



STRUCTURAL CHANGES IN GLOBAL VALUE NETWORKS: CURRENT FACTORS AND RISKS

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ABSTRACT

Objective: The study examines structural changes in global value networks (GVNs), driven by internal and external shocks, such as trade wars, interregional conflicts, the COVID-19 pandemic, and increased digitalization. The objective is to analyze the impact of contemporary economic crises on these networks and assess how they affect economic stability and the sovereignty of national economies.

Methods: Factorial, comparative, qualitative, and quantitative analysis methods were employed. The research analyzed the share of manufactured products in GVNs from 2000 to 2022, using concentration indicators to evaluate the importance of major participants within these networks.

Results: The study reveals that economic shocks over the past decades have led to the regionalization and localization of GVNs, requiring a revision of global supply chain models. Large firms play a crucial role in mitigating economic shocks, while trade policy significantly influences the functioning of these networks under crisis conditions.

Conclusions: The transformations in GVNs highlight the need for companies and governments to adapt their policies and strategies to increase economic sustainability and protect national interests. The conclusions emphasize the importance of regionalization, supplier diversification, and investments in digitalization as measures to address contemporary global economic challenges.

Keywords: Global value chains. Added value. Logistics chains. Reshoring. Production localization.



MUDANÇAS ESTRUTURAIS NAS REDES GLOBAIS DE VALOR: FATORES E RISCOS ATUAIS

RESUMO

Objetivo: O estudo examina as mudanças estruturais nas redes globais de valor, impulsionadas por choques internos e externos, como guerras comerciais, conflitos interregionais, a pandemia de COVID-19 e a digitalização crescente. O objetivo é analisar o impacto das crises econômicas contemporâneas sobre essas redes e avaliar como elas afetam a estabilidade econômica e a soberania das economias nacionais.

Métodos: Foram utilizados métodos de análise fatorial, comparativa, qualitativa e quantitativa. A pesquisa analisou a participação de produtos manufaturados em redes globais de valor (GVNs) entre 2000 e 2022, utilizando indicadores de concentração para avaliar a importância dos principais participantes nessas redes.

Resultados: O estudo revela que os choques econômicos das últimas décadas provocaram uma regionalização e localização das GVNs, exigindo uma revisão dos modelos de cadeias de suprimentos globais. Grandes empresas desempenham um papel crucial na mitigação de choques econômicos, enquanto a política comercial influencia significativamente o funcionamento dessas redes em condições de crise.

Conclusões: As transformações nas GVNs destacam a necessidade de adaptar as políticas e estratégias das empresas e dos governos para aumentar a sustentabilidade econômica e proteger os interesses nacionais. As conclusões sublinham a importância da regionalização, diversificação de fornecedores e investimentos em digitalização como medidas para enfrentar os desafios econômicos globais contemporâneos.

Palavras-chave: Redes globais de valor. Valor agregado. Cadeias logísticas. Relocalização. Localização da produção.

INTRODUCTION

The last decades of the 20th century were characterized by globalization processes (Ermolaev, Sigarev, 2023), increased global competition, and gradual transformations in the global economic environment (Galanov et al., 2024), which formed new views on the international economy (Fedchenko et al., 2023) through the concept of global value networks (GVNs). This concept made it possible to analyze the strategy of the behavior of multinational corporations (Cherckesova et al., 2024) as the main actors in the global trade arena (Bagratuni et al., 2023). It also gave a holistic view of the impact of the GVNs on the processes occurring at the micro-, meso-, and macro-levels and the further trajectory of the socioeconomic development of countries (Zenin et al., 2019). The COVID-19 pandemic (Degtev et al., 2022), some cross-country and interregional trade conflicts (Seifullaeva et al,



2022), economic and geopolitical conflicts in recent years, and the digitalization of markets and business processes (Chumakova et al., 2024) have adjusted the transformation of existing GVN.

The changing economic centers of power (Garnov et al., 2024), increased competition, and changes in consumer demand also affect the structure of GVN. Companies are forced to adapt to new conditions, reorganize their supply chains, and find new ways to cooperate and manage risks (Lochan et al., 2021).

The events have raised questions about the need to concentrate efforts and resources aimed at ensuring the economic sovereignty of national economies and their structural changes, influenced by both endogenous and exogenous shocks occurring in modern realities.

In this regard, the problem of theoretical understanding of the concept of GVN remains relevant.

LITERATURE REVIEW

For the first time, the concept of value chains in its modern sense was proposed in the 1970s by the American economist M. Porter. By the value chain, he understood "the totality of various types of company activities aimed at the development, production, marketing, delivery and maintenance of its products" (Ilyas et al., 2005). Porter drew attention to the firm's task of building relationships with suppliers and consumers to ensure its competitiveness. By 1985 Porter had transformed it into the concept of value chains as a tool for strategic analysis of the company's activities (Porter et al., 1985). Porter considered industrial relations within an enterprise, paying attention to the study of the enterprise's types of activities and production operations, limiting the scope of his research to the level of one or more interconnected enterprises, without considering the processes of inter-firm and international interaction. Porter's concept was continued in the works of many researchers, including those studying economic development problems, and was reflected in the works by G. Gereffi and M. Korzeniewicz (1994), D. Rodrik (2018), etc.

In 1994, the American economist and sociologist G. Gereffi (1994) proposed a new concept, the global commodity chain. Unlike Porter, Gereffi drew attention to the cross-country nature of added value creation in the process of industrial cooperation of enterprises. Gereffi understood the concept of a global commodity chain as a set of intra-organizational networks aimed at the production of an end product connecting households, enterprises, and states in the global economy.





Subsequently, the concept of commodity chain was transformed into a new category, the value chain. In a broad sense, it refers to "the full range of activities that firms and workers perform to bring a product from its conception to end use and beyond. This includes activities such as research and development (R&D), design, production, marketing, distribution, and support to the final consumer" (Greff, 2011, p. 21). This set of actions can be concentrated within a single enterprise or distributed among several firms. As the network of intra-company interactions spread beyond the borders of countries, global value chains began to form, based on which a deeper structuring of global production and cross-border commodity flows took place in the future (Cigna et al., 2022).

Thus, gradually the concept began to be used to analyze stable cooperative relations between companies at the micro- and meso-levels. Later, with the growing interdependence of developed economies, it moved to the global level, and the term "GVN" began to be used to denote a form of organization of the international division of labor with the placement of separate production stages for final consumption products in different countries.

With the spread of GVN, the risks of GVN functioning began to increase.

From the point of view of negative factors affecting the functioning of the GVNs, there is a multilevel classification of the causes of the formation of bottlenecks depending on the predictability and strength of their impact on their effectiveness. There are two categories and four types of factors that can lead to the formation of bottlenecks in individual links of supply chains and, as a result, hurt the entire chain.

The first category includes catastrophic phenomena that affect all spheres of human life and cause large-scale losses. Two types can be distinguished in this category: predictable and unpredictable disasters. Regular hurricanes in the Gulf of Mexico, for example, can be attributed to predictable disasters. These two types have one thing in common: namely, that people cannot control them yet.

The second category includes so-called disruptions, which, like disasters, can cause significant damage to the economies of individual countries or industries. Disruptions are also divided into types depending on the predictability of their occurrence. Predictable disruptions, for example, include trade disputes/wars, which, regardless of the validity of the arguments for their initiation, arise and are carried out within the framework of formalized procedures. Unpredictable disruptions, such as data leaks, industrial accidents, etc., can sometimes have a stochastic development trajectory. In practice, as a rule, well-established mechanisms for managing the latter type of bottleneck formation causes (accidents, supply disruptions, etc.) are used. Recently, businesses have also begun to assess the likelihood



of adverse effects on supply chains from trade disputes. This type of cause is characterized as atypical events that occur rarely and unexpectedly but lead to large losses. Unpredictable disruptions include, for example, the COVID-19 pandemic.

Since the GVN's affect a wide range of related areas, like regional development, industrial policy, innovative growth, etc., their impact on the intensification of macroeconomic shocks can also be traced. Traditionally, GVN's play a leading role in transmitting the shocks of global crises and decrease more strongly under their influence. Therefore, there are discussions in the scientific literature about the impact of the active development of the GVN's on the spread of external negative factors in the global economy and how events affect them.

The objective of this study is to examine the impact of contemporary economic crises on structural changes within the global supply chain system (GSCS) and to evaluate their effects on the economic stability and sovereignty of national economies.

METHODS

The following methods were used in this study:

factor analysis aimed at studying the causes influencing the receipt and distribution of added value in network structures, as well as influencing the formation of risks of their functioning;

a comparative analysis aimed at identifying the features of the distribution of added value in different network structures in the cross-country context, comparing macroeconomic indicators of GVN functioning;

qualitative analysis, where the secondary data are obtained from peer-reviewed scientific literature, government reports, industry publications, and international databases;

an analytical approach to study structural changes in GVN's in the face of modern shocks and trends such as the COVID-19 outbreak, trade wars, digitalization, etc.

As part of the quantitative analysis, we used data on the shares of manufactured products by country in the GVN's from 2000 to 2022 and calculated the concentration indicators.

RESULTS AND DISCUSSION

The events of the last decades force us to look at the economic efficiency of the GVN's differently and to define the ongoing processes of their structural dynamics. Financial crises, technological accidents, the pandemic, and geopolitical events have dramatically affected



all participants of the GVN, provoking, among other things, a complete cessation of supplies and shutdown of enterprises. The analysis of events shows that the highest probability of failures is inherent in spatially dispersed chains, which allows us to identify two main ways for the shocks to spread and affect global networks.

The first way is related to the structure of exports and is determined by the fact that the fragmentation of production underlying the GVN mainly affects sectors of the economy specializing in capital goods such as machinery, equipment, and electronics. For example, this effect was observed in China during the 2008 financial crisis 2008, and it was associated with a change in the structure of exports due to the predominance of durable goods.

The second way is related to supply chains and characterizes the specifics of the GVN associated with the repeated border crossing by commodity flows within these chains, which increases their vulnerability to external shocks. Possible disruptions in the supply of resources in the production network in one country lead to a reduction in imports of intermediate products and exports of finished products by its participants in other countries.

This effect has led to an active application of a strategy aimed at shortening those chains (reshoring) which allows for the formation of less fragmented, shorter, and more stable value chains. This significantly simplifies production operations, changing historically established trends in international production. Thus, under the influence of the COVID-19 pandemic, after the closure of borders, as well as large-scale disruptions and even breaks in the established GVN, there was a tendency to return part of production to national economies to reduce their dependence on imported products, especially in what concerned essential goods.

Global or macro-regional factors that had a direct or indirect impact on all countries involved in international trade and affected the functioning of the GVN have their specifics related to the causes, scale of impact on the regions, and the economic disruptions occurring in them, their further consequences, as well as government measures aimed at reducing further risks. These factors can be interrelated, having a reinforcing and aggravating effect on each other in certain conditions. For example, trade tensions between the US and China were overlapped by the COVID-19 pandemic, creating increasing uncertainty in trade policy.

The trend in the formation and development of GVN in recent years has developed into processes of their regionalization and localization under the influence of several key factors that revealed their vulnerability and raised issues of protecting national economic interests. In the context of the emergence of political, financial, and economic risks in the modern economy, the localization of global value chains at the regional level seems to be a



necessary stage in ensuring the national security of countries. The decrease in the power of transnational corporations (TNCs) as the main subjects of the international economy and trade, the integration of states as economic agents into value networks, and the creation of new networks by states change the balance of power in the world economic arena. Global networks began to lose their "globality", uniting only a few countries, often within the framework of regional associations.

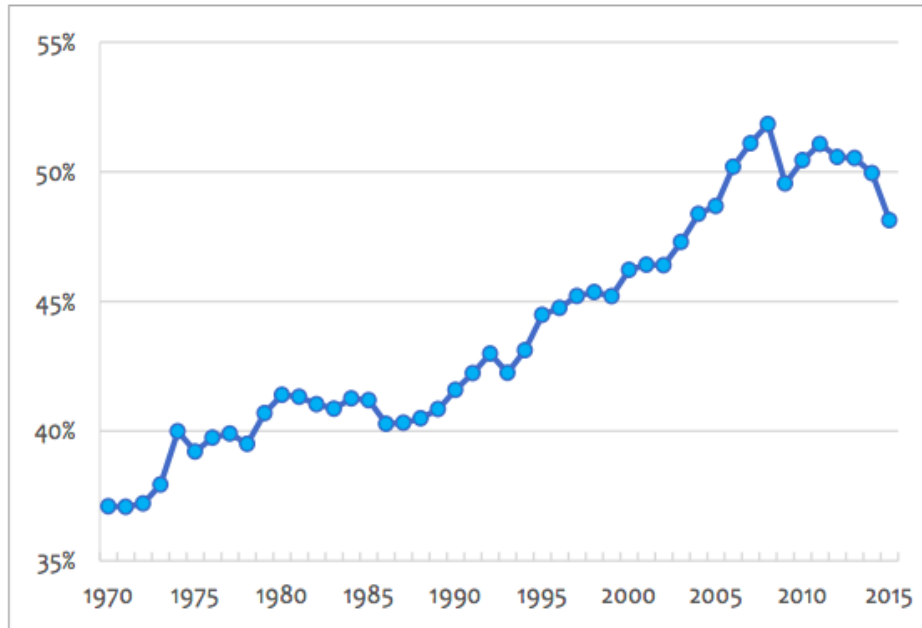


Figure 1: The share of the GVN in the total volume of world trade, %
 Source: Antràs (2020)

This is confirmed by the following data. Fig. 1 shows the declining share of the GVN in the total volume of world trade. The increasing trend changed to a decreasing one after the crisis of 2008-2009.

However, it is worth considering this issue by country (Table 1).

Table 1: The share of manufactured products in the GVN by country, %

Country	2000	2007	2010	2015	2020	2022
USA	32.21	25.48	22.58	23.26	23.24	24.12
Germany	6.01	6.21	5.48	4.67	4.65	4.11
Japan	15.08	8.27	8.93	6.13	5.99	4.32
France	4.19	4.63	4.06	3.16	2.97	2.81
Italy	3.84	4.29	3.58	2.55	2.32	2.54
UK	4.78	5.15	3.7	3.65	2.99	2.99
China	5.64	10.38	15.62	24.55	26.98	27.65
South Korea	2.04	2.45	2.28	2.45	2.30	2.24
Netherlands	1.35	1.51	1.35	1.07	1.13	1.04
Russia	0.77	2.2	2.28	1.7	1.78	2.24
India	1.54	2.29	2.89	3.09	3.09	3.47

Source: GVC output by country (2022)

Table 1 shows that the contribution of different countries in terms of the share of products produced in the GVN's varies from 2000 to 2022.

It is worth noting a significant increase in China's share, about five times over the period from 2000 to 2022. The role of India is also growing. Japan's share has significantly decreased. The US contribution is unstable. There has been a decrease after the global crisis of 2008-2009, and then the indicator began to grow.

As for Russia, its share has been increasing since the early 2000s, which may be due to an increase in importance in the energy markets and world oil prices. The fall in 2015 is the result of the sanctions policy introduced by Western countries and the decline in global oil prices. Until 2022, the indicator was recovering, and data for 2023 are not yet available.

Let's calculate the concentration indicators CR3 and CR5, as the sum of the shares of the three and five largest participants in the GVN's. The calculation of these indicators will allow us to conclude the degree of concentration of the main participants of the GVN's. The higher the values of these indices, the greater the role of the main participants in the GVN's (Table 2).

Table 2: Concentration indices CR3 and CR5

	2000	2007	2010	2015	2020	2022
CR3	53.3	44.13	47.13	53.94	56.21	56.09
CR5	63.72	55.49	56.67	62.26	63.95	63.67

Table 2 data allow us to conclude that the role of major participants in the GVN's is growing. If we consider the issue more comprehensively, considering the information presented in Fig. 1, the conclusion is as follows: the share of the GVN's in the total volume of global trade is decreasing, but within the GVN's, the role and importance of major participants is increasing.

Large firms also play an important role in spreading shocks through the GVN's. Negative fluctuations at the company level may be related to general economic fluctuations (Gabaix, 2011). The reason is that the degree of shock transmission depends on the types of transactions between firms. This can be arm's length trading (i.e., trading between independent parties) or intra-group trading (i.e., trading between vertically linked firms). For example, during the trade collapse caused by the global financial crisis of 2008-2009, intra-network trade in intermediate goods experienced a faster decline, followed by a faster recovery, than trading at arm's length (Altomonte et al., 2012).

Trade policy plays a decisive role in dealing with shocks and helping to prevent their negative consequences. For example, during the COVID-19 pandemic in 2020, trade flows requiring lower trade costs decreased less than average as more expensive and lower-



priority suppliers were pushed out of international markets (Nicita, Tresa, 2023). However, trade policy in the global value chain is also a tool for spreading shocks because countries are interconnected.

The growth of the GVNS was partly the result of the liberalization of trade in intermediate goods. Access to foreign intermediate resources can increase the volume and quality of exports, opening up new resources and technologies to enterprises (Cali et al., 2022). Even though tariffs are relatively low in most cases, their minor changes can significantly affect the global production chain. Economic shocks and the potential consequences of their spread are forcing countries to reconsider their policies in the international trading system and communications through the GVN's (Blanchard et al., 2016).

GVNs may increase the impact of tariff changes on imported intermediate goods. The multi-stage production model assumes that trade costs play a big role for two reasons. Firstly, products cross borders several times, so tariffs are repeatedly imposed on some of their parts. Secondly, even if a country's added value is only a small percentage of the value of the exported goods, the trading partners will still charge duties on the total value. These two effects are sometimes referred to as accumulation and magnification (Dollar et al., 2017).

Thus, under the influence of these factors and macroeconomic shocks, there was a serious reason to rethink the previous pre-crisis model, according to which global supply chains functioned.

Possible disruptions in the supply of resources in the production network in one country lead to a reduction in imports of intermediate products and exports of finished products by the trading partners located further down the production chain.

At the same time, the effectiveness of globalization processes was questioned even before the pandemic due to the risks associated with global financial imbalances, increased income inequality, and increased debate about the need for structural changes in the current system for organizing production at the global level (Dollar et al., 2017; Reglobalization For A Secure, Inclusive, And Sustainable Future, 2023; Herskovic et al., 2020).

However, in terms of changing supply chains, the shifts associated with past emergencies, such as the outbreak of severe acute respiratory syndrome (SARS) that swept across Asia in 2003, the accident at the Japanese Fukushima-1 nuclear power plant, and the flooding in Thailand in 2011, did not have such negative and sustained consequences such as the pandemic of the new coronavirus infection COVID-19 (Zelinskaya, Takmasheva, 2023).





Disruptions in global production chains have become one of the main negative consequences of the pandemic. The recovery in demand turned out to be rapid in most countries and regions, and the expansion of the supply of goods lagged behind demand due to problems with the supply of some components and the rise in the cost of logistics. This showed the vulnerabilities of the current system of organizing global production networks focused on uninterrupted operation and led to the realization of the need to move some of the production facilities back to the national territory, diversify suppliers, and reduce the transport leverage.

The observed decline in trade within GVN, which took place during the global financial crisis, trade tensions between China and the US, and the COVID-19 pandemic, may also indicate subsequent reconfiguration strategies implemented by governments and companies to reduce dependence on cross-border trade in intermediate products. Such initiatives or dialogues gain momentum during periods of large-scale upheaval, as global chains, with their overly complex production networks that transmit and mitigate risks, come under greater scrutiny. It is important to note that after the three crises mentioned above, the recovery in the value of gross exports and the return to the usual trade structures occurred quite quickly compared to the beginning of the crises. Reconfiguration strategies may well have played a big role in this.

International manufacturing is expected to undergo a drastic transformation shortly. This will be possible due to technological changes caused by the developing economy that these technologies will imply and shaped by the interaction between political trends and trends in sustainable development. It is expected that these events will cause a reconfiguration of the prevailing structure of the GVN. In general, the direction chosen by individual industries will depend on the starting point of their archetypal international production configurations.

Increased macroeconomic shocks are characterized by varying degrees of impact on the GVN related to their duration, and form bottlenecks in commodity and logistics systems. Furthermore, under the influence of the dynamics of market conditions, the events taking place have a related impact on the associated links of the supply chain.

Supply chain connections play a crucial role in how shocks are transmitted between countries. This has far-reaching implications for the interaction between supply, demand, and trade. Traditional models usually assume that a country's imports depend on its domestic demand. However, in modern conditions characterized by complex international supply chains, the dynamics of demand in other countries have also become a determining





factor. According to the Organization for Economic Cooperation and Development (OECD) trade in value added (TIVA) statistics, more than 20% of global imports are used as resources for domestic production processes and then integrated into goods that are subsequently re-exported. Negative demand factors in a particular country can spread up the GVN to resource suppliers. Similarly, supply disruptions can be transmitted down the supply chain, affecting other parts of it.

The observed decline in trade within GVN, which has been observed during the negative trends of recent years, dictates the need for GVN reconfiguration strategies implemented by governments and companies to reduce dependence on cross-border trade in intermediate products. Such initiatives or dialogues gain momentum during periods of large-scale upheaval, as the GVN, with their overly complex production relationships that both transmit and mitigate risks, are subject to greater scrutiny. It is important to note that after the crises, the recovery in the value of gross exports and the return to the usual trade structures occurred quite quickly compared with the beginning of the crises. Reconfiguration strategies may well have played a role in this.

To reduce the negative impact of external shocks resulting from increased political and economic instability, states have increasingly begun to use opportunities for regional integration. Many companies have begun to prefer the placement of their production in regions and countries that can provide the best combination of guarantees for the sustainability of production, cost, and efficiency. As a result of the reshoring, the role of regional value chains (RVCs) has increased.

Among the reasons motivating economic participants of value networks to make chains more sustainable due to their regionalization, one can highlight the following:

1. geographical proximity, which is associated with lower transportation costs and simplification in solving problems that arise during delivery;
2. lower trade barriers within the same region;
3. low information costs due to the ease of tracking the movement of goods during the delivery process;
4. low time costs (fast delivery of intermediate goods and the ability to predict deliveries).

A survey of 120 companies in the US conducted in March 2021 showed that about 41% of respondents had already moved part of their production back to the US in three years, and 22% of respondents were going to do so shortly.





Based on the study, GVN's under the influence of many factors are undergoing significant transformational changes. Adaptation to new conditions by governments and companies is becoming critically important for ensuring economic sustainability and protecting national interests and should include a set of measures aimed at the tasks.

The adaptation of companies and governments to the new conditions of the global economy requires an integrated approach, including regionalization and localization of production processes, diversification of supplies, investments in digitalization and innovation, promotion of international cooperation, and strengthening the role of the state in the economy.

We offer the following recommendations aimed at solving current problems.

1. Recommendations for companies participating in value networks:

1) Aiming for regionalization of production processes:

- development of regional value chains to reduce dependence on remote supplies and reduce risks in logistical disruptions;
- stimulating the creation of regional economic clusters that provide a synergistic effect and strengthen the relationship between producers, suppliers, and consumers within the same region.

2) Localization of production:

- the return of a part of production to national borders (reshoring) to increase the stability and independence of the economy, primarily in strategically important industries such as the production of medical equipment, essential supplies, and critical technologies;
- analysis of supply chains to identify the most vulnerable links in them and plan measures for their localization in the future.

3) Diversification of supplies:

- development of strategies for supplier diversification, including the creation of a network of suppliers in different regions to reduce dependence on a single supplier;
- creation of stocks of critical components and materials, which will reduce the risks associated with supply disruptions.

4) Investments in digitalization and innovation:

- digitalization of logistics processes through the introduction of digital technologies to increase transparency, manageability, and prompt response to changes in supply and demand;

*- the introduction of advanced technologies into production processes, which will increase the flexibility of **production**.*





II. Recommendations for governments:

1) Promotion of international cooperation and trade policy:

- participation in the development and support of multilateral trade agreements aimed at reducing trade barriers and simplifying trade procedures;
- Development of mechanisms to protect national producers within the framework of international trade agreements.

2) Regional economic integration:

- Strengthening economic ties between neighboring countries through regional free trade agreements;
- the creation of regional economic unions that promote joint development and integration of production processes.

3) Government support for strategically important industries:

- providing financial and administrative support to industries of critical importance to national security and the economy, such as energy, healthcare, and the food sector;
- development and implementation of government programs aimed at supporting R&D in strategically important industries.

4) Regulation and control of foreign economic activity:

- the introduction of mechanisms for monitoring and regulating foreign economic activity to protect national interests and prevent negative consequences from external shocks.

5) Infrastructure development and innovation support:

- investments in the modernization and development of transport and logistics infrastructure, which will increase the efficiency and reliability of logistics chains;
- creating favorable conditions for the development of communications infrastructure and digitalization, which will provide access to modern technologies and increase the competitiveness of the national economy;
- financing and support of scientific research and development, creation of innovative clusters and technology parks.

The proposed measures will help to increase the economic sustainability of value networks and protect national interests in the face of modern challenges and changes.

CONCLUSIONS

1. Modern macroeconomic trends have shown a significant vulnerability in the functioning of the GVN, which has led to the need to review and reassess the economic





efficiency of these systems. Countries and companies faced new challenges related to disruptions in logistics chains, which highlighted the importance of developing strategies to diversify suppliers and reduce dependence on global supply chains. These measures have become strategically important for countries to ensure the stability and continuity of production processes.

2. One of the increasing trends caused by the global economic turmoil of recent decades has been the regionalization of production processes, which allows countries and companies to reduce the risks associated with long and complex supply chains and increase the sustainability and independence of economies. Strengthening inter-country regional ties should facilitate faster and more effective adaptation to external shocks, which is strategically important in matters of national security.

3. Large companies play a leading role in spreading and/or mitigating economic shocks through the GVN, as they have the resources and capabilities to quickly adapt to changes and implement new supply chain management strategies. In conditions of strong economic fluctuations, large firms have a significant impact on the stability of the GVN, contributing to the introduction of innovative solutions and improving the efficiency of production process management.

4. Despite the decrease in the share of GVN in the total volume of world trade, the role and importance of major players are increasing within these networks. One should especially note the growing influence of China, which has significantly increased its share in the GVN over the past 20 years. This highlights the relevance of considering changes in the international trading system and adapting management strategies to ensure competitiveness and sustainability in global markets.

5. In the context of global economic events, it is necessary to strengthen regional supply chains, diversify sources and suppliers, actively introduce digital technologies and innovations, as well as strengthen the role of the state in supporting strategically important industries and regulating foreign economic activity, which will help increase economic sustainability, protect national interests and ensure stability and continuity of production processes.

6. For a deeper understanding of the GVN and effective management in conditions of uncertainty, it is necessary to continue research in this area. It is important not only to study new factors and trends affecting global value chains but also to develop methods and tools for analyzing and predicting their dynamics. Scientific research should focus on



identifying successful practices and innovative solutions that will help increase the sustainability and adaptability of the GVN's in the face of global challenges and changes.

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