of trade openness was more pronounced in coastal regions, particularly during the pre-war and crisis periods, suggesting that the sea access enhances the positive effects of trade openness on the region's economic development. The findings indicate that coastal regions benefit significantly from trade openness and FDI, underscoring the importance of the geographic location in shaping economic outcomes. We also confirmed the hypothesis about the different impact of the 2007-2009 global financial crisis on the regional economic development (namely, coastal regions experience a more significant decline in eco-

nomic performance compared to non-coastal regions due to their higher dependence on trade openness and FDI). On the other hand, we also accepted the hypothesis about a stronger relationship between FDI and economic development in regions with a higher level of trade openness.

The research results provide partial support for the hypothesis about the significant interaction between exchange rate fluctuations and economic development, particularly in regions with a higher level of trade openness. The findings also partially confirm the hypothesis about a higher sensitivity of the economic development of coastal regions to changes in FDI and trade openness. The only exception is the pre-war period, when coastal regions were highly sensitive to changes in foreign direct investments.

We also accepted the hypothesis about the various impacts of trade openness, exchange rates, and FDI across different regional categories (occupied, non-occupied and neighbouring). Occupied regions exhibited unique patterns, *i.e.*, trade openness and FDI had different effects compared to non-occupied regions. Neighbouring regions also showed distinct interactions, particularly during the war period.

Our findings support the results of some other studies on this topic. For instance, Benita (2019) investigated the interaction between trade openness and GDP per capita of 15 Latin American countries before, during, and after the 2007-2009 global financial crisis. Benita tested measures of trade openness and identified mixed outcomes. If one analyses only Latin American countries, a slightly positive nexus between trade openness and economic growth is found. Hossain *et al.* (2022) investigated the impact of trade openness and FDI on the economic growth of 30 Asian countries, considering 1997-1998 and 2008-2009 financial shocks. The results confirmed that trade openness and FDI have positive effects on the economic development of countries in the long run. Ali and Imai (2015) identified similar research results in their study regarding the influence of various crises and trade openness on the economic development of African countries. They determined that while there is an association of crises with the economic decline of countries, trade openness encourages their economic growth. Moreover, the researchers conclude that the openness of trade could mitigate the negative effects of crises, but this is possible when a certain level of trade openness is achieved.

Simultaneously, our findings differ from the conclusions of Nam and Ryu (2024). They argue that excessive trade openness could have a negative influence on economic growth, using data on ten Asian countries. Besides, our results are somewhat different from the findings of Musila and Yiheyis (2015). Their study revealed that while trade openness has a positive impact on the economic growth of Kenya, its effect is statistically insignificant.

CONCLUSIONS

This study provides a rigorous analysis of the impact of trade openness, exchange rate fluctuation, and foreign direct investment on the economic development of Ukrainian regions over the 2003-2021 period. The empirical results demonstrate that trade openness exerts a significant positive influence on regional economic performance, particularly during the pre-war period. Coastal regions and regions with a higher level of trade openness exhibit the most substantial benefits. Moreover, FDI is also identified as a critical driver of economic development, with its effects being more pronounced in non-coastal and non-occupied regions.

Conversely, we found that exchange rate fluctuations have a detrimental short-term impact on economic performance, reflecting the adverse events experienced by Ukraine during the research period. The analysis further revealed significant heterogeneity across different regional categories on the effect of these variables, including coastal versus non-coastal regions, regions with varying levels of urbanisation, and regions affected by military occupation. Coastal regions and regions with higher trade openness experience stronger positive effects of FDI and trade openness, while non-coastal regions exhibit a more stable influence of FDI.

The findings indicate that coastal regions benefit more from trade openness compared with non-coastal regions, which supports our research hypothesis. The impact of trade openness was more pronounced in coastal regions, particularly during the pre-war and crisis periods, suggesting that the sea

access enhances the positive effects of trade openness on regional economic development. The findings indicate that coastal regions benefit significantly from trade openness and FDI, underscoring the importance of the geographic location in shaping economic outcomes.

During the crisis period, coastal regions, which are more integrated into international trade and attract higher FDI levels, face greater economic challenges. In contrast, non-coastal regions, which are less dependent on international trade and FDI, exhibit more resilience during the financial crisis. The economic performance of these regions is less affected by the decline in global trade and investment, resulting in a relatively stable economic environment compared to their coastal counterparts.

The different impact of the financial crisis on Ukrainian regions underscores the importance of regional characteristics in shaping economic outcomes. Coastal regions, with their higher exposure to global economic fluctuations, are more vulnerable to external shocks, while non-coastal regions benefit from a more insulated economic structure. These findings highlight the need for tailored economic policies that consider regional disparities and aim to enhance the resilience of regions to global economic shocks.

The novelty of our article is threefold: (i) practical analysis of Ukraine that can serve as a benchmark in future research for comparative analysis between this country and other economies; (ii) comparison of the impact of trade openness on economic development of regions under crisis and non-crisis conditions; and (iii) the use of several classifications of the country's regions (*i.e.*, the proximity to the war zone, the sea access, and the urbanisation level) to identify peculiarities of the above-mentioned impact during the 'hybrid' stage of the war.

This article can contribute to theory and practice in this research field. The article's results are important to better understand the interaction between trade openness and the economic development of Ukrainian regions, especially during the crisis and war periods. The findings indicate that higher trade openness supports the economic stability of the country's regions. Therefore, it is necessary to develop a strategy for the expansion and diversification of Ukrainian exports.

The obtained results could help improve target programs that aim to promote the economic development of the country's regions. The findings could also be useful for trade-oriented businesses to understand regional processes in more detail and to enhance decision-making under war conditions.

There are some limitations of our study. Firstly, we did not investigate the influence of trade openness on demographic changes. Secondly, we did not consider the relationship between trade openness and foreign direct investment by origin and sector. Future research could explore the effect of trade openness on human capital allocation and export diversification.

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Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.