POST-PANDEMIC ECONOMIC RECOVERY: ASSESSMENTS OF THE STABILITY OF GLOBAL MACROECONOMIC SYSTEMS

ПОСТПАНДЕМІЧНЕ ВІДНОВЛЕННЯ ЕКОНОМІКИ: ОЦІНКИ СТІЙКОСТІ СВІТОВИХ МАКРОЕКОНОМІЧНИХ СИСТЕМ

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The article provides a comprehensive assessment of the stability of global macroeconomic systems in the post-pandemic period with a focus on the impact of the COVID-19 pandemic. The dynamics of macroeconomic indicators in the period from 2001 to 2025, including the pre-crisis, crisis, post-crisis and post-COVID stages, are considered. The results of the analysis showed that the pandemic significantly worsened the macroeconomic stability of most countries, increasing the share of countries with a low level of stability in the post-COVID period. At the same time, the share of countries with a high level of stability decreased which indicates the growing vulnerability of even the most developed economies. Clear structural shifts were observed in the distribution of countries by level of stability which indicates a reassessment of traditional development models. The practical value of the article lies in the formation of approaches to monitoring, modeling and forecasting macroeconomic stability in the context of global crises.

Keywords: macroeconomic stability, COVID-19 pandemic, economic «shocks», economic adaptation, Kohonen self-organizing maps, post-crisis period, country classification.

У статті наведено комплексну оцінку стабільності глобальних макроекономічних систем у постпандемічний період з акцентом на вплив пандемії COVID-19. Розглянуто динаміку макроекономічних показників у період з 2001 по 2025 рік, включаючи докризовий, кризовий, посткризовий та постковідний етапи. Для аналізу міграції країн за рівнем стабільності використовуються методи класифікації та самоорганізуючі карти Кохонена, що дозволило виявити ключові тенденції та структурні зрушення в адаптації економік до нових викликів. У дослідженні було використано комбінацію методів кластерного аналізу, нейромережевих підходів (зокрема, самоорганізуючі карти Кохонена), а також статистичних методів порівняльної оцінки. Це дозволило виявити динаміку змін рівня макроекономічної стабільності країн та згрупувати їх за типами адаптивних стратегій у різні часові періоди. Результати аналізу показали, що пандемія значно погіршила макроекономічну стабільність більшості країн, збільшивши частку з низьким рівнем стабільності в постковідний період. Водночас, частка країн з високим рівнем стабільності зменшилася, що свідчить про зростання вразливості навіть найрозвиненіших економік. У розподілі країн за рівнем стабільності спостерігалися чіткі структурні зрушення, що свідчить про переоцінку традиційних моделей розвитку. Практична цінність статті полягає у формуванні підходів до моніторингу, моделювання та прогнозування макроекономічної стабільності в умовах глобальних криз. Запропонований методичний інструментарій може бути використаний для оцінки ефективності державної політики, а також для виявлення слабких місць в економічній структурі країн з метою запобігання майбутнім «шокам». Висновки підкреслюють важливість системного підходу до оцінки економічної стабільності, який враховує не лише рівень розвитку країни, але й її здатність адаптуватися до зовнішніх «шоків». В умовах глобалізації та зростаючої взаємозалежності економік світу актуальною стає розробка гнучких стратегій реагування на кризи, заснованих на аналітичному моніторингу ризиків, прогнозуванні вразливостей та зміцненні інституційного потенціалу держав.

Ключові слова: макроекономічна стійкість, пандемія COVID-19, економічні «шоки», адаптація економіки, самоорганізаційні карти Кохонена, посткризовий період, класифікація країн.

ЕКОНОМІКА

Formulation of the problem. The global economy has experienced an unprecedented "shock" due to the COVID-19 pandemic which led to a deep decline in production, disruption of global supply chains, a sharp increase in unemployment and a decrease in consumption. Governments have taken large-scale fiscal and monetary measures to mitigate the consequences of the crisis, but the effectiveness of these steps has been uneven in different regions of the world and has a diverse focus. At the same time, prolonged uncertainty, new waves of infections and geopolitical instability have exacerbated the issue of the long-term stability of macroeconomic systems.

It is important that even after the formal exit from the acute crisis phase, many economies remain vulnerable to new "shocks". Inflationary pressures, debt burdens and structural imbalances prompt a deeper analysis of the systemic nature of states in ensuring macroeconomic stability in the post-crisis period. An assessment of the stability of economies should take into account not only the short-term pace of recovery, but also the long-term ability to adapt to changes and maintain functionality in new global conditions.

Currently, the scientific community is focused on finding indicators that allow objectively measuring the level of stability of macroeconomic systems. The lack of unified approaches to such analysis complicates the formation of effective policies. Hence the need to develop new analytical models or adapt past developments that allow assessing not only economic growth after the pandemic, but also the potential of systems for recovery, strategies for reducing vulnerability and increasing adaptability in conditions of uncertainty.

Analysis of recent research and publications. The research issues have been widely reflected in the scientific works of Ukrainian researchers. In particular, the issues of economic turbulence and mechanisms of response to external and internal crises are considered in the studies of R. Hryhoryan [1], O. Kabanova [2], A. Zolkover [3] and Yu. Chaika [4]. Their works highlight the nature of the impact of "shocks" on the economy, the dynamics of recovery and tools for overcoming crisis phenomena.

These scientific approaches form an important theoretical basis for further assessments of the stability of macroeconomic systems in the post-pandemic period. The experience accumulated in studying the impact of "shocks" on the economy allows us to better understand the potential for adaptation of national economies to new challenges, in particular global crises caused not only by the pandemic, but also by other unstable factors of world development.

Highlighting previously unresolved parts of the overall problem. Despite a significant body of research, the long-term stability of economies in the context of recurrent or unexpected crises remains understudied. Most studies focus on the short-term consequences of the pandemic and operational anti-crisis measures, but less attention is paid to the ability of systems to self-recover, structural adaptation and stability development in conditions of prolonged uncertainty.

Existing models often do not take into account the complex interaction of factors affecting recovery. This creates a need for new analytical approaches that can provide a more holistic view of macroeconomic stability in a post-pandemic world.

Formulation of the goals of the article (statement of the task). The aim of the article is to comprehensively assess the stability of global macroeconomic systems in the post-pandemic period. Particular attention is paid to the analysis of the structural characteristics of economies, the effectiveness of anti-crisis policies, and the potential for long-term growth after the impact of "shocks".

Presentation of the main research material. The basis of the development structure is proposed to determine the own research [5], in which the features of assessing the stability of macroeconomic systems to exogenous "shocks" were previously identified for the period from the beginning of the 21st century to the start of COVID-19.

That is, it is proposed to consider further dynamics from the beginning of COVID-19 to 2025. Thus, the plan of the current study includes:

1. Selection of the information space of features.

This stage involves identifying and justifying a comprehensive set of macroeconomic indicators that will serve as the basis for assessing the stability of national economic systems. Special attention will be given to data availability, cross-country comparability, and the capacity of the selected features to reflect both short-term shocks and long-term stability.

2. Implementation of a classification model of macroeconomic systems by the level of stability.

At this stage a machine learning or statistical classification method will be applied to categorize

countries into stability groups. The model will be trained on historical data and validated using appropriate performance metrics. The goal is to detect patterns in macroeconomic behavior and stability, particularly during and after the COVID-19 pandemic.

3. Analysis of migrations of countries between the results of the past and current study.

This phase will focus on tracking and interpreting changes in country positions between the previous stability assessment and the current one. The analysis will explore whether countries have improved or deteriorated in terms of stability, investigate the driving factors behind these shifts, and evaluate how national policy responses to global shocks, such as the pandemic, influenced economic system stability.

I will continue the work in the paradigm of considering different groups of criteria for the stability of macroeconomic systems, considering the parameters of stability by the starting conditions of economic development (GDP per capita; GDP growth rate), the parameters of the stability of the foreign economic sector (indicators of the ratio of imports to GDP, exports to GDP, total imports and exports to GDP) and

the parameters of stability by general economic indicators of response to the impact of "shocks" (inflation and unemployment).

The previous assessment of the impact of exogenous "shocks" on macroeconomic systems was carried out in three periods and a new stage will be added: pre-crisis (2001–2007); crisis (2008–2011); post-crisis (2012–2020); post-COVID (2021–2025).

When selecting input observations (countries for analysis), the classification proposed by the International Monetary Fund is used. Its feature is the division of countries into two main groups: states with developed economies and states with developing economies, taking into account regional specifics.

Further data processing [6–7] and construction were carried out in the "Statistica" software package and Deductor Studio.

A visual check of the cluster structure was carried out which, as in previous periods, should show the optimal division of data into 3 groups: low (L), medium (M) and high (H) levels of stability of macroeconomic systems. The constructed dendrogram (based on the example from [8]) confirmed the scientific assumption (Fig. 1):
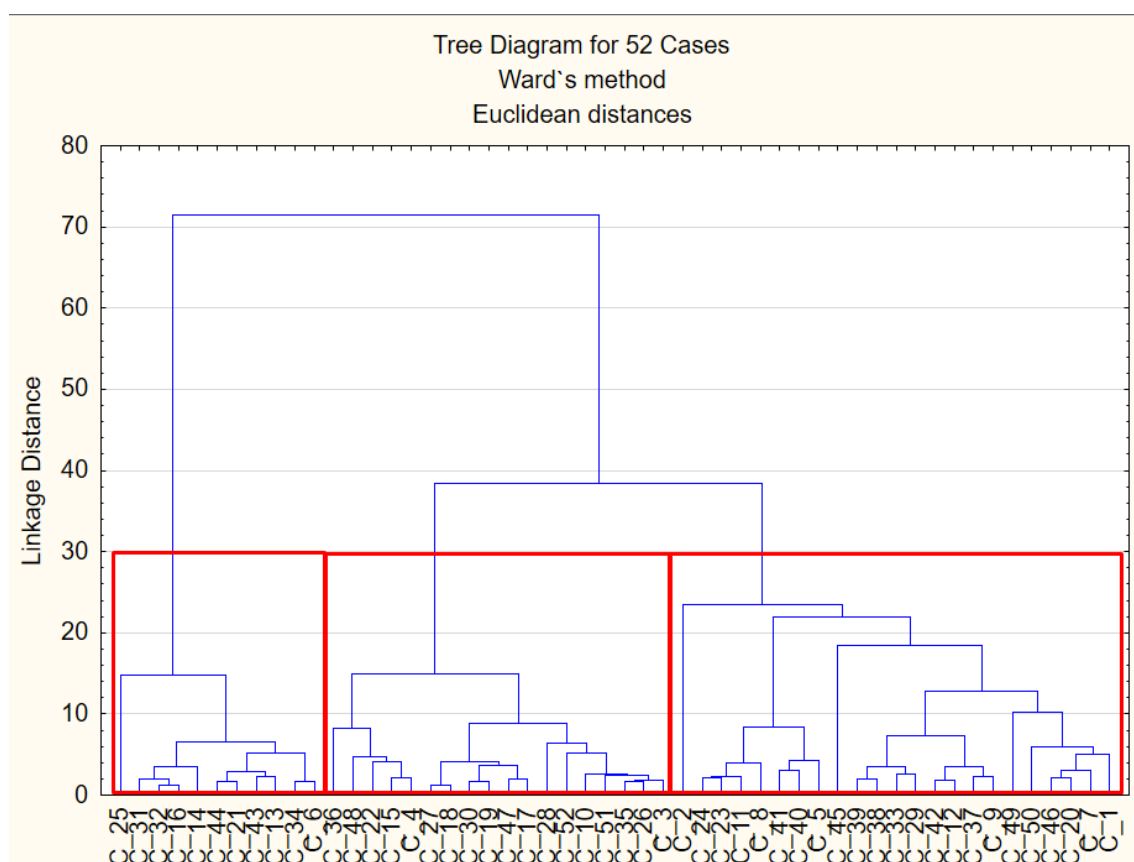

Figure 1. Dendrogram of the distribution of observations by groups (2001–2025)

Source: developed by the author

Moving on to the study of the graph of average values of observations, it has been shown that visually identifying the key elements of each group is quite a difficult task. This situation prompts the choice of a solution vector that includes a self-tuning algorithm, Kohonen neural networks (self-organizing maps).

The result of using Kohonen self-organizing maps (based on the example from [9]) is presented in Fig. 3.

Taking into account the results of the construction, Table 1 is presented which presents countries that changed their level of stability throughout the entire study period (25 years).

Table 1 shows that after COVID-19 only 2 countries changed their stability level. We are talking about Bulgaria (was Medium, became Low) and Switzerland (was High, became Medium). That is the consequences of the COVID-19 pandemic significantly affected Bulgaria's ability to maintain the previous level of economic stability. Switzerland demonstrated higher variability during the analyzed periods, however, with a predominance of a high level
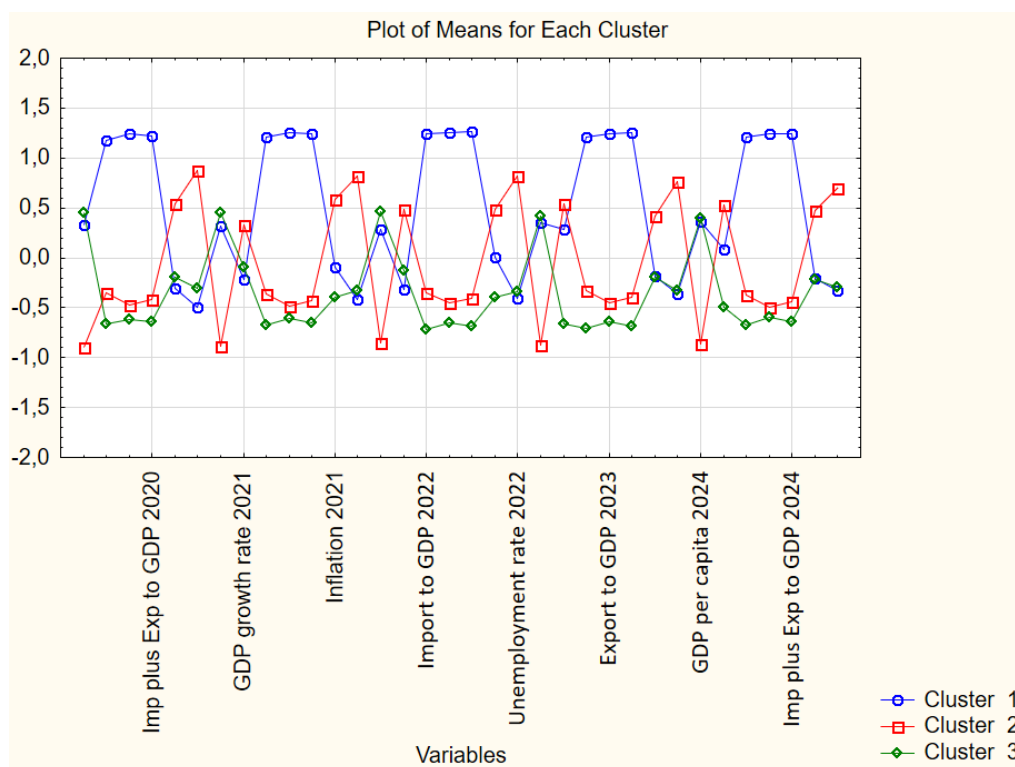

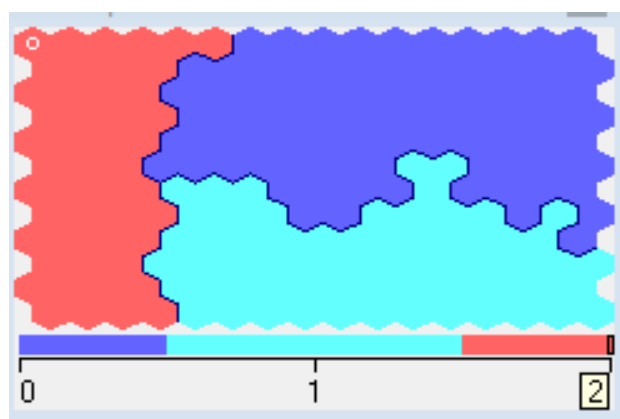**Figure 2. Graph of means (2001–2025)**
Source: developed by the author

Figure 3. Implementations of classification based on Kohonen self-organizing maps
Source: developed by the author

Table 1

Element migration analysis

Country	Pre-crisis period (2001–2007)	Crisis period (2008–2011)	Post-crisis period (2012–2020)	Post-COVID period (2021–2025)
Azerbaijan	M	L	L	L
Bosnia and Herzegovina	M	L	L	L
Bulgaria	M	M	M	L
Croatia	M	H	L	L
Greece	L	H	L	L
Kazakhstan	M	L	L	L
Mexico	H	L	L	L
Portugal	L	H	L	L
Saudi Arabia	H	L	B	B
Spain	L	H	L	L
Switzerland	H	M	H	M
Ukraine	M	L	L	L

* only countries with cluster-to-cluster migration are represented

Source: developed by the author

of stability: the pre-crisis and post-crisis periods were characterized by a high level, and the crisis period by an average level. In the post-COVID period, the level decreases again to an average level which is a deviation from the previous high indicator. For Switzerland, such a decrease is likely to be temporary and is associated with adaptation to new global conditions.

The results of Table 2 show that in the dynamics in the post-COVID period (2021–2025), there is a continuation of the global decrease to a low level of stability among the countries considered.

The post-COVID period has seen the highest level of countries with low stability ever analyzed – 42%. This indicates that the COVID-19 pandemic has become a critical challenge for most countries, regardless of their previous level of stability. The consequences of the pandemic have significantly reduced the adaptive capabilities of countries.

The share of countries with an average level of stability remained stable – 23%, i.e., it has not changed compared to the previous (post-crisis) period.

In contrast, the share of countries with high stability has slightly decreased – to 35% which continues the downward trend recorded in the previous period. This indicates that even the most stable economies were not protected from the impact of global turbulence. The decrease in the share of such countries is a clear sign that the post-COVID reality requires fundamentally new approaches to ensuring macroeconomic and social stability. The post-COVID period has recorded a general deterioration in global stability which poses new challenges for states.

Conclusions. The study confirmed that the COVID-19 pandemic has become a powerful macroeconomic "shock" that has significantly weakened the stability of most world economies. The increase in the share of countries with a low level of stability and the simultaneous decrease in the number of countries with high stability in the post-COVID period indicate

Table 2

Distribution of countries in clusters

Stability	Pre-crisis period (2001–2007), %	Crisis period (2008–2011), %	Post-crisis period (2012–2020), %	Post-COVID period (2021–2025), %
L	29 %	35 %	40 %	42 %
M	33 %	25 %	23 %	23 %
H	38 %	40 %	37 %	35 %

Source: developed by the author

that even the most developed systems have proven vulnerable to new global challenges. This emphasizes the need to review existing approaches to managing economic stability and adaptation.

The starting point of the work was the identification of the limitations of traditional methods of assessing stability which do not always take into account the complexity and multidimensionality of adaptation and recovery processes in conditions of protracted uncertainty. The use of Kohonen self-organizing maps made it possible to more flexibly and clearly identify the migration of countries between levels of stability which opens up new opportunities for comprehensive monitoring of macroeconomic systems.

The results obtained emphasize the importance of developing new macroeconomic strategies and policies aimed at strengthening the long-term adaptability and ability of systems to self-recovery. This approach will contribute to a more effective reduction of the risks of future crises and an increase in the stability of economies in dynamic global conditions which makes the proposed models relevant and of practical value for state and international analytical organizations.

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