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Forecasting of macroeconomic stability post-pandemic recovery: The case of European countries

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Abstract. The unfolding of the COVID-19 pandemic has revealed "bottlenecks" not only in the healthcare system, which was unable to cope with a significant influx of patients and quickly eliminate the spread of coronavirus infection, but also the vulnerability of the socioeconomic systems of countries all over the world. The research aims to determine country-specific trend patterns of volatility of the integral level of macroeconomic stability and its components and forecast their values for the medium term to determine the dynamics of post-pandemic recovery. The implementation of the research objectives involves the implementation of the following steps: 1) determining outliers in data series that characterise the dynamics of the components of macroeconomic stability in the context of each of the 10 studied countries; 2) eliminating outliers; 3) determining

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the highest-quality functional form of the dependence of the change in the corresponding individual macroeconomic indicator over time; 4) forecasting the change in individual indicators and the integral level of macroeconomic stability for the medium term (2023-2025); 5) determining the deviations of the forecast values of the above indicators from their pre-pandemic level (2019) and end-of-pandemic level (2022); 6) qualitative interpretation of the forecasting results.

Keywords: macroeconomic stability, economic growth, unemployment, inflation, coronavirus disease, COVID-19, European countries.

JEL Classification: C32, C53, E17, F62, O11

1. INTRODUCTION

The unfolding of the COVID-19 pandemic revealed the "bottlenecks" not only of the healthcare system, which was unable to cope with a significant influx of patients and quickly level the spread of coronavirus infection but also the vulnerability of the socioeconomic systems of the countries all over the world. According to expert assessments, the world economy's economic losses after the pandemic were among the largest in the last few decades. In particular, during the first year of the pandemic, global GDP decreased by almost 7%, while the unemployment rate at the beginning of 2021 reached almost 225 million people (the last time such a critically high level of the macroeconomic indicator was recorded in 1990) (Statista, 2023). Thus, the economic consequences of the pandemic for some countries were even more devastating than those caused by the global financial crisis. Understanding the course of crisis processes and the response of macroeconomic indicators due to destructive processes lies in clarifying the country-specific trend patterns of the volatility of these indicators (both in terms of individual macroeconomic indicators and the integral level of macroeconomic stability). The revealed patterns will allow us to assess the level of determinism of the variation of macroeconomic indicators caused by internal impulses and predict the levels of the studied parameters in the medium term. Generalisation of actual and forecast levels of macroeconomic indicators will allow us to formalise the dynamics of the European countries' post-pandemic recovery of economic systems. All the above-mentioned factors determine this study's relevance, goal, and objectives.

2. LITERATURE REVIEW

Many scientific publications have been devoted to studying the impact of the coronavirus pandemic on macroeconomic parameters, a significant part of which is focused on assessing the economic effects for the state (Yoon, 2023; Richardson, 2024; Firstová & Vysochyna, 2024; Vasilyeva and al., 2019; Vasilyeva and al., 2022; Kuzior and al., 2022; Kuzmenko et al., 2020) and business (Bensadok & Abid, 2023; Iwu, Sibanda, Makwara, 2023; Ahmed & Akaak, 2024; Akhtar et al., 2024; Kaya & Engkuchik, 2024). Thus, Yoon (2023) examined the consequences of the pandemic on economic growth in South Korea. The scientist notes that the main blow to the country's economy fell in 2020, manifested in a significant reduction in the pace of economic dynamics. However, the country's government took stimulating measures to restore it (developed by the Korean New Deal policy, additional budget funds were allocated for economic recovery). However, these measures only allowed to contain a significant deterioration in economic stability, not to prevent economic potential loss. A more extended period and comprehensive supporting state interventions and budget investments will be needed for a complete post-pandemic recovery of the country's economy. Among the macroeconomic indicators that have been significantly affected by the coronavirus pandemic, trade openness is also highlighted (Němečková, Hayat, 2022; Tvaronavičienė et al., 2024; Kubatko et al.,

2024). At the same time, researchers note that stimulating the openness of trade relations in developing countries not only carries the threat of rapid dissemination of shocks but also contributes to improving the quality of domestic institutions. In particular, scientists have empirically confirmed a positive relationship between net foreign direct investment inflows and government stability.

Akinyemi (2024), Knapińska & Woźniak-Jasińska (2024), Grencikova et al. (2022), Kuzior et al. (2020) studied the impact of the pandemic on the state of the labour market. Scientists note that the COVID-19 pandemic has been a heavy blow to labour market outcomes and simultaneously served as a trigger for reviewing state policies of countries worldwide to eliminate the pandemic's negative impact on this sector. In the context of overcoming the consequences of the pandemic, governments of countries tested various strategies aimed at targeted budget financing to reduce disparities in the labour market, restore the pre-pandemic level of employment of the population and eliminate wage disparities. The researchers also note that for the OECD countries, the destructive impact of the pandemic on the labour market was more devastating than during the global financial crisis, which also required immediate and effective management decisions. The results of the empirical study showed that for the OECD countries, the following patterns are fair: increased government spending on labour market interventions contributes to improving labour market outcomes; a more significant number and density of the trade union network contributes to adequate protection of the rights of employees and decent wages.

Scientists also note (Aliu et al ., 2024; Nugroho, 2024; Čermák, Ligocká, 2022; Tchoketch-Kebir & Madouri, 2024; Niftiyev, Kheyirkhabarli, 2024) that among the economic indicators that have suffered the most significant destructive impact due to the COVID-19 pandemic, price stability and the exchange rate can be distinguished. Researchers emphasise the intensification of transmission effects when price and currency volatility in one country destabilises the economic situation in trading partner countries. In addition, researchers note that price and currency stability are affected not only by public health damages but also by geopolitical turbulences. The deterioration of the situation in the money market was also facilitated by the spread of destructive processes to other segments of the financial market, in particular, the stock market (Issam et al., 2024; Zohaib & Ismail, 2024; Dobrovolska & Fenenko, 2024).

Some groups of researchers have also focused on identifying relationships between the level of economic growth, unemployment rate and inflation during the pandemic periods and within post-pandemic recovery (Mahfoudh et al., 2024; Zhuchenko et al., 2023). The modelling results from data from countries such as Tunisia, Egypt, and Saudi Arabia, in particular, found no long-term equilibrium between unemployment and economic growth. At the same time, moderate inflation can drive economic growth. Investigating the experience of Poland in terms of the mutual conditionality of economic growth and structural shifts in the labour market for the period 2008–2022, the researcher (Cyrek, 2024) found that the dynamics of economic growth determine structural changes in the country's economy, and not vice versa.

To eliminate the adverse economic effects of the pandemic, many countries around the world have allocated additional budget funding for the implementation of relevant state interventions (Alyaseri et al., 2024; Lima, 2024; Pozovna, Haluszko, Polishchuk, 2023; Lyeonov et al., 2021). However, the excessive growth of public spending has sometimes been accompanied by an increase in public debt, which in the long term may have negative economic consequences for the country's economic sustainability (Gherghina et al., 2024). Khang et al. (2024) also note the positive impact of increased government spending to ensure macroeconomic stability in conditions of global turbulence, such as the COVID-19 pandemic. However, as in the previous work, careful planning of this type of government intervention is emphasised since the increase in government spending must be coordinated with the change in the size of the public debt. Therefore, excessive expenditure on public funds can, on the contrary, provoke a deterioration in macroeconomic indicators due to increased debt pressure.

It is also worth noting that the effectiveness of the post-pandemic recovery of macroeconomic stability was influenced not only by the successful steps of governments around the world, increased funding and state support for the most problematic segments but also by the pre-pandemic efficiency of the public administration system. In particular, researchers note that countries with a higher level of shadow economy are less effective in absorbing the negative economic consequences of the pandemic (Bozhenko et al., 2024; Tiutiunyk et al., 2022). Another group of scholars emphasises the importance of budget transparency and good governance in countering global turbulence and building public trust in government interventions (Raluca et al., 2024). In addition, there is empirical evidence that economies with higher levels of digitalisation have proven to be more effective in absorbing economic shocks caused by the pandemic (Li, 2024; Suhanyi, Gavura, Suhanyiova, 2024; Chao, Di, 2024; Kiseľáková et al., 2024; Aden Dirir, 2023; Dluhopolskyi et al., 2023). Thus, a study of the experience of Slovenia (Murko, Babšek, Aristovnik, 2024) and Romania (Androniceanu, 2024) in introducing artificial intelligence technologies to help improve the efficiency of public administration during the pandemic showed that the implementation of these technologies contributed to the improvement of administrative efficiency, cost-effectiveness, and service quality (Yarovenko et al., 2024; Hadouga, 2023). Scholars (Abbas & Hassouni, A. 2024; Asad, Popesko, Damborský, 2024; Kliuchnikava, 2022) also note that more innovation-driven economic systems demonstrate faster rates of post-pandemic recovery of macroeconomic stability and its components. Digital innovation technologies played a significant role in the post-pandemic recovery of the tourism sector (Lewicki, Florek, 2024; Bilan, Tovmasyan, Dallakyan, 2024; Choirisa, 2022; Lincényi, Bulanda, 2023; Nicolae, Grigore, Muşetescu, 2023; Shaon et al., 2024). In addition, researchers (Noguera-Méndez, Molera, Semitiel-García, 2024) note that the effectiveness of management decisions and the public's loyalty to a positive perception of state interventions is determined by the level of education of the population on these issues. That is why reforming educational programs taking into account the goals of sustainable development is an important task and one of the indirect tools for improving the quality of response to global turbulence in the future.

Thus, the scientific literature reflects theoretical and empirical research on identifying the impact of the COVID-19 pandemic on both the overall level of macroeconomic stability and its components. However, additional study is required to determine the prerequisites for the post-pandemic recovery of macroeconomic indicators, predict their speed, and develop a roadmap of recommendations to accelerate these processes.

3. METHODOLOGY

The study aims to determine country-specific trend patterns of volatility of the integral level of macroeconomic stability and its components and forecast their values for the medium term to determine the dynamics of post-pandemic recovery. Thus, to implement the task of forecasting the volatility of the level of macroeconomic stability for the medium term, it is necessary to implement the following procedures:

1) detection of outliers (abnormally high or low values of the indicator that can worsen the predictive properties of the functional dependence of the trend) in the context of time series that characterise the dynamics of individual indicators of measuring the integral level of macroeconomic stability using graphical and analytical methods using the Stata 14.2/SE software product. Within the framework of the analytical approach (using the "egen std (exp)" command), new variables are created that characterise the standardised values of the corresponding indicators. If the calculated value exceeds the value "2", then such a value is anomalous and may be an outlier. The analytical method is confirmed by the graphical method,

within which a box plot is constructed, and points (observations) that deviate significantly from the rest of the values are marked;

2) elimination of outliers – for indicators located in the middle of the observation range, the outlier value is replaced by the arithmetic mean of two neighbouring values, and for outlier values located at the beginning or end of the observation range, the value is replaced by a value similar to the value of the previous period;
3) normalisation of the values of individual indicators for assessing the level of macroeconomic stability to ensure their comparability using Savage normalisation and natural normalisation with a preliminary division of indicators into stimulating and inhibiting indicators;
4) determining the functional form of the dependence for a data series by constructing trend lines using MS Excel; selecting the most acceptable and reliable variant of the functional dependence of variables taking into account the values of the coefficient of determination; verification of the reliability of the selected functional form of dependence using ex-post forecasting;
5) forecasting the values of individual indicator levels (GDP growth rates, unemployment rate, inflation rate, trade volume and current account balance);
6) formation of an integral level of macroeconomic stability according to the methodology described in the previous paper (Vysochyna et al., 2024), as well as forecasting the integrated level of macroeconomic stability considering the predicted values of individual indicators.

The construction of forecast levels for both the components of macroeconomic stability and its integral level for 2023-2025 will allow us to identify the scale of losses in macroeconomic stability caused by the pandemic and calculate the approximate terms of restoring pre-COVID dynamics for each country. An in-depth analysis of the actual values and the obtained forecast calculations will allow us to formalise the determinants and tools of post-pandemic recovery specific to each country. It will allow us to identify future macroeconomic stability resistance triggers to similar threats.

This approach was tested in practice on 10 post-socialist European countries: the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Moldova, Poland, Romania, the Slovak Republic, and Ukraine. The observation period was 2000-2022.

The research was implemented based on statistical data generated from the World Bank Group's World Development Indicators collection (World Bank DataBank, 2024).

4. EMPIRICAL RESULTS AND DISCUSSION

4.1. Identification and elimination of outliers among the values of individual macroeconomic stability indicators

Thus, previous studies (Vysochyna et al ., 2024) determined that the level of macroeconomic stability (*Macro*) can best be characterised through the prism of the five most frequently used economic indicators, such as GDP growth (annual %) (*GDPg*); unemployment rate (% of the total labour force) (according to the methodology of the International Labor Organization) (*Unempl*); inflation rate (%) (*CPI*); trade volume (% of GDP) (*Trade*); current account balance (% of GDP) (*CAB*). Summary statistics on these variables for the 10 studied countries are presented in Table 1.

Table 1

Summary statistics in terms of components of macroeconomic stability

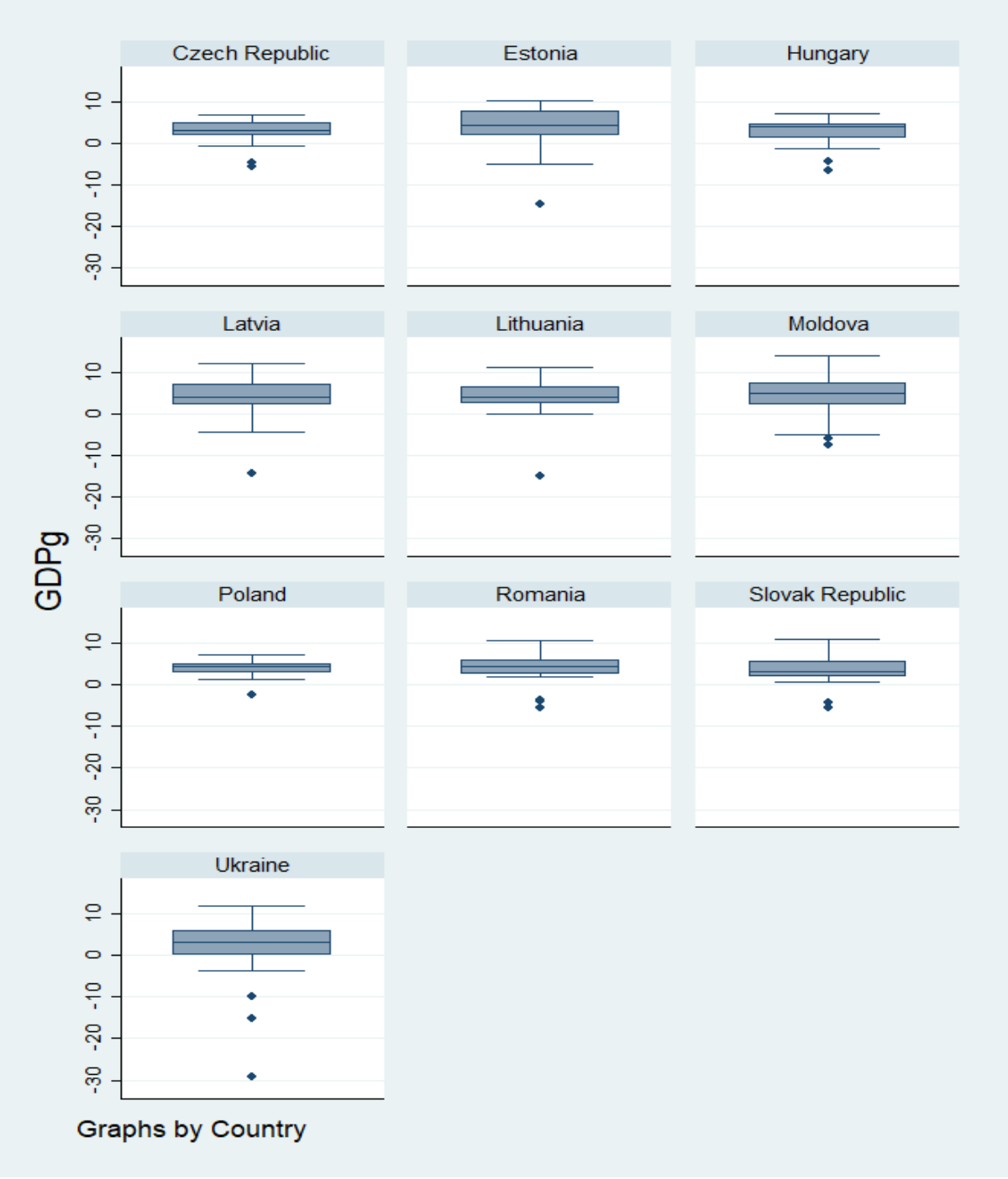
Variable	Obs	Mean	Std. Dev.	Min	Max
GDPg	230	3.199	5.011	-29.1	13.94
Unempl	230	8.522	4.015	.91	19.89
CPI	230	5.828	6.931	.03	48.7
CAB	230	-3.66	4.995	-20.96	10.28
Trade	230	119,413	33,786	48.52	204.12

Source: Authors' calculations in Stata 14.2/SE software (Stata, 2024) based on World Bank Data (World Bank DataBank, 2024)

As can be seen from the data presented in Table 1, there is a fairly significant gap between the minimum, average, and maximum values of individual indicators, which highly likely indicates the existence of outliers.

Box plots were constructed to determine the specific values of individual macroeconomic stability indicators for each country of the sample. In particular, the graph for the variable "GDPg" is presented in Figure 1, while similar graphs for the remaining components of macroeconomic stability are given in Appendix A. The dots on the graphs indicate potential outliers. To confirm the anomalous values, the command "egen std(exp)" was used in the Stata 14.2/SE software. Summarising the results of analytical and graphical methods, 14 outliers were identified in the "*GDPg*" variable, 5 outliers – in the "*Unempl*" indicator, 15 outliers – in the "*CPI* " variable, 7 outliers – in the "*CAB*" variable and 3 outliers – in the "*Trade* " variable. Notably, most anomalous values fell at the beginning (2020) or end (2022) of the coronavirus pandemic and in the last year of the global financial crisis – 2009. For some observation series, anomalous values were also recorded at the beginning of the observation period in 2000. It is also worth noting that 2015 was also a turning point for Ukraine, in which the inflation rate was anomalous.

In the next step, all outliers were eliminated using one of two approaches – replacing the outlier in the series with the arithmetic mean of the sum of its two neighbouring values (for outliers within the range) or replacing the outlier with a value similar to its neighbour (for outliers at the beginning or end of the observation range).



Graph 1. Box graph of gross domestic product growth rate for 10 European countries in 2000-2022

Source: Authors' calculations in Stata 14.2/SE software (Stata, 2024) based on World Bank Data (World Bank DataBank, 2024)

4.2. Bringing the values of individual indicators to a comparable form for assessing the level of macroeconomic stability

At the next stage, bringing the indicators to a comparable form is necessary to integrate individual indicators into the macroeconomic stability index. The indicators were normalised using natural

normalisation and Savage normalisation, the approach to using which is described in more detail in previous work (Vysochyna et al., 2024). At the same time, the consumer price index and the unemployment rate suppress the dynamics of macroeconomic stability, while GDP growth, trade openness and the current account balance positively affect the integrated level of macroeconomic stability. It is worth noting that Savage normalisation is applied to the first block of macroeconomic indicators, and natural normalisation is applied to the second block of individual indicators.

4.3. Forecasting the values of the components and the integral level of macroeconomic stability

Numerous economic research argued that the volatility of the above-mentioned macroeconomic indicators results from the cumulative impact of different socio-economic indicators, which triggers a shift in the value of the macroeconomic indicators within both explicit and latent channels. Nevertheless, within this research, we aim to clarify the dynamics of macroeconomic stability post-pandemic recovery with consideration of just internally conditional impetus. The focus of the empirical study on internal conditionality helps not only to understand the weight of individual indicators' contribution to the post-pandemic recovery of macroeconomic stability but also to point out those components that are more sensitive to the external impact together with macroeconomic indicators, which are quite resilient to it. Analysis of actual and forecasted values of individual indicators and integral macroeconomic stability index allow underlining country-specific components that trigger macroeconomic fragility.

Within this research stage, different functional forms of the trend lines (linear, logarithmic, polynomial, power, exponential) for each macroeconomic indicator were preliminarily constructed. It used country-specific data for 2000-2022 to identify the best-fitted functional form of the trend line. In order to fulfil this task, we consider the coefficient of determination value. It is commonly considered that the model is reliable if the coefficient of determination is close to 1 (or at least higher than 0.7). Table 2 demonstrates values of the coefficient of determination (R^2) for different functions of the GDPg trend lines. The same results for the remaining variables are presented in Appendix B.

Table 2

Values of coefficients of determination for different functional forms of trend lines for "GDPg" variable for 10 European countries

Country	Linear	Logarithmic	Polynomial(2)	Polynomial(3)	Power	Exponential
Czech Republic	0.0413	0.034	0.0554	0.1007	n/a	n/a
Estonia	0.2082	0.2463	0.2539	0.2623	n/a	n/a
Hungary	0.0406	0.0005	0.5478	0.5496	n/a	n/a
Latvia	0.1851	0.1765	0.2263	0.2438	n/a	n/a
Lithuania	0.3081	0.2069	0.3105	0.3062	n/a	n/a
Moldova	0.0065	0.0048	0.0133	0.0113	n/a	n/a
Poland	0.0814	0.0622	0.1071	0.4655	0.0663	0.0873
Romania	0.0458	0.0242	0.0471	0.0962	n/a	n/a
Slovak Republic	0.1717	0.0341	0.2626	0.551	0.0237	0.147
Ukraine	0.1558	0.1901	0.283	0.243	n/a	n/a

Source: Authors' calculations in MS Excel based on World Bank Data (World Bank DataBank, 2024)

Notes: n/a – some functional forms of trend lines are not applicable if data have "0" or negative values; the highest values of R^2 are shadowed

The preliminary stage of identifying the functional form of macroeconomic indicators' trend line demonstrates that some equations are unreliable as they explain only up to 10% of the variation. In order to find more appropriate functions, in some cases it is additionally tested not only quadratic and cubic polynomial functions but also polynomials, of degree up to 5. Table 3 shows generalised macroeconomic indicators' trend functions with the highest value of R^2.

Table 3

Results of determining the functional form of the trend line dependence in terms of the components of macroeconomic stability

Variable	**Equation**	**R^2**
	Czech Republic	
GDPg	$y = -0{,}0006x^4 + 0{,}0316x^3 - 0{,}524x^2 + 3{,}0393x - 0{,}5973$	0.419
Unempl	$y = -0.0101x^2 - 0.0463x + 8.046$	0.7977
CPI	$y = 0.0015x^3 - 0.0376x^2 + 0.1474x + 2.8864$	0.2094
CAB	$y = -0.0047x^3 + 0.1501x^2 - 0.9423x - 3.1756$	0.7307
Trade	$y = -0.179x^2 + 6.882x + 81.649$	0.8445
	Estonia	
GDPg	$y = -0.0017x^3 + 0.0817x^2 - 1.3956x + 11.137$	0.2623
Unempl	$y = -2.311\ln(x) + 13.625$	0.3796
CPI	$y = 0.0037x^3 - 0.1278x^2 + 1.0942x + 2.0984$	0.2022
CAB	$y = -0.0129x^3 + 0.4407x^2 - 3.3709x - 3.2138$	0.7133
Trade	$y = -0.0774x^2 + 3.5319x + 116.13$	0.5173
	Hungary	
GDPg	$y = 0.0358x^2 - 0.7996x + 6.2631$	0.5478
Unempl	$y = 0.0005x^3 - 0.0632x^2 + 1.1326x + 3.3811$	0.632
CPI	$y = 0.0023x^3 - 0.0535x^2 - 0.1126x + 8.1573$	0.5957
CAB	$y = -0.0412x^2 + 1.4873x - 12.691$	0.6696
Trade	$y = -0.1085x^2 + 4.8281x + 115.07$	0.7259
	Latvia	
GDPg	$y = 0.0234x^2 - 0.8555x + 9.7983$	0.2263
Unempl	$y = -0.0206x^2 + 0.2439x + 11.793$	0.2817
CPI	$y = 0.0069x^3 - 0.2539x^2 + 2.4298x - 1.0319$	0.5333
CAB	$y = -0.0111x^3 + 0.3914x^2 - 3.3058x - 1.0058$	0.4916
Trade	$y = -0.0753x^2 + 4.1225x + 73.562$	0.8086
	Lithuania	
GDPg	$y = 0.0034x^2 - 0.3102x + 7.7927$	0.3105
Unempl	$y = 15.963x^{-0.233}$	0.272
CPI	$y = 0.0053x^3 - 0.2029x^2 + 2.1802x - 2.9418$	0.3072
CAB	$y = -0.0098x^3 + 0.3554x^2 - 3.0049x - 1.0746$	0.5702
Trade	$y = -0.1414x^2 + 6.329x + 79.722$	0.782
	Moldova	
GDPg	$y = -0{,}0013x^4 + 0{,}0639x^3 - 0{,}9917x^2 + 5{,}3354x - 1{,}753$	0.4684
Unempl	$y = 8.3675e^{-0.035x}$	0.7031
CPI	$y = 0.0039x^3 - 0.1428x^2 + 1.108x + 8.1203$	0.4162
CAB	$y = -0.0079x^3 + 0.2985x^2 - 3.262x + 1.5197$	0.3117
Trade	$y = 0.0444x^3 - 1.531x^2 + 11.378x + 113.12$	0.8676
	Poland	
GDPg	$y = 0{,}0024x^3 - 0{,}0815x^2 + 0{,}7758x + 1{,}9725$	0.4655
Unempl	$y = 0.0141x^2 - 1.1266x + 21.006$	0.8617
CPI	$y = 0.03x^2 - 0.7886x + 6.7671$	0.3588

Variable	Equation	R^2
CAB	$y = -0.003x^3 + 0.1216x^2 - 1.1866x - 1.8758$	0.5975
Trade	$y = 2.651x + 55.546$	0.9656
	Romania	
GDPg	$y = -0{,}0007x^4 + 0{,}0383x^3 - 0{,}6622x^2 + 4{,}0425x - 1{,}1713$	0.4767
Unempl	$y = 0.0006x^3 - 0.0263x^2 + 0.232x + 6.6968$	0.6297
CPI	$y = 0.0009x^3 + 0.0791x^2 - 3.075x + 26.857$	0.8951
CAB	$y = -0.012x^3 + 0.4199x^2 - 3.8452x + 1.4994$	0.6876
Trade	$y = -0.0492x^2 + 3.1056x + 44.192$	0.9149
	Slovak Republic	
GDPg	$y = 0.0049x^3 - 0.1921x^2 + 1.9796x + 0.1071$	0.551
Unempl	$y = -0.596x + 19.573$	0.8163
CPI	$y = 0.0279x^2 - 0.8978x + 8.8082$	0.624
CAB	$y = -0.0074x^3 + 0.255x^2 - 2.1812x - 0.7472$	0.485
Trade	$y = -0.1218x^2 + 6.2978x + 110.66$	0.8542
	Ukraine	
GDPg	$y = 0.058x^2 - 1.7719x + 12.608$	0.283
Unempl	$y = -0.0033x^3 + 0.1377x^2 - 1.6485x + 13.328$	0.7277
CPI	$y = 0{,}0002x^3 + 0{,}0369x^2 - 1{,}0481x + 16{,}265$	0.456
CAB	$y = 0.0021x^3 + 0.0024x^2 - 1.3307x + 8.028$	0.5284
Trade	$y = -0.0174x^3 + 0.5708x^2 - 5.1918x + 108.89$	0.4097

Source: Authors' calculations in MS Excel based on World Bank Data (World Bank DataBank, 2024)

According to the results presented in Table 3, it can be noted that the most reliable predictive models (with the highest value of the coefficient of determination) are characteristic of the indicator "Trade", which indicates a high internal conditionality of the variation of this indicator. In contrast, "GDPg" has the lowest forecasting quality, which indicates a high influence of external factors on the variation of the level of the specified macroeconomic indicator.Using the functional dependencies presented in Table 3, the series levels for each macroeconomic stability component were forecasted for 2023-2025 for each of the 10 European countries. The forecast period is due to the lack of actual observations of these indicators after 2022. The forecast results are presented in Table 3. In order to check the reliability of the functions of macroeconomic indicators' trend lines, it is used ex post forecasting approach. It is realised forecast for three trend lines with the highest values of coefficient of determination. For each of them, it is calculated such statistical indicators as mean squared error, coefficient of determination, mean absolute deviation, mean absolute percent error. Based on the comparison of the above-mentioned statistical indicators together with actual-to-predicted value deviation, it was concluded that trend lines presented in Table 3 are fitted the best for this data.

Analysing the forecast results presented in Table 4, it can be noted that for most of the sample countries, a decrease in economic growth rates in 2022 compared to 2019 is revealed, which confirms the negative impact of the pandemic on economic dynamics in the studied European countries. The exceptions are Latvia, Poland, Romania and Ukraine, for which GDP growth demonstrates for this period insignificant positive dynamics.. It is fair to note that according to the forecast, by the end of 2025, economic dynamics in most of the studied countries will recover to the pre-pandemic level and, in some cases, will significantly exceed it. However, restoring pre-pandemic economic growth rates will take 2-3 years more for countries such as Estonia and Lithuania.

Table 4

Actual (2019-2022) and forecast values (2023-2025) of macroeconomic stability components for 10 European countries

Variable	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**Δ 2022/ 2019**	**Δ 2025/ 2022**	**Δ 2025/ 2019**
Czech Republic										
GDPg	3.03	3.19	3.34	2.35	8.29	7.26	5.42	-22.40	130.39	78.79
Unempl	2.01	2.55	2.89	2.22	1.12	0.58	0.4	10.45	- 81.98	- 80.10
CPI	2.85	3.16	3.84	3.84	5.46	6.46	7.61	34.83	98.21	167.26
CAB	0.36	2.02	-0.81	-5.98	-4.31	-6.36	-8.82	-1780.33	47.49	-2578.38
Trade	141.80	135.15	142.11	151.92	143.71	141.82	139.58	7.14	-8.13	-1.57
Estonia										
GDPg	4.10	-2.95	8.35	-1.29	0.10	-0.50	-1.20	-131.43	-6.43	-129.41
Unempl	4.45	6.80	6.33	5.57	6.28	6.19	6.10	25.17	9.44	36.98
CPI	2.28	0.44	4.65	4.65	5.90	7.39	9.19	104.33	97.41	303.38
CAB	2.52	-0.46	-1.25	-3.23	-8.60	-13.61	-19.67	-228.04	508.98	-879.76
Trade	143.94	141.87	160.79	171.57	156.31	156.05	155.64	19.20	-9.29	8.13
Hungary										
GDPg	4.55	5.83	7.10	4.55	7.69	8.65	9.67	0.01	112.41	112.43
Unempl	3.42	4.25	4.12	3.61	5.27	5.14	5.02	5.56	38.98	46.71
CPI	3.34	3.33	5.11	5.11	6.43	7.84	9.49	53.09	85.65	184.21
CAB	-0.66	-1.00	-2.88	-8.03	-0.73	-1.26	-1.87	1107.66	-76.68	181.60
Trade	161.24	155.94	161.91	186.72	168.45	163.13	167.25	15.81	-10.43	3.73
Latvia										
GDPg	2.48	-3.77	4.48	3.36	2.74	3.04	3.37	35.19	0.45	35.80
Unempl	6.31	8.10	7.60	6.81	5.78	5.02	4.21	7.92	-38.20	-33.30
CPI	2.81	0.22	3.28	3.28	6.42	8.84	11.78	16.52	259.63	319.04
CAB	-0.67	2.92	-2.92	-4.73	-8.35	-12.46	-17.46	611.28	269.10	2525.32
Trade	120.38	119.70	130.22	130.22	129.13	129.56	129.84	8.17	-0.29	7.86
Lithuania										
GDPg	4.57	-0.13	5.00	2.44	2.31	2.16	2.03	-46.65	-16.98	-55.71
Unempl	6.26	8.49	7.90	5.96	7.61	7.54	7.47	-4.79	25.37	19.36
CPI	2.33	1.20	4.68	4.68	5.78	7.56	9.74	100.62	107.87	317.04
CAB	3.46	7.36	1.43	-5.46	-3.96	-7.20	-11.20	-257.56	105.13	-423.20
Trade	149.37	137.72	136.09	175.70	150.17	149.57	148.69	17.63	-15.37	-0.45
Moldova										
GDPg	3.68	8.81	13.94	-5.02	7.12	2.44	-4.38	-236.16	-12.59	-219.03
Unempl	5.10	3.82	3.96	3.96	3.61	3.49	3.37	-22.31	-14.99	-33.96
CPI	4.84	3.77	5.11	5.11	6.37	7.51	8.94	5.55	75.11	84.83
CAB	-9.29	-7.53	-11.62	-11.62	-14.04	-16.91	-20.36	25.19	75.12	119.24
Trade	85.90	77.07	88.61	110.73	118.12	134.45	154.37	28.91	39.40	79.70
Poland										
GDPg	4.74	5.24	5.73	5.26	6.83	7.93	9.23	10.86	75.50	94.56
Unempl	3.28	3.16	3.37	2.89	2.09	1.65	1.25	-11.89	-56.89	-62.01
CPI	2.23	3.37	5.06	5.06	5.12	5.80	6.54	126.94	29.45	193.76
CAB	0.47	-0.05	-0.58	-2.43	-1.78	-2.42	-3.25	-611.75	34.10	-786.24
Trade	106.04	105.58	117.62	123.93	119.17	121.82	124.47	16.88	0.43	17.39
Romania										
GDPg	4.19	-3.75	5.88	4.60	11.64	11.02	9.56	9.72	108.13	128.35
Unempl	4.61	5.03	5.17	5.61	5.41	5.43	5.50	21.69	-2.04	19.21
CPI	3.83	2.63	5.05	13.80	11.06	13.48	16.20	260.40	17.41	323.14

Variable	2019	2020	2021	2022	2023	2024	2025	Δ 2022/ 2019	Δ 2025/ 2022	Δ 2025/ 2019
CAB	-4.88	-5.02	-6.95	-9.09	-13.95	-18.45	-23.84	86.37	162.29	388.85
Trade	84.89	78.64	87.36	92.82	90.39	91.08	91.68	9.34	-1.23	8.00
Slovak Republic										
GDPg	2.61	2.81	3.02	1.75	4.71	6.10	7.84	-32.81	347.86	200.90
Unempl	5.75	6.69	6.74	6.14	5.27	4.67	4.08	6.78	-33.60	-29.10
CPI	2.66	1.94	3.15	3.15	3.33	3.80	4.33	18.20	37.34	62.35
CAB	-3.35	0.44	-1.93	-7.32	-8.51	-11.53	-15.14	118.22	106.83	351.33
Trade	184.13	169.95	188.36	204.12	191.65	191.98	192.07	10.86	-5.91	4.31
Ukraine										
GDPg	3.20	-3.75	3.40	3.40	3.49	4.56	5.75	6.27	69.02	79.61
Unempl	8.19	9.13	8.88	8.53	7.46	6.62	5.55	4.17	-34.93	-32.22
CPI	7.89	2.73	13.87	20.18	15.13	16.25	17.47	155.92	-13.42	121.56
CAB	-2.68	3.36	-1.32	4.97	7.12	7.94	8.76	-285.33	76.27	-426.69
Trade	90.51	79.16	82.62	87.71	72.53	63.97	53.94	-3.10	-38.50	-40.40

Source: Authors' calculations in MS Excel based on World Bank Data (World Bank DataBank, 2024)

Summarising the results of forecasting changes in the unemployment rate in the studied countries by 2025, it can be noted that the employment problems triggered by the pandemic will not be resolved in some sample countries by the end of 2025. At the same time, a decrease in the unemployment rate is predicted in such countries as the Czech Republic, Latvia, Moldova, Poland, Slovakia, and Ukraine.

The most extensive destructive impact of the pandemic among macroeconomic indicators was recorded on the inflation rate, since in all 10 European countries, by the end of 2025, an increase in the price level is forecast compared to a similar indicator in 2019, i.e. the goal of ensuring price stability should be the highest priority in the context of macroeconomic stabilisation within the framework of the post-pandemic recovery.

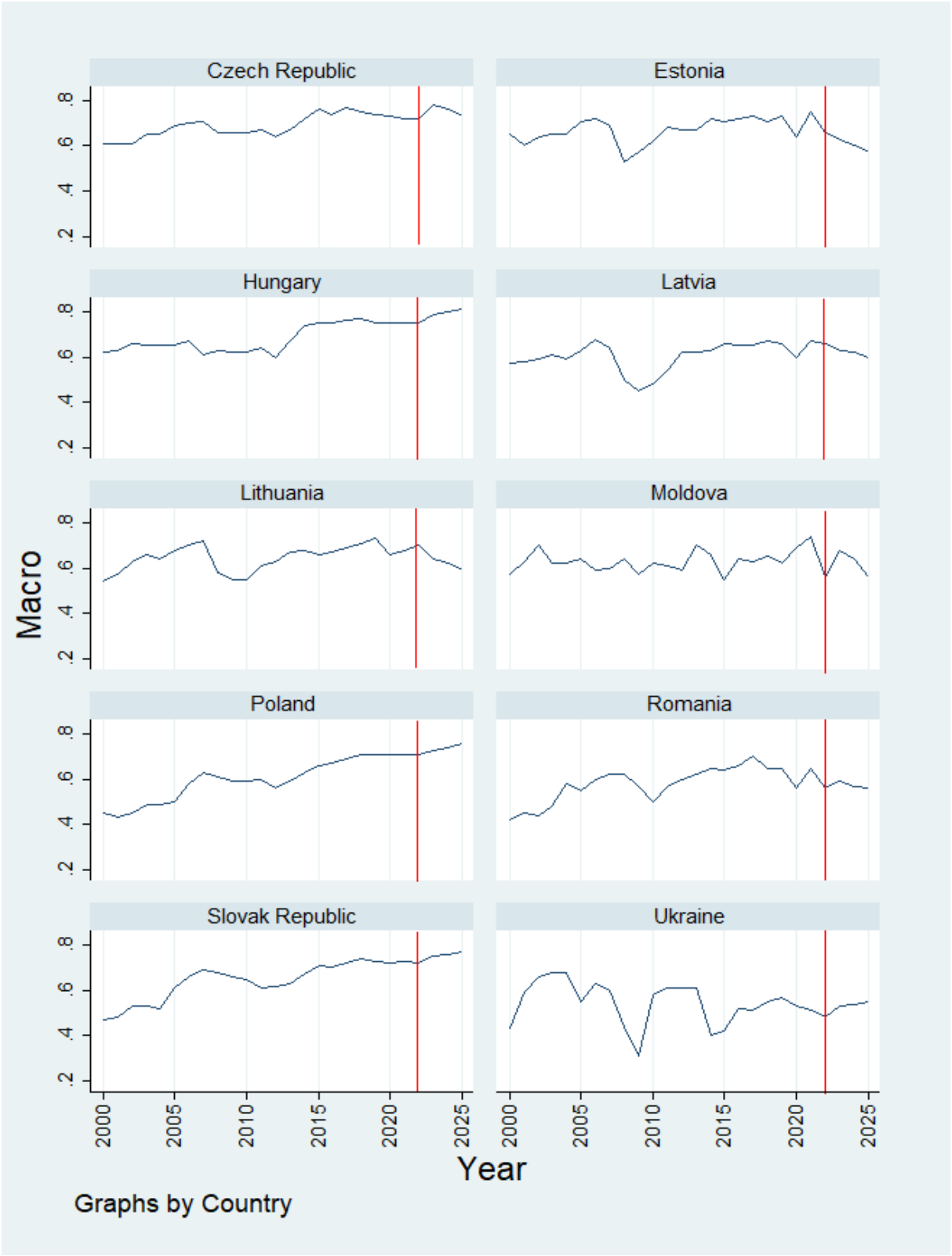
A deterioration in the current account balance also characterises most countries. In particular, negative dynamics are characteristic of all countries except Ukraine. However, restoring a positive trade balance would be possible if no military threats existed. Since in conditions of martial law, it is practically impossible to adhere to this post-pandemic recovery scenario.

The slightest variation margin is characterised by the indicator "Trade"; at the same time, the most significant positive dynamics, according to the forecast, are characterised by the change in the indicator in Moldova, while for Ukraine, a decrease in the level of this indicator is predicted compared to its pre-pandemic level.

The forecast results indicate that most macroeconomic indicators in the studied countries should restore their pre-pandemic dynamics by the end of 2025. However, more efforts will be required to restore employment and price stability.

Taking into account the actual and forecast values of the components of macroeconomic stability, an integral indicator was formed, the dynamics of which are presented in Figure 2. The weighting coefficients of each of the components of macroeconomic stability were justified in previous work (Vysochyna et al., 2024) and are presented in formula (1):

$$Macro = 0{,}307 \cdot GDPg + 0{,}231 \cdot Unempl + 0{,}231 \cdot CPI + 0{,}077 \cdot Trade + 0{,}154 \cdot CAB \quad (1)$$



Graph 2. Dynamics of actual and forecasted (after the red vertical line) values of macroeconomic stability for 10 European countries in 2000-202 5

Source: Authors' calculations in Stata 14.2/SE software (Stata, 2024) based on World Bank Data (World Bank DataBank, 2024)

According to the results of the forecast of the level of macroeconomic stability in European countries, it can be noted positive dynamics by the end of 2025 for Poland, Slovakia and Hungary, stabilisation of the volatility trends of the indicator at the pre-pandemic level the Czech Republic and Ukraine, slight decrease – for Romania, as well as a tendency to deterioration of macroeconomic dynamics for Estonia, Latvia, Lithuania and Moldova. It is also worth noting that in the absence of war in Ukraine, the pace of post-pandemic restoration of macroeconomic stability could be moderately positive. However, this forecast does not apply to the current conditions.

5. CONCLUSION

To determine the intensity and dynamics of post-pandemic recovery, it is necessary to develop a methodological toolkit that involves forecasting the volatility of the level of macroeconomic stability and its components in the medium term. In particular, the basic assumption within the framework of this study is that the rates of post-pandemic recovery of macroeconomic indicators, as well as other socioeconomic indicators, are individual for each country and are formed as a result of individual combinations of external and internal impacts. Thus, based on the results of choosing the functional form of the dependence of the change in the corresponding individual macroeconomic indicator over time, it was established that the least sensitive to the action of external factors, and accordingly the most internally determined parameter is trade openness, while the least qualitative predictive models were formed based on the GDP growth indicator, which indicates a high dependence of this indicator on the action of external factors. At the same time, the analysis of trend patterns of GDP growth volatility allows us to note that for 8 out of 10 studied countries, by the end of 2025, the restoration of the pre-pandemic level of economic dynamics will be achieved. In some cases, it will be exceeded. However, according to forecast data, Estonia and Lithuania will need another 2-3 years for recovery. Analysis of trend patterns of changes in the unemployment rate and its forecast until 2025 indicates good prospects for stabilising the situation in the labour market in countries such as the Czech Republic, Latvia, Moldova, Poland, Slovakia and Ukraine, while for the rest of the sample countries, further aggravation of employment problems is predicted. In the context of forecasting the restoration of price stability for the 10 studied European countries, it can be noted that there are no significant positive developments in this direction by 2025. Given the above, this goal should be a priority in the context of post-pandemic recovery. The pandemic had the least detrimental effect on trade openness, which allows for positive changes in this indicator by the end of 2025. According to the results of the analysis of volatility trends of actual and forecast values of the integral indicator of macroeconomic stability in the 10 studied countries, it can be noted that in Poland, Slovakia and Hungary, this indicator is projected to grow. In the Czech Republic and Ukraine – stabilisation at pre-pandemic levels is predicted, while in Estonia, Latvia, Lithuania, Moldova and Romania, a deterioration in macroeconomic dynamics is projected.

In order to formalise a detailed and step-by-step strategy for the formation of the process of post-pandemic recovery of macroeconomic indicators as a prospect for further research, an alternative forecast of these same parameters can be carried out in order to determine the values of the indicated indicators that could potentially have been if the COVID-19 pandemic had not occurred. Comparing the first and second forecast values will allow for a clearer formalisation of the specific steps of post-pandemic recovery for each country. As an alternative, the forecast might be realised with consideration of not only internal conditionality but also external determinants influence.

It is also worth noting that the proposed approach is quite universal and can be used to forecast other socioeconomic indicators.

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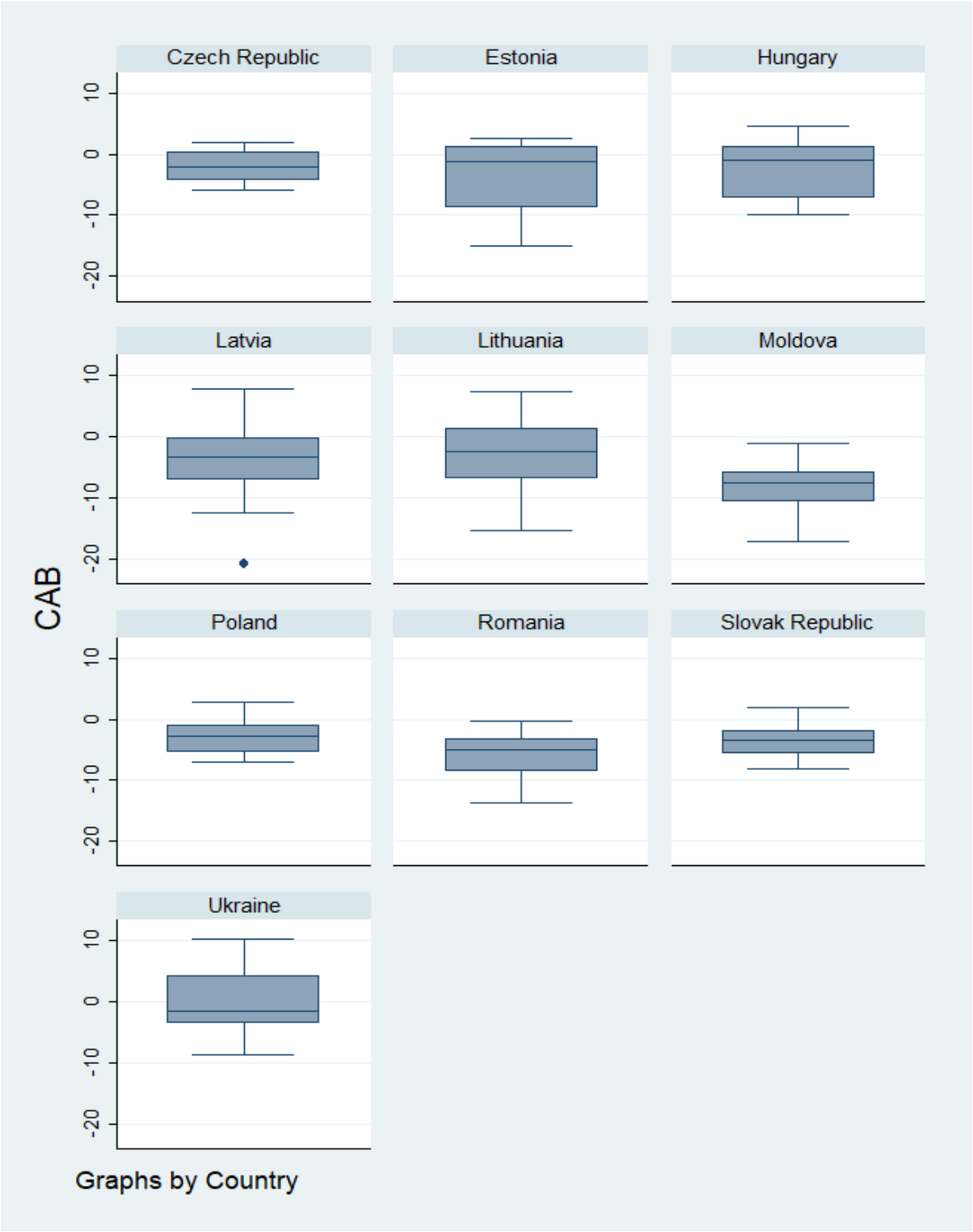
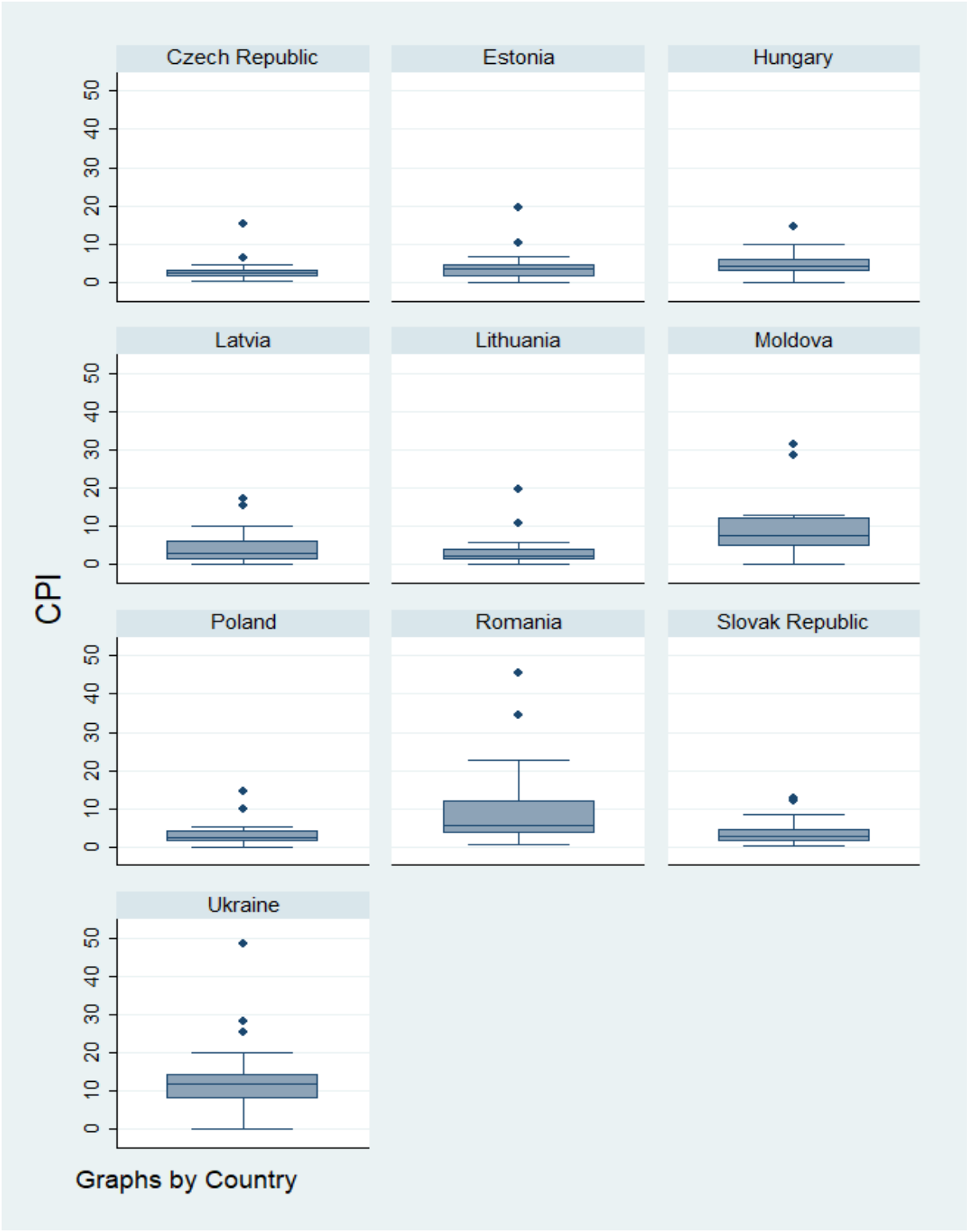
APPENDIX A



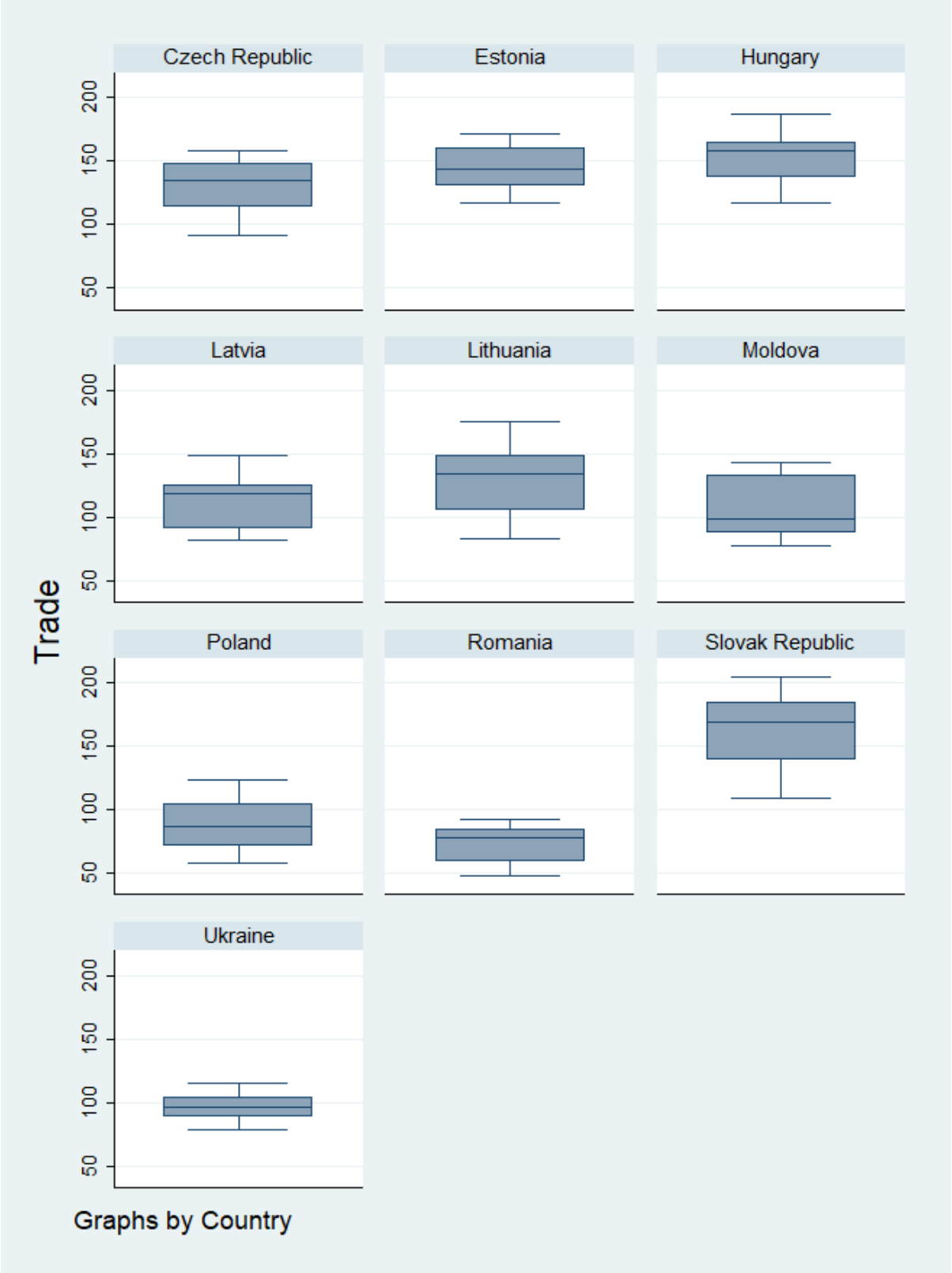
Graph A.1. Box graph of current account balance to GDP rate for 10 European countries in 2000-2022

Source: Authors' calculations in Stata 14.2/SE software (Stata, 2024) based on World Bank Data (World Bank DataBank, 2024)



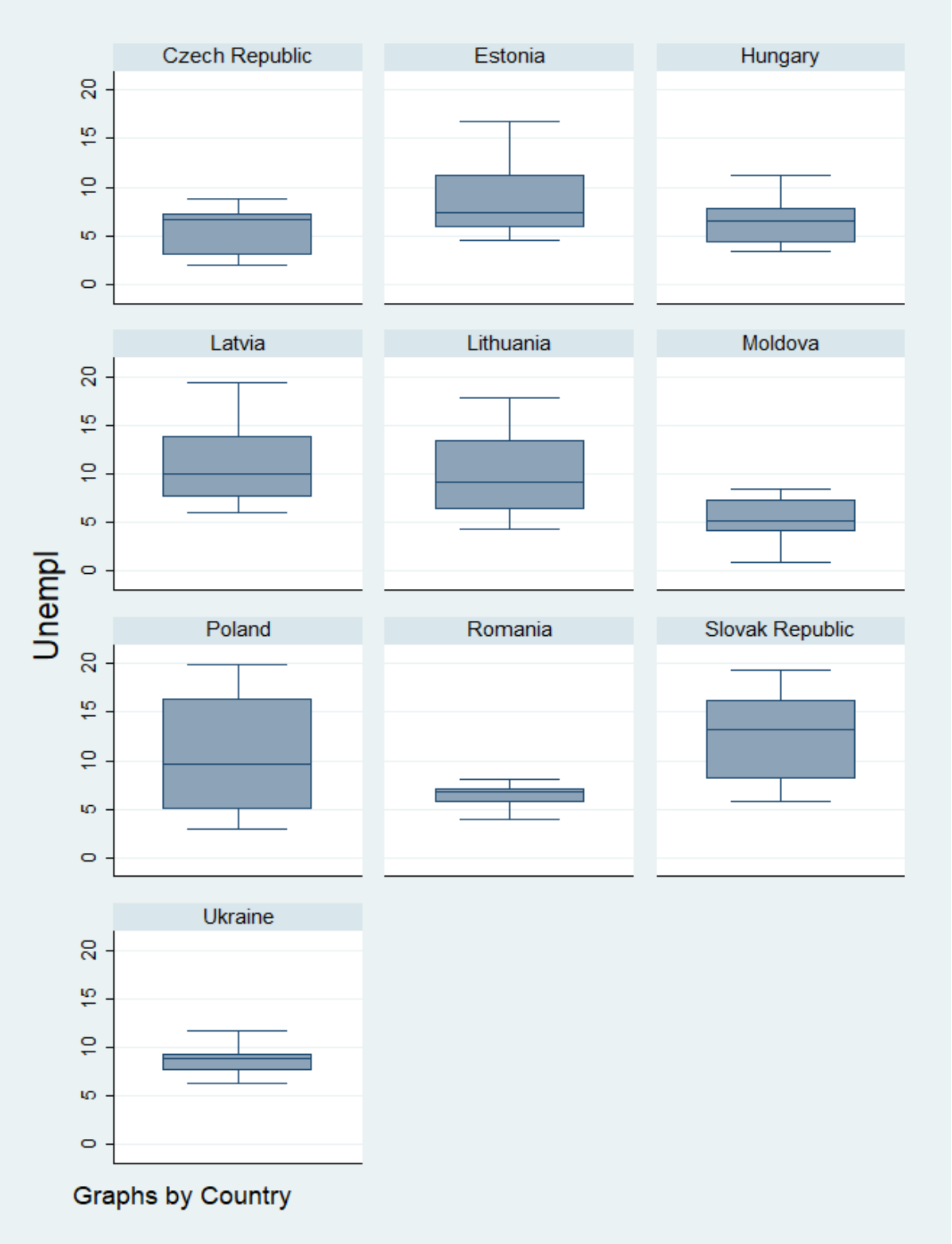
Graph A.2. Box graph of inflation rate for 10 European countries in 2000-2022

Source: Authors' calculations in Stata 14.2/SE software (Stata, 2024) based on World Bank Data (World Bank DataBank, 2024)



Graph A.3. Box graph of trade openness for 10 European countries in 2000-2022

Source: Authors' calculations in Stata 14.2/SE software (Stata, 2024) based on World Bank Data (World Bank DataBank, 2024)



Graph A.4. Box graph of the unemployment rate for 10 European countries in 2000-2022

Source: Authors' calculations in Stata 14.2/SE software (Stata, 2024) based on World Bank Data (World Bank DataBank, 2024)

APPENDIX B

Table B.1

Values of coefficients of determination for different functional forms of trend lines for "Unempl" variable for 10 European countries

Country	Linear	Logarithmic	Polynomial(2)	Polynomial(3)	Power	Exponential
Czech Republic	0.765	0.5909	0.7977	0.799	0.4676	0.6687
Estonia	0.3707	0.3796	0.371	0.376	0.367	0.3706
Hungary	0.1142	0.0118	0.629	0.632	0.0076	0.0808
Latvia	0.2279	0.1769	0.2817	0.2753	0.1663	0.2121
Lithuania	0.2438	0.2707	0.2439	0.2495	0.272	0.2427
Moldova	0.6951	0.6374	0.604	0.6088	0.5776	0.7031
Poland	0.8521	0.7442	0.8617	0.8602	0.5042	0.8396
Romania	0.556	0.3562	0.6143	0.6297	0.3223	0.534
Slovak Republic	0.8163	0.7286	0.814	0.813	0.6281	0.8011
Ukraine	0.0125	0.1448	0.7277	0.7266	0.1576	0.0131

Source: Authors' calculations in MS Excel based on World Bank Data (World Bank DataBank, 2024)
Notes: the highest values of R^2 are shadowed

Table B.2

Values of coefficients of determination for different functional forms of trend lines for "CPI" variable for 10 European countries

Country	Linear	Logarithmic	Polynomial(2)	Polynomial(3)	Power	Exponential
Czech Republic	0.0019	0.0276	0.1591	0.2094	0.0307	0.0014
Estonia	0.0713	0.0588	0.0071	0.2022	0.044	0.0073
Hungary	0.3446	0.4812	0.5527	0.5957	0.4815	0.437
Latvia	0.1437	0.0564	0.1524	0.5333	0.0133	0.1018
Lithuania	0.011	0.0418	0.0435	0.3072	0.0306	0.0087
Moldova	0.3544	0.2536	0.3549	0.4162	0.1969	0.3454
Poland	0.0465	0.2029	0.3588	0.3508	0.2897	0.0622
Romania	0.4676	0.714	0.8942	0.8951	0.6618	0.6801
Slovak Republic	0.4083	0.5215	0.624	0.604	0.4532	0.514
Ukraine	0.0038	0.037	0.065	0.456	0.043	0.0036

Source: Authors' calculations in MS Excel based on World Bank Data (World Bank DataBank, 2024)
Notes: the highest values of R^2 are shadowed

Table B.3

Values of coefficients of determination for different functional forms of trend lines for "CAB" variable for 10 European countries

Country	Linear	Logarithmic	Polynomial(2)	Polynomial(3)	Power	Exponential
Czech Republic	0.423	0.4328	0.5338	0.7307	n/a	n/a
Estonia	0.4395	0.3349	0.4674	0.7133	n/a	n/a
Hungary	0.3585	0.4114	0.6696	0.6052	n/a	n/a
Latvia	0.2693	0.1771	0.2725	0.4916	n/a	n/a
Lithuania	0.3884	0.2698	0.3885	0.5702	n/a	n/a
Moldova	0.0735	0.1022	0.09	0.3117	n/a	n/a
Poland	0.4322	0.2721	0.5031	0.5975	n/a	n/a
Romania	0.0482	0.0168	0.0597	0.6876	n/a	n/a
Slovak Republic	0.1375	0.0924	0.1589	0.485	n/a	n/a
Ukraine	0.0922	0.2082	0.5181	0.5284	n/a	n/a

Source: Authors' calculations in MS Excel based on World Bank Data (World Bank DataBank, 2024)
Notes: n/a – some functional forms of trend lines are not applicable if data have "0" or negative values; the highest values of R^2 are shadowed

Table B.4

Values of coefficients of determination for different functional forms of trend lines for "Trade" variable for 10 European countries

Country	Linear	Logarithmic	Polynomial(2)	Polynomial(3)	Power	Exponential
Czech Republic	0.7231	0.7702	0.8445	0.8375	0.7872	0.6873
Estonia	0.4812	0.4635	0.5173	0.5168	0.4753	0.4714
Hungary	0.6701	0.6263	0.7259	0.7203	0.6514	0.6515
Latvia	0.7797	0.7297	0.8086	0.8044	0.7623	0.7565
Lithuania	0.7233	0.7629	0.782	0.7781	0.7767	0.6913
Moldova	0.6464	0.5102	0.6606	0.8676	0.4539	0.6544
Poland	0.9656	0.808	0.9423	0.9323	0.8743	0.9564
Romania	0.8944	0.8306	0.9149	0.9042	0.8749	0.8658
Slovak Republic	0.817	0.8087	0.8542	0.845	0.8342	0.7918
Ukraine	0.0944	0.0632	0.1663	0.4097	0.0623	0.0924

Source: Authors' calculations in MS Excel based on World Bank Data (World Bank DataBank, 2024)
Notes: the highest values of R^2 are shadowed