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THE TRANSFORMATION OF EU ENERGY IMPORTS: IMPLICATIONS FOR ENERGY SECURITY AND GEOPOLITICAL RISK

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SUMMARY

The paper analyses the impact of the geopolitical conflict in the Middle East on the energy security of the European Union (EU) in the context of efforts to reduce dependence on Russian energy resources following the outbreak of the war in Ukraine and the subsequent adoption of European sanctions against the Russian Federation. In this context, the EU diversified its supply sources by increasing imports of liquefied natural gas and oil from countries such as Qatar, while also strengthening energy relations with suppliers in the Middle East and other regions. However, the escalation of regional tensions and the risks to maritime security in the Strait of Hormuz create new vulnerabilities for the European energy market and the stability of energy prices. The research is based on the hypothesis that the European Union has not eliminated the geopolitical vulnerability of its energy security but has instead transferred it to new external dependencies and trade routes exposed to geopolitical instability. The methodology combines qualitative analysis of European energy policies, particularly the European Green Deal and REPowerEU, with quantitative analysis of EU energy trade flows using COMEXT data. The study aims to assess the extent to which current European policies are sufficient to strengthen strategic energy autonomy and highlights the need to accelerate investments in renewable energy, green hydrogen, storage infrastructure, and nuclear energy as complementary solutions for reducing the European Union's external vulnerabilities.

Keywords: *decoupling, energy diversification, geopolitical risk, green deal, hydrogen, LNG, REPowerEU, strategic autonomy*

INTRODUCTION

The outbreak of the war in Ukraine in 2022 fundamentally reshaped the European Union's energy security architecture and accelerated efforts to reduce dependence on Russian energy resources. The successive rounds of sanctions imposed on the Russian Federation, combined with Moscow's gradual reduction in gas supplies to European markets, exposed the structural vulnerabilities of the EU's energy system, particularly its high dependence on external fossil fuel suppliers. In response, the European Union adopted a series of strategic measures to diversify energy imports, stabilise supply chains, and strengthen long-term energy resilience through initiatives such as REPowerEU and the European Green Deal.

The rapid decoupling from Russian energy resources generated significant changes in the geography of European energy imports. To compensate for the decline in pipeline gas deliveries from the Russian Federation, the EU increased imports of liquefied natural gas (LNG), strengthened partnerships with alternative suppliers, and expanded its reliance on global maritime energy trade routes. Within this context, the Middle East gained renewed strategic importance due to its role in global oil and LNG markets, particularly through suppliers such as Qatar and its influence on international energy prices.

However, the intensification of geopolitical tensions in the Middle East has introduced new uncertainties regarding the stability of global energy markets. The onset of new conflicts in the Middle East, particularly those involving Iran, has significant geopolitical and economic ramifications, especially concerning global energy markets and the energy security of regions such as the European Union (EU) (Rettig, 2026). The complexity of these dynamics is underscored by how regional actors adapt their policies and forge new alliances to mitigate the impact of supply disruptions and diplomatic challenges (Rettig, 2026). In particular, the strategic relevance of the Strait of Hormuz represents a major vulnerability for the international energy system, given that a substantial share of global oil and LNG trade transits through this maritime chokepoint. Any disruption to maritime security in the region may lead to supply shortages, price volatility, and additional pressure on European energy markets.

Against this background, the present study examines the extent to which the European Union's Current energy transition strategies can address not only climate objectives but also the geopolitical dimensions of energy security. The paper is based on the hypothesis that the diversification of EU energy imports following the reduction of dependence on Russian energy resources has not eliminated geopolitical vulnerabilities related to energy supply security, but has instead shifted them toward new suppliers and trade routes exposed to geopolitical instability.

Given the multidimensional nature of energy security, the present study adopts a focused analytical perspective. Rather than examining all dimensions of energy security, such as affordability, environmental sustainability, energy poverty, or the technical resilience of energy systems, the paper concentrates on the external dimension of energy security, namely the security of energy supply, import dependence, diversification of suppliers, and exposure to geopolitical risks within global energy value chains.

Hence, energy security is understood as the European Union's capacity to ensure stable and reliable access to energy resources while limiting strategic vulnerabilities arising from excessive dependence on external suppliers, critical transport corridors, and geopolitically unstable regions. Particular attention is therefore devoted to the transformation of EU energy import structures after

2022 and to the extent to which diversification strategies promoted through REPowerEU and the European Green Deal contribute to strengthening the Union's strategic energy autonomy.

Consequently, the analysis does not seek to provide a comprehensive assessment of energy security in all its dimensions, but rather to evaluate how changes in external energy dependencies and global supply chains affect the geopolitical dimension of EU energy security.

METHODOLOGY

Methodologically, the research combines qualitative analysis of European energy policies, particularly REPowerEU and the European Green Deal, with quantitative analysis of EU energy trade flows using COMEXT statistical data. The empirical analysis primarily covers the 2019–2024 period, while selected indicators for 2025 are included where partial data are available. The analysis focuses on several indicators, including the evolution of extra-EU imports of natural gas, liquefied natural gas (LNG), crude oil, and petroleum products, as well as the geographical diversification of energy suppliers. Particular attention is given to the decline of energy trade relations with the Russian Federation and to the evolution of imports from other alternative suppliers. Through this approach, the study seeks to determine whether diversifying energy imports has reduced the EU's geopolitical vulnerabilities or merely shifted them to other politically unstable regions. The study also evaluates whether current European policies are sufficient to strengthen the EU's strategic energy autonomy or whether additional investments in renewable energy, green hydrogen, energy storage infrastructure, and nuclear energy are required to reduce long-term external vulnerabilities. Furthermore, the paper contributes to the broader debate concerning the relationship among the energy transition, geopolitical risk, and strategic autonomy in an increasingly fragmented international system.

The present study is subject to several limitations. First, the highly dynamic geopolitical context in the Middle East and the ongoing evolution of the war in Ukraine may lead to rapid changes in energy markets, trade routes, and European energy policies that cannot be fully captured within the research timeframe. Second, the analysis is limited by the availability of statistical data, particularly for 2025, as complete and harmonised datasets for EU energy trade flows were not yet available at the time of writing for certain product categories.

In addition, the study focuses primarily on external energy trade relations and import diversification, without conducting a detailed assessment of domestic energy production capacities or the long-term technological feasibility of alternative energy solutions such as hydrogen infrastructure and next-generation nuclear technologies. Consequently, the findings should be interpreted within the broader context of ongoing geopolitical and economic developments affecting the global energy system.

THE EU ENERGY SECURITY – MAIN APPROACHES IN THE LITERATURE REVIEW

Recent literature increasingly emphasizes the strong interconnection between geopolitical instability and energy security, particularly in the context of the war in Ukraine and the escalation of tensions in the Middle East. Geopolitical conflicts in both regions have profoundly affected global energy markets and the European Union's energy security architecture by generating supply disruptions, market volatility, inflationary pressures, and the need for urgent policy responses focused on diversification and resilience (Basdekis et al., 2026; Torok, 2026). Existing studies underline that the EU energy market has entered a new phase characterized by structural uncertainty, where energy policy can no longer be separated from geopolitical and security considerations (De Jong, 2026; Wang et al., 2026).

A significant body of literature focuses on the consequences of the Russia–Ukraine war for European energy markets. Geopolitical shocks associated with the conflict increased tail risk in crude oil and natural gas markets, generating heightened volatility and substantial downside risks for European energy supplies (Basdekis et al., 2026; Kallel et al., 2026). Several studies also demonstrate that the efficiency of electricity and gas markets in Europe deteriorated after the outbreak of the war, particularly in Germany, where price discovery mechanisms weakened and market correction capacities became less effective during periods of crisis (Xin et al., 2026). In response to these disruptions, the European Union attempted to preserve market integration and maintain coordinated energy governance. Nevertheless, national governments increasingly prioritized energy security objectives, strategic reserves, and long-term supply contracts, contributing to the emergence of a more hybrid and interventionist energy market structure (Bolton, 2026).

The literature also highlights the environmental and social consequences of the energy crisis. Due to reduced gas supplies and rising prices, several Member States temporarily increased coal consumption in order to stabilize electricity production, generating significant environmental and public health costs associated with higher emissions (Liebensteiner & Kimani, 2026). At the same time, renewable energy sources acquired a more stabilizing role within European energy systems, while

fossil fuels became increasingly associated with market instability and geopolitical exposure (Wang et al., 2026). In this regard, recent studies introduced new analytical tools, such as the War-Induced Energy Intensity index, to evaluate the differentiated impact of geopolitical crises across EU Member States (Wang et al., 2026).

Another important research direction concerns resilience and diversification strategies. Decentralized energy generation systems, particularly bioresource-based systems, have been identified as effective instruments for strengthening energy resilience in politically unstable environments such as Ukraine (Fedoreiko et al., 2026). Similarly, studies examining Franco-German energy cooperation emphasize the strategic importance of hydrogen imports, large-scale energy storage infrastructure, and coordinated industrial policies for achieving long-term European energy security (Meisinger et al., 2026). The literature further underscores that the vulnerability of the EU energy system remains unevenly distributed, with smaller Member States particularly exposed to supply disruptions and price fluctuations, thereby reinforcing the need for diversification policies and targeted institutional support (Torok, 2026).

An expanding area of research investigates the relationship between geopolitical risk, financial markets, and energy transition policies. Recent studies demonstrate that geopolitical risk indices increasingly influence the dynamics of European carbon markets and improve the forecasting of market reactions compared to traditional economic indicators (Cao et al., 2026). Deep learning and AI-based forecasting models are also being developed to monitor geopolitical risks and provide early-warning mechanisms for policymakers and energy market surveillance (Bozkurt, 2026; Cao et al., 2026). Other studies analyze the effects of geopolitical instability on energy-related financial instruments, including clean energy and carbon ETFs, revealing significant spillover effects during periods of economic downturn and geopolitical uncertainty (Gabriel et al., 2026).

Beyond the energy sector itself, the literature increasingly recognises the cross-sectoral effects of energy crises. Price volatility in energy markets has amplified price transmission mechanisms within agri-food supply chains, as demonstrated by studies of Germany's malt-beer sector (Bublik & Čechura, 2026). Other authors stress that local realities, including phosphorus scarcity, fuel-switching practices, and municipal planning decisions, are closely connected to broader geopolitical transformations, although these dimensions are often insufficiently represented in public discourse and media coverage (Metson et al., 2026; Bettineschi et al., 2026). Furthermore, the war in Ukraine generated unprecedented concerns regarding nuclear safety and security, highlighting the necessity of international coordination and robust technical safeguards for critical infrastructure during wartime conditions (Dolin et al., 2026).

Several studies also point to the differentiated global effects of geopolitical crises. Research on the resilience of the United States stock market illustrates the asymmetric impact of conflicts across sectors and regions, while analyses of commodity co-movements indicate that crisis periods alter traditional relationships between energy assets and safe-haven commodities such as gold (Jardak & Belghith, 2026; Hkiri et al., 2026). At the same time, geopolitical events continue to accelerate the global reallocation of energy trade flows, often affecting Europe more severely due to slow energy transitions, technological lock-in, and persistent dependence on imported fossil fuels (Ren et al., 2026). A recent study shows that EU-level market design and shifts in external dependencies are connected to regional siting, municipal planning, and household-level perceptions (Radtke & Canzler, 2026).

Other contributions also explore how governance structures and policy responses evolved during the European energy crisis. Studies examining electricity pricing policies show that energy governance increasingly shifted toward national priorities focused on industrial competitiveness and energy security objectives (Bolton, 2026). In parallel, research on municipal gas companies in France and Spain demonstrates how local institutional and economic conditions influenced adaptation strategies in the post-war energy market environment (Fernandez & Larrinaga, 2026). Likewise, analyses of the so-called Iberian Exception implemented in Spain and Portugal indicate that, although the mechanism reduced electricity bills for consumers, it also increased gas demand and partially offset the expected reduction in price pressures (Lou et al., 2026).

Within the broader geopolitical context, the Middle East occupies an increasingly important position in discussions concerning European energy security. The adaptive strategies Israel developed in its oil import policies, including diversifying suppliers and investing in clean energy technologies, illustrate how regional actors respond diplomatically and technologically to trade disruptions and geopolitical instability (Rettig, 2026). However, despite growing attention to the consequences of the war in Ukraine, relatively little research examines in detail the long-term implications of renewed instability in the Middle East for the European Union's energy security architecture.

The existing literature therefore reveals several important research gaps. First, most studies focus on the immediate consequences of the Russia–Ukraine war and on short-term diversification policies, while fewer analyses address the long-term strategic implications of the EU's new external energy dependencies (Torok, 2026). Second, the environmental and social consequences of crisis-induced fuel switching remain insufficiently explored at the local and regional levels across the European Union (Liebensteiner & Kimani, 2026; Bettineschi et al., 2026). Third, the effectiveness and scalability of decentralized energy systems in politically unstable environments require further investigation (Fedoreiko et al., 2026). Existing research also underrepresents the broader cross-sectoral effects of energy insecurity, particularly

regarding agri-food supply chains and local governance structures (Bublik & Čechura, 2026).

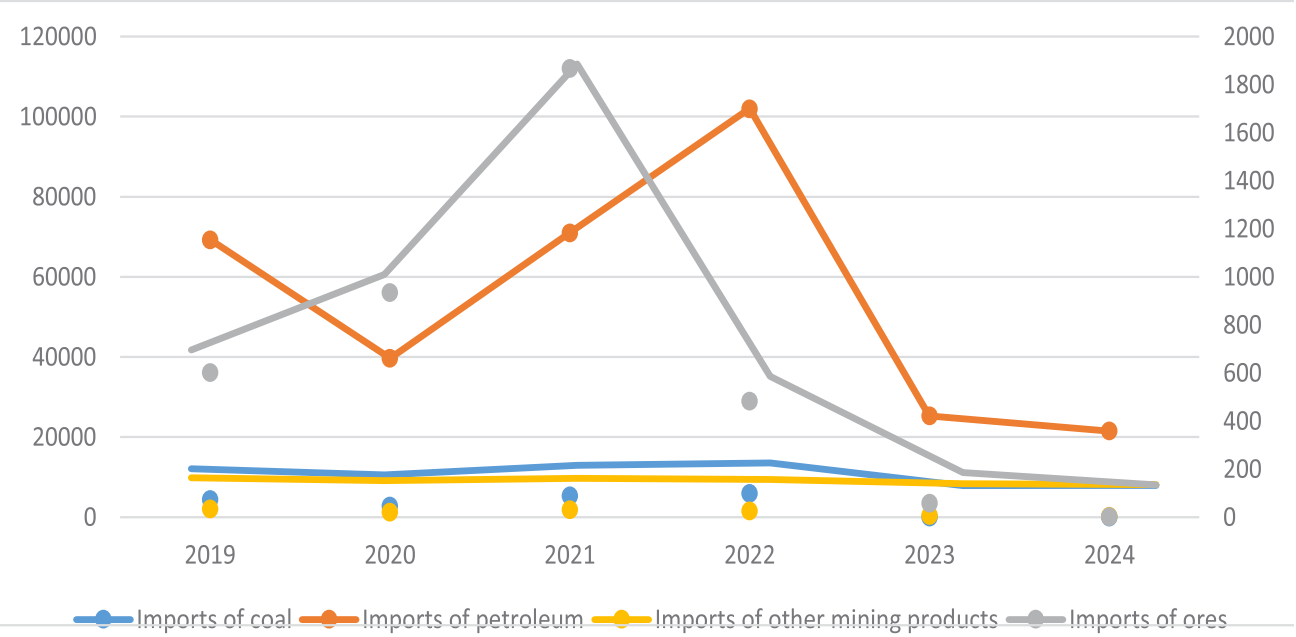
Most importantly, relatively little attention has been devoted to analysing how the escalation of geopolitical tensions in the Middle East may reshape the European Union's energy security following the decoupling from the Russian Federation. This study contributes to the literature by examining whether the diversification of energy imports after 2022 reduced the EU's geopolitical vulnerabilities or merely shifted them to alternative suppliers and to strategically vulnerable maritime routes, such as the Strait of Hormuz. In doing so, the paper seeks to connect the literature on energy transition, geopolitical risk, and strategic autonomy within the evolving context of European energy security.

MAIN RESULTS

THE IMPACT OF SANCTIONS IMPOSED ON THE RUSSIAN FEDERATION ON EU ENERGY TRADE

The sanctions imposed by the European Union against the Russian Federation between 2022 and 2025 represent one of the most extensive economic coercion mechanisms implemented in recent decades. From a theoretical perspective, economic sanctions are generally designed to generate sufficient economic pressure to alter the political behaviour of the targeted state by restricting access to strategic resources, financial markets, technologies, and international trade networks. Within the framework of interdependence theory and coercive economic diplomacy, sanctions are expected to increase the economic costs of conflict and reduce the targeted state's capacity to sustain military operations over the long term. In the case of the European Union and the Russian Federation, sanctions proved highly effective in accelerating the decoupling of bilateral energy trade relations (Figure 1). Figure 1 illustrates the evolution of EU–Russian Federation energy trade between 2019 and 2025. The selected timeframe allows the analysis to capture both the effects of the COVID-19 pandemic on international energy markets and, more importantly, the structural changes generated by the successive sanctions packages adopted after the outbreak of the war in Ukraine in 2022. The period also reflects the progressive decoupling of the European Union from Russian fossil fuel imports and the reconfiguration of European energy supply chains.

Figure 1.
The EU energy imports from Russian Federation, 2019-2024 (EUR million)



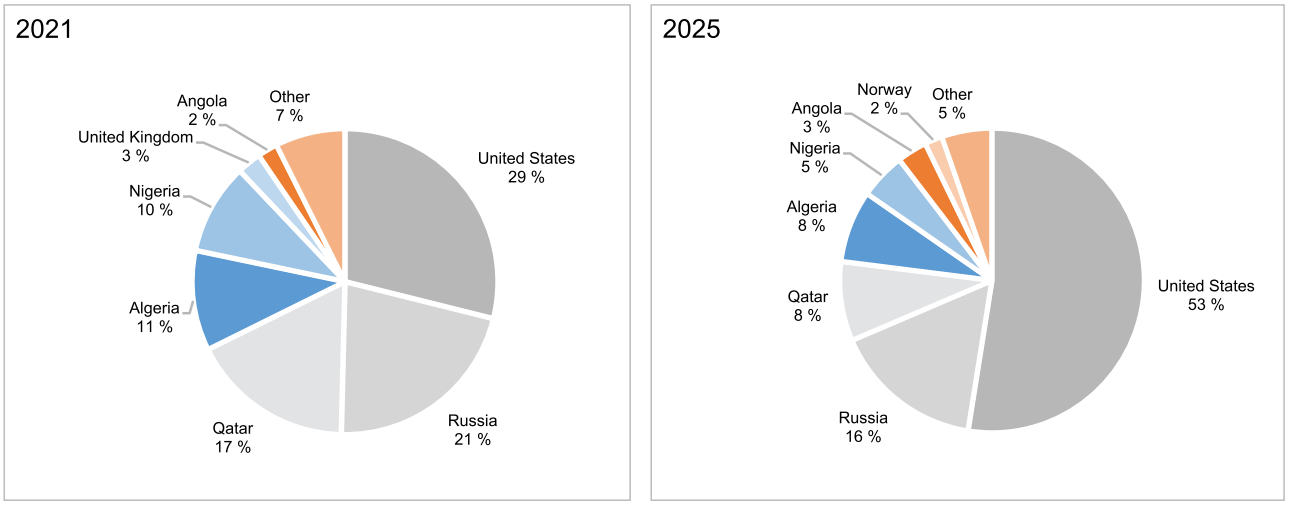
Source: *Author's processing based on COMEXT data (https://ec.europa.eu/eurostat/comext/newxtweb/setupdimselection.do)*

Note: *The 2019–2024 timeframe was selected to compare pre-war trade dynamics with the post-2022 transformations in EU–Russian Federation energy trade relations, induced by successive sanctions packages. The selected categories of energy imports aim to illustrate the reduction of the European Union's energy dependence on the Russian Federation in the context of economic sanctions. Data for 2025 are only partially available and will therefore be considered in future research. Trade values originally reported in EUR in the Eurostat COMEXT database were converted into million EUR for improved readability and graphical representation.*

The progressive embargoes on coal and oil imports, restrictions on maritime transport and insurance services, and the gradual reduction of pipeline gas imports significantly transformed the structure of EU energy supply chains. Statistical data from 2021 to 2025 indicate diversification of suppliers and expansion of LNG imports from alternative partners.

Figure 2.

The evolution of EU's LNG imports by partner, 2021–2025 (%)



Source: Author's processing based on COMEXT data (https://ec.europa.eu/eurostat/comext/newxtweb/setupdimselection.do)

However, the broader geopolitical effectiveness of sanctions remains more contested. Although sanctions contributed to the reduction of direct energy dependence between the EU and the Russian Federation, they did not produce the anticipated political outcome of ending the war in Ukraine or substantially limiting Russia's capacity to finance military operations. Existing literature increasingly highlights the adaptive capacity of sanctioned economies and the emergence of sanctions circumvention mechanisms within globalised markets. In the Russian case, the development of "shadow trade" networks and the so-called "shadow fleet" played a significant role in maintaining hydrocarbon exports despite Western restrictions. The concept of "shadow fleet" refers to a network of ageing tankers operating under opaque ownership structures, frequently registered under flags of convenience and employing complex maritime practices to circumvent sanctions and price caps. Similarly, "shadow trade" involves indirect commercial routes, intermediary states, re-export practices, oil blending operations, and alternative payment systems that allow sanctioned commodities to continue reaching global markets. Through these mechanisms, Russian hydrocarbons continued to circulate internationally, often through intermediary markets in Asia, the Middle East, or other third countries. At the same time, the escalation of geopolitical tensions in the Middle East placed additional pressure on global energy markets by heightening price volatility and concerns about supply security, particularly around the Strait of Hormuz. Rising oil and LNG prices indirectly helped sustain hydrocarbon revenues for major exporting states, including the Russian Federation. Consequently, the current geopolitical environment demonstrates that while sanctions can effectively reshape trade patterns and reduce direct dependencies, their capacity to generate rapid political change remains constrained by the flexibility of global energy markets, the adaptability of sanctioned actors, and the existence of alternative commercial and financial networks.

For the European Union, this process generated high economic and strategic costs. The rapid reduction in Russian energy imports required recalibrating supply chains, developing new LNG infrastructure, and establishing alternative partnerships with suppliers in the Middle East, North Africa, and the United States. Although these measures strengthened diversification, they also transferred part of the EU's geopolitical vulnerability toward new regions affected by instability and geopolitical tensions. As a result, the current energy transition highlights the complex relationship between sanctions, energy security, and strategic autonomy within an increasingly fragmented international system.

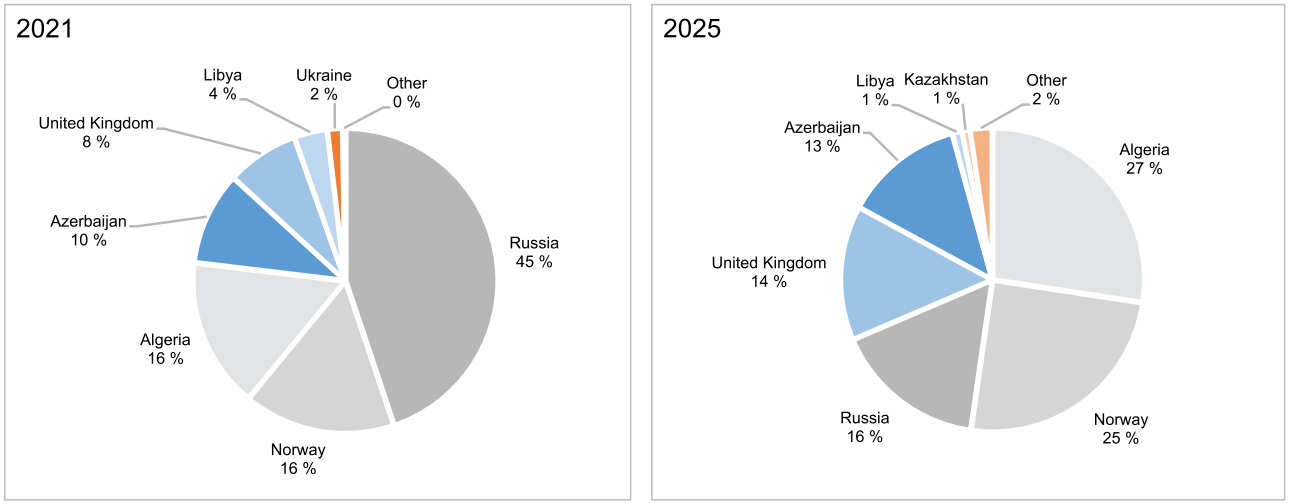
THE MAIN ENERGY SUPPLIERS OF THE EU IN THE CURRENT GEOPOLITICAL CONTEXT

The successive sanctions packages imposed on the Russian Federation after 2022 significantly accelerated the reconfiguration of the European Union's external energy supply structure. As direct energy trade relations with the Russian Federation progressively declined, the European Union intensified its efforts to diversify imports of crude oil, natural gas, and liquefied natural gas (LNG) through alternative suppliers. Within this

context, the strategic importance of the United States and the Middle East increased considerably, particularly regarding LNG exports, maritime oil trade, and global energy market stabilisation. The United States rapidly emerged as the European Union's main LNG supplier, benefiting from the expansion of transatlantic energy cooperation and the growing European demand for non-Russian gas supplies. At the same time, Middle Eastern producers, particularly Qatar and Iraq, consolidated their roles in the European energy market by increasing LNG and crude oil exports. These developments helped reduce direct dependence on Russian fossil fuels while increasing the EU's exposure to global maritime trade routes and geopolitical instability in strategically important regions, such as the Strait of Hormuz. Figures 3 and 4 illustrate the comparative evolution of the European Union's energy imports of natural gas and petroleum products between 2021 and 2025. The data highlight the structural transformation of European energy supply chains following the outbreak of the war in Ukraine and the implementation of sanctions against the Russian Federation.

Figure 3.

EU's imports of natural gas in gaseous state, 2021–2025 by partner (%)

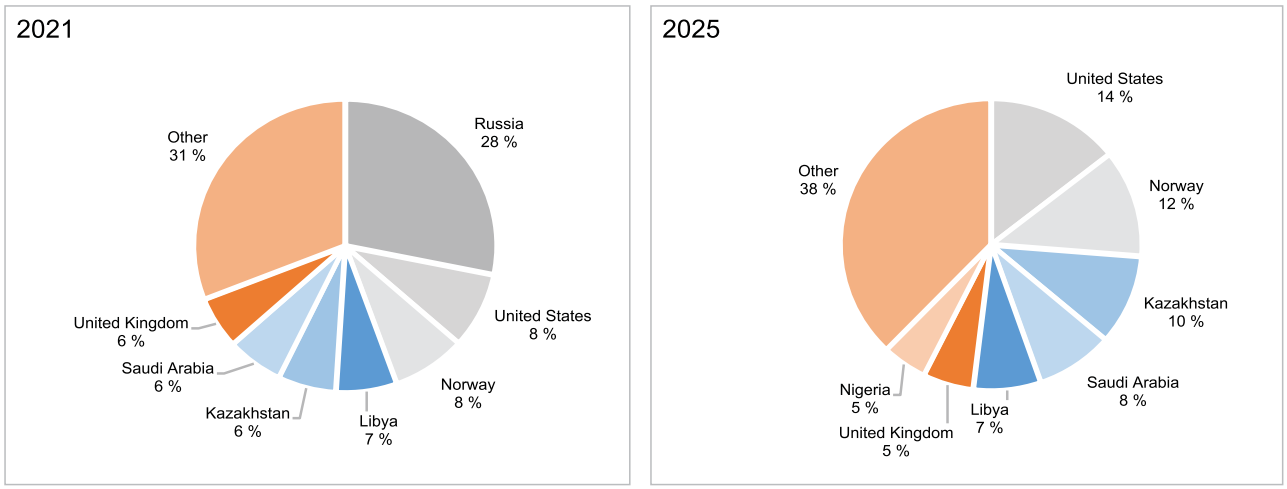


Source: Author's processing based on COMEXT data (https://ec.europa.eu/eurostat/comext/newxtweb/setupdimselection.do)

Figure 3 highlights that although the share of the Russian Federation in EU imports of natural gas in gaseous state declined significantly after 2022, Russian gas did not disappear entirely from the European market. At the same time, alternative suppliers such as Norway, Algeria, Azerbaijan, and the United Kingdom increased their relative importance, illustrating the European Union's strategy of regional diversification and supply substitution. The data also indicate that the diversification of natural gas imports differs structurally from LNG diversification. While LNG imports increasingly relied on transatlantic and global maritime suppliers, gaseous natural gas imports remained closely tied to regional pipeline infrastructure and geographic proximity. Consequently, the European Union's energy transition generated a complex redistribution of dependencies rather than a complete elimination of external vulnerabilities.

Figure 4.

EU's imports of petroleum oil, 2021–2025 by partner (%)



Source: Author's processing based on COMEXT data (https://ec.europa.eu/eurostat/comext/newxtweb/setupdimselection.do)

Figure 4 illustrates the profound transformation of the European Union's petroleum import structure between 2021 and 2025. While the Russian Federation represented one of the EU's largest petroleum suppliers before the war in Ukraine, its role declined substantially following the implementation of sanctions and embargo measures. At the same time, alternative suppliers such as the United States, Norway, Kazakhstan, Saudi Arabia, Libya, and Nigeria increased their relative importance within the European energy market. However, the diversification of petroleum imports also generated new geopolitical vulnerabilities. Several of the emerging suppliers are located in politically unstable regions or depend on strategically sensitive maritime trade routes affected by geopolitical tensions in the Middle East and North Africa. In particular, instability in Libya, tensions in the Red Sea region, and security risks surrounding the Strait of Hormuz highlighted the European Union's continued exposure to external energy shocks despite a reduction in direct dependence on the Russian Federation.

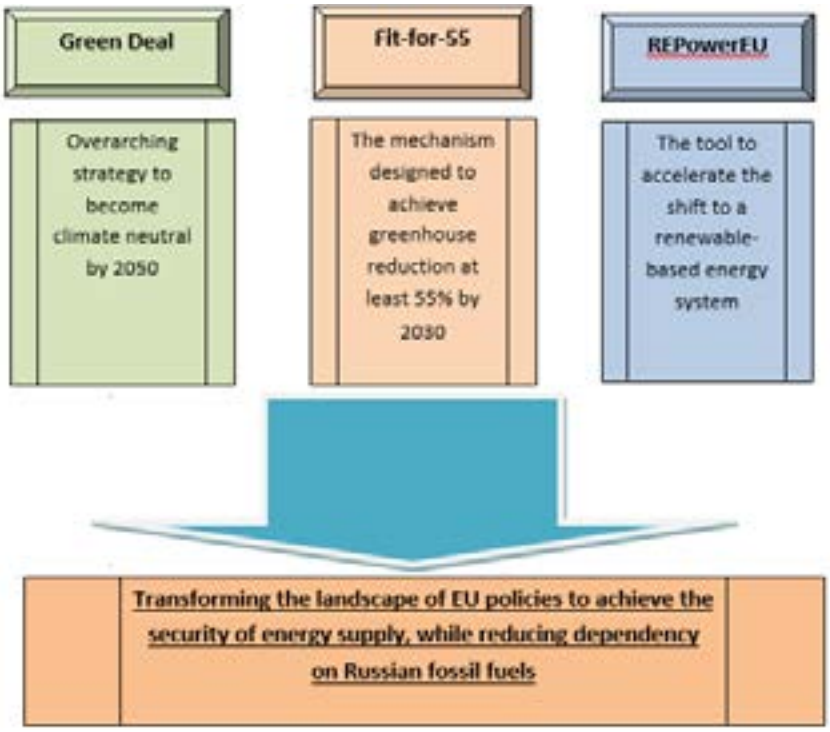
Consequently, the data suggest that the post-2022 restructuring of European petroleum imports did not eliminate geopolitical vulnerability, but rather redistributed it across a broader network of suppliers and transport corridors exposed to political instability and global market volatility.

EU STRATEGIC APPROACHES TO STRENGTHENING ENERGY SECURITY IN A CHANGING GEOPOLITICAL ENVIRONMENT

In recent years, the European Union has implemented several strategic initiatives to strengthen energy security while maintaining the objectives of the green transition. The outbreak of the war in Ukraine and the subsequent energy crisis highlighted the structural vulnerabilities generated by the European Union's dependence on imported fossil fuels, particularly those originating from the Russian Federation. At the same time, the geopolitical instability affecting global energy markets and strategic maritime routes emphasized the necessity of accelerating the transition toward a more resilient and diversified energy system.

As illustrated in Figure 5, the European Green Deal, the Fit-for-55 package, and the REPowerEU strategy represent the main pillars of the European Union's current energy transformation framework. While the European Green Deal established the long-term objective of achieving climate neutrality by 2050, the Fit-for-55 package introduced concrete legislative mechanisms designed to reduce greenhouse gas emissions by at least 55% by 2030. Complementary to these initiatives, REPowerEU emerged as a strategic response to the post-2022 geopolitical environment, focusing on reducing dependence on Russian fossil fuels, diversifying energy suppliers, accelerating renewable energy deployment, and increasing investments in energy infrastructure and storage capacities.

Figure 5.
Main EU approaches to enhancing energy security



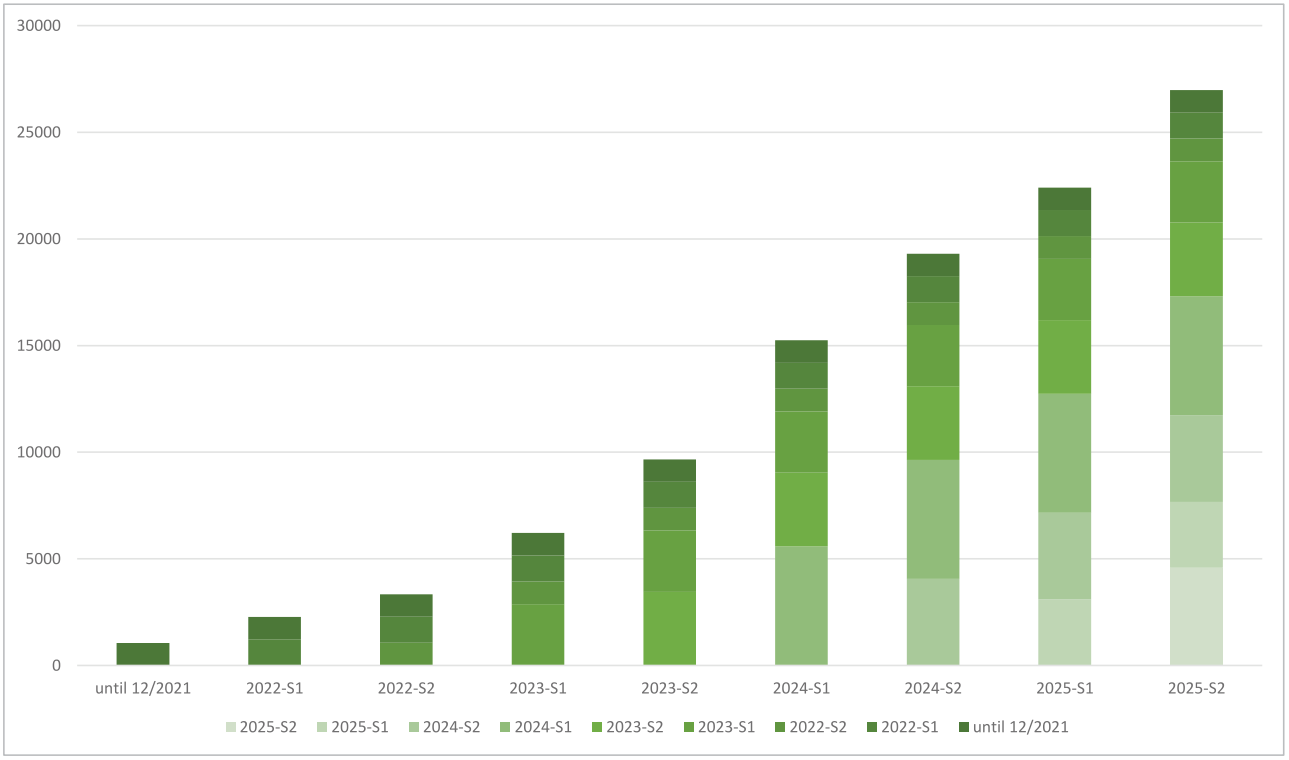
Source: Author's own representation.

Beyond the immediate objective of replacing Russian energy imports, these strategies also reflect the broader ambition of achieving greater strategic autonomy in the energy sector. In this context, renewable energy sources, hydrogen technologies, energy storage systems, and nuclear energy increasingly occupy a central role within the European Union's long-term security framework. However, the transition process remains complex, as the rapid diversification of suppliers and the growing reliance on LNG imports have also created new geopolitical vulnerabilities tied to maritime transport routes and politically unstable supplier regions.

Against this background, it should be noted that data provided by the Recovery and Resilience Scoreboard indicate a substantial increase in additional operational renewable energy capacity installed at the EU level after 2022, reflecting the strategic acceleration of the green transition in response to the energy crisis and geopolitical instability (Figure 6).

Figure 6.

Evolution of additional operational capacity installed for renewable energy in all EU Member States (MW)



Source: Author's own representation based on Recovery and Resilience Scoreboard data (/recovery-and-resilience-scoreboard/RRFCI02.html).

Note: Figure 6 illustrates the cumulative additional operational renewable energy capacity installed in the European Union, expressed in MW. The indicator is a stock indicator provided by the Recovery and Resilience Scoreboard, meaning that the installed operational capacities accumulate over time and can therefore only increase throughout the analysed period. The values presented for each semester include the operational capacities installed during the previous reporting periods. Data for Germany were unavailable due to ongoing verification procedures by the European Commission.

Consequently, the current geopolitical context demonstrates that energy security can no longer be understood exclusively through the lens of supply diversification. Instead, the European Union must simultaneously accelerate investments in clean energy technologies, strengthen internal energy production capacity, modernise interconnection infrastructure, and reduce strategic external dependencies to build a more resilient and sustainable energy system.

After four years of sanctions against the Russian Federation, formerly the largest supplier of fossil fuels to the European Union, the EU's energy security is once again exposed to geopolitical risks stemming from the ongoing conflict in the Middle East.

Against this background, the current state of the European energy market can be critically assessed through a SWOT analysis of the main achievements and remaining vulnerabilities of the European Union's energy security strategy (Figure 7).

Figure 7.
SWOT analysis of the EU's energy security under the current economic environment

Strengths	Weaknesses
• The coherent vision to achieve a climate-neutral economy • The increasing of diverse supply of fossil fuels from other destinations then Russian Federation • The increase of LNG and of renewables in the energy mix	• The higher cost of renewable energy • The persistence of fossil fuel dependence • Overlapping regulations that make the enforcement process more difficult
Opportunities	**Threats**
• New partnerships with the US to increase the energy supply • The Green Deal as a reallocation mechanism to foster investment shifts, while supporting vulnerable segments of society through the decarbonisation process.	• Geopolitical instability in the Middle East is affecting global energy supply chains • The current legal framework sets too ambitious targets, while lacking a more tailored approach for the specific needs of Member States

Source: Author's own representation.

As highlighted by the SWOT analysis, the European Union currently benefits from a relatively coherent legal and strategic framework that can accelerate the green transition while supporting more efficient resource use to strengthen energy security. Nevertheless, greater attention should be paid to the mechanisms of a just transition, particularly in underdeveloped regions and vulnerable industrial sectors that may face difficulties adapting to the ambitious objectives set by the European Green Deal, Fit-for-55, and REPowerEU strategies. In addition, the transition process requires substantial investments in workforce reskilling, technological innovation, energy infrastructure, and strategic energy storage capacity to reduce long-term external vulnerabilities.

CONCLUSIONS

The current geopolitical context demonstrates that the European Green Deal, Fit-for-55, and REPowerEU can no longer be interpreted exclusively as environmental or climate-oriented initiatives. Increasingly, these strategies also function as instruments of geopolitical resilience, industrial transformation, and strategic autonomy within a highly unstable international energy market. At the same time, the accelerated energy transition creates significant asymmetries among Member States, as differences in industrial capacity, infrastructure, technological development, and fiscal resources affect their ability to adapt to the new energy framework. Consequently, maintaining the balance between climate ambitions, economic competitiveness, and social cohesion will remain one of the European Union's main strategic challenges during the next decade. In this regard, investments in renewable energy, hydrogen technologies, energy storage systems, smart grids, and nuclear energy may gradually reduce the European Union's structural external vulnerabilities and strengthen its long-term capacity to respond to future geopolitical shocks affecting global energy markets.

The empirical analysis demonstrates that the structure of the European Union's energy imports has changed significantly after 2022. While the Russian Federation progressively lost its position as the EU's main external energy supplier, the strategic importance of the United States and Middle Eastern partners increased substantially, particularly for LNG and petroleum imports. However, this diversification process also generated new geopolitical vulnerabilities associated with global maritime trade routes, politically unstable supplier regions, and the growing dependence on external energy supply chains.

Against the backdrop of overlapping geopolitical and energy crises stemming from the prolonged conflicts in Ukraine and the Middle East, the European Union may increasingly need to strengthen its internal energy production capacity and reduce its excessive dependence on global energy value chains. Consequently, greater emphasis could be placed on the development of domestic renewable energy production, hydrogen technologies, strategic storage infrastructure, and, where politically and economically feasible, the modernisation or reopening of nuclear energy capacities. In the long term, the consolidation of European energy security will depend not only on supplier diversification but also on the European Union's capacity to enhance strategic autonomy and internal resilience in an increasingly fragmented geopolitical environment.

Data Availability Statement

The data used in this research are publicly available through the Eurostat COMEXT (EasyComext) database and were used to analyse the European Union's energy trade flows. The datasets can be accessed online at: https://ec.europa.eu/eurostat/comext/newxtweb/setupdimselection.do

The research is based exclusively on publicly available statistical data accessible to researchers and interested institutions. No original datasets were generated during the study.

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ON THE BUOYANCY OF TOTAL BUDGET REVENUES IN MOLDOVA: ECONOMETRIC ESTIMATES AND REVENUE FORECASTS

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SUMMARY

An economy's total budget revenue is a key variable for the efficient design and conduct of economic policy and for maintaining fiscal and debt sustainability. Following a brief analysis of the notion of the buoyancy of total budget revenues and its estimation, the paper estimates the buoyancy of total revenues in the Moldovan economy using quarterly data on total budget revenues and Gross Domestic Product for the period from the first quarter of 2016 to the fourth quarter of 2025, thereby providing updated country-specific evidence based on high-frequency data. The empirical work reported in the paper suggests that the buoyancy of total budget revenues in Moldova's economy is close to 1.06. The paper then forecasts the medium-term evolution of total budget revenues using quarterly Gross Domestic Product forecasts from an estimated time series model. The total revenue forecasts are lower than the Ministry of Finance's latest forecasts. The paper suggests regularly updating the buoyancy estimate and revenue forecasts for both monitoring and forecasting purposes.

Keywords: buoyancy, total budget revenues, Moldova

INTRODUCTION

The evolution of total budget revenues is a key variable for the efficient design of economic policy and the maintenance of fiscal and debt sustainability. The goal of this paper is to estimate the buoyancy of total budget revenues in Moldova and to generate medium-term forecasts of total budget revenues.

The paper is organised as follows: Section 2 briefly analyses the notion of buoyancy and its estimation. Section 3 presents the data used for empirical work and the econometric estimate of the buoyancy of total budget revenues in Moldova. Section 4 presents quarterly forecasts of nominal Gross Domestic Product (GDP) and total budget revenues from the first quarter of 2026 through the fourth quarter of 2028. Section 5 concludes. The paper's statistical annex reproduces the data used for empirical work.

A NOTE ON THE NOTION OF BUOYANCY AND ITS ESTIMATION

The buoyancy of a tax, B, is defined by the ratio of the percentage change of the revenues generated over the percentage change of the tax's base according to the equation:

$$B = (\text{percentage change of revenues}) / (\text{percentage change of the tax base}) \quad (1)$$

In equation (1), the base is frequently the country's GDP, though other bases may be more appropriate depending upon the particular tax under consideration. Thus, for example, for the cases of VAT and import tariffs, more appropriate bases are consumption and imports, respectively.

For the buoyancy of total budget revenues, the appropriate base is the GDP. The buoyancy of total budget revenues indicates how much economic growth would increase total budget revenues over time: thus, a buoyancy estimate greater (less) than one implies that revenues are likely to grow faster (slower) than GDP growth.

Buoyancy is a policy-relevant indicator for macroeconomic management and forecasting. Recent studies have further refined empirical approaches to estimating tax buoyancy and its implications for fiscal policy analysis (Khan, 2024; Raouf, 2026), underscoring the importance of robust econometric techniques. It is notable that buoyancy includes the effects of discretionary policy measures, such as changes in tax rates and brackets, modifications to the tax base definition, and changes in tax administration and enforcement. In contrast, the elasticity measures the responsiveness of revenues to changes in the tax base while holding policy constant. It thus captures the automatic response of revenues to economic growth, abstracting from any discretionary policy changes. In other words, the elasticity is defined as the ratio of the percentage change in revenues over the percentage change of the tax's base under the condition that there is no change in the tax system over the period. By disentangling the effect of changes induced by tax policy through time the elasticity of a tax provides an indication of the automatic response of the tax under consideration to changes in macroeconomic conditions.

A simple methodology to estimate the buoyancy over a period, which we will not utilise in this paper, is to use equation (1) to estimate the annual buoyancies and estimate the buoyancy as the average of the annual estimates over the period.

A widely-used method to estimate the buoyancy of revenues, which we will use in this paper, is to use time-series data to regress the logarithm of revenues on the logarithm of GDP. In the log-linear equation (2) below:

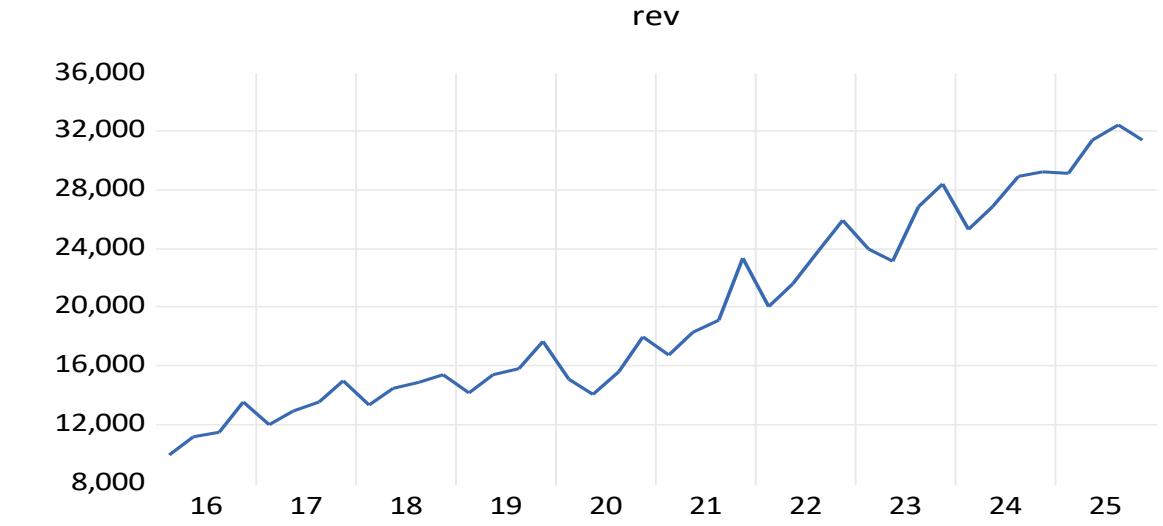
$$\log \text{Revenues}_t = a + b \log \text{GDP}_t + e_t \quad (2)$$

- The parameters a and e represent the constant term and the error term of the equation to be estimated through the use of time series data; while
- The econometric estimate of parameter b in equation (2) provides an estimate of the buoyancy of revenues.

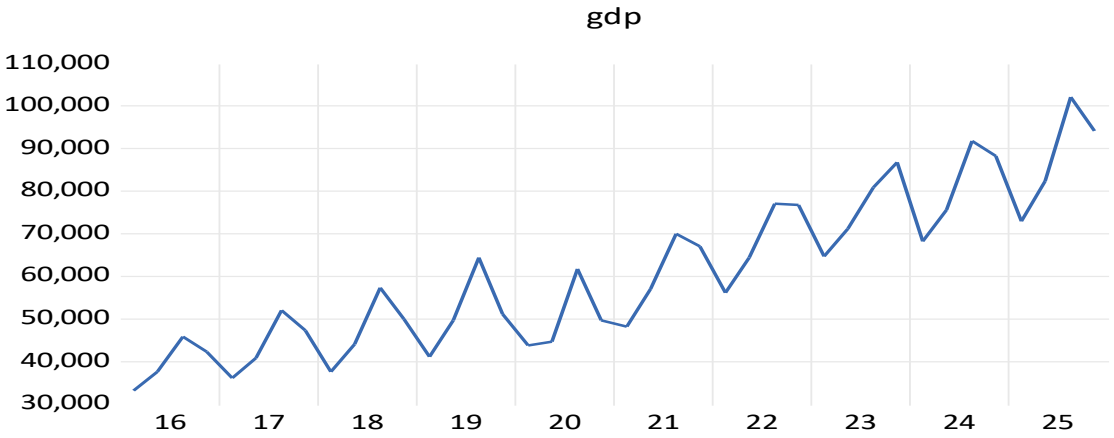
A number of studies in the literature have provided evidence of the international experience on tax buoyancy. The recent IMF working paper by Cornevin, Corrales and Angel (2023) provided an empirical overview of tax buoyancy in 185 countries over the period 1990 to 2020 and indicated that long-run buoyancy of taxes typically hovers around unity. The paper by Dudine and Jalles (2017) estimated both short- and long-run buoyancies for 107 countries over the period 1980 to 2014 and reported that long-run buoyancy is not significantly different from 1 overall, while short-run buoyancy tends to exceed 1 in emerging markets and low-income countries. The study by Gupta, Jalles and Liu (2022) estimated buoyancy for 44 Sub-Saharan African countries over the period 1980 to 2017 and indicated that long-term buoyancy often equals or slightly exceeds 1 for most countries, while short-term buoyancy was lower in states with weaker institutions. Finally, a World Bank country study utilising data from 2000 to 2017 reported that the buoyancy of total revenue in Moldova was 1.12 (World Bank, 2019).

DATA AND ECONOMETRIC ESTIMATES

The following two graphs depict the evolution of total revenues and nominal GDP from the first quarter of 2016 to the fourth quarter of 2025, in millions of Moldovan lei (MDL). The estimates of the fourth quarter of 2025 are preliminary.



Source: *Ministry of Finance @2026. https://mf.gov.md/en*



Source: *National Bureau of Statistics of the Republic of Moldova*

It is notable that standard stationarity tests indicate that both total revenues and nominal GDP, as well as the logarithms of these variables, are not stationary. And it is well-known that regressing nonstationary variables may result in spurious regressions.

The econometric estimates of the log-linear model will indicate whether the buoyancy of total revenues in Moldova is less than or greater than one. The econometric estimates of the log-linear model are reported below:

Table 1.

Regression results of the log-linear model

Dependent Variable: LOG(REV)				
Method: Least Squares				
Sample: 2016Q1 2025Q4				
Included observations: 40				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.757421	0.685835	-2.562454	0.0145
LOG(GDP)	1.056753	0.062501	16.90778	0.0000
R-squared	0.882670	Mean dependent var		9.834330
Adjusted R-squared	0.879582	S.D. dependent var		0.336466
S.E. of regression	0.116758	Akaike info criterion		-1.408723
Sum squared resid	0.518031	Schwarz criterion		-1.324279
Log likelihood	30.17447	Hannan-Quinn criter.		-1.378191
F-statistic	285.8730	Durbin-Watson stat		1.922725
Prob(F-statistic)	0.000000			

Source: developed by the author

The econometric estimation suggests that the buoyancy of total revenues in Moldova is close to 1.06. This is greater than one but less that the 1.12 estimate reported in the World Bank study discussed above (World Bank, 2019).

FORECASTS

The estimated log-linear econometric model may be used to generate forecasts of revenues subject to a projected path of the future nominal GDP evolution.

As there are no official quarterly forecasts of nominal GDP these may be generated by the forecasts of an estimated Auto-Regressive Integrated Moving Average (ARIMA) model fitted on the historical evolution of nominal GDP.

The stationarity test reported below indicates that the quarterly time series of nominal GDP is not stationary.

Table 2.

Stationarity test of the nominal GDP series

Null Hypothesis: GDP has a unit root			
Exogenous: Constant			
Lag Length: 3 (Automatic - based on SIC, maxlag=8)			
		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		1.320258	0.9982
Test critical values:	1% level	-3.639407	
	5% level	-2.951125	
	10% level	-2.614300	
*MacKinnon (1996) one-sided p-values.			

Source: developed by the author

In contrast the next table indicates that first difference of the quarterly time series of nominal GDP is stationary.

Table 3

Stationarity test of the first difference of the nominal GDP series

Null Hypothesis: D(GDP) has a unit root			
Exogenous: Constant			
Lag Length: 3 (Automatic - based on SIC, maxlag=8)			
		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.383025	0.0187
Test critical values:	1% level	-3.639407	
	5% level	-2.951125	
	10% level	-2.614300	
*MacKinnon (1996) one-sided p-values.			

Source: developed by the author

EViews's automatic ARIMA selection, with the Akaike information criterion as the criterion choice, suggests the following (2,1,3) ARIMA model fitted on the historical evolution of nominal GDP as the preferred model.

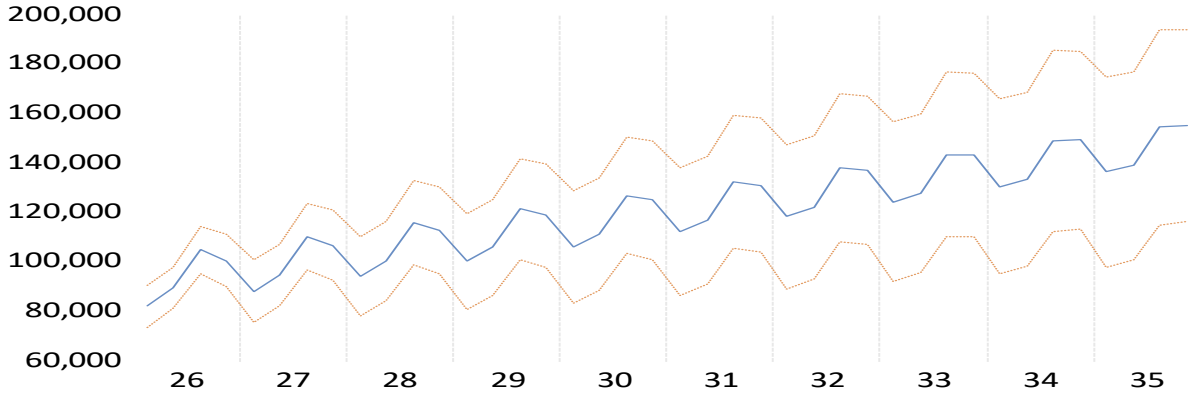
Table 4

Regression results of the (2,1,3) model

Dependent Variable: D(GDP,1)				
Method: ARMA Maximum Likelihood (OPG - BHHH)				
Sample: 2017Q3 2025Q4				
Included observations: 34				
C	1445.954	345.4707	4.185460	0.0003
AR(1)	0.018716	0.035922	0.521037	0.6066
AR(2)	-0.996748	0.008999	-110.7560	0.0000
MA(1)	-0.662098	1.031532	-0.641859	0.5264
MA(2)	1.097350	7.739318	0.141789	0.8883
MA(3)	-0.417443	3.084448	-0.135338	0.8933
SIGMASQ	10800736	78549941	0.137502	0.8917
R-squared	0.904074	Mean dependent var		1573.324
Adjusted R-squared	0.882757	S.D. dependent var		10770.64
S.E. of regression	3687.943	Akaike info criterion		19.73931
Sum squared resid	3.67E+08	Schwarz criterion		20.05357
Log likelihood	-328.5684	Hannan-Quinn criter.		19.84648
F-statistic	42.41128	Durbin-Watson stat		2.117584
Prob(F-statistic)	0.000000			

Source: developed by the author

The graph of the out-of-sample forecast of nominal GDP on the basis of the above (2,1,3) ARIMA model is as follows:



Source: developed by the author

We reproduce below the point estimates of the quarterly nominal GDP forecast generated by the (2,1,3) ARIMA model from the first quarter of 2026 to the fourth quarter of 2028.

2026Q1	82282.92
2026Q2	89649.92
2026Q3	104961.1
2026Q4	100764.8
2027Q1	88284.99
2027Q2	95094.23
2027Q3	110521.0
2027Q4	106882.8
2028Q1	94298.22
2028Q2	100549.2
2028Q3	116070.0
2028Q4	112990.0

The table below compares the annual GDP estimates of the (2,1,3) model to the annual GDP estimates in the latest macroeconomic forecast of the Ministry of Economic Development and Digitalisation (MoEDD) published in December 2025.

Table 5.

Comparison of the GDP forecasts

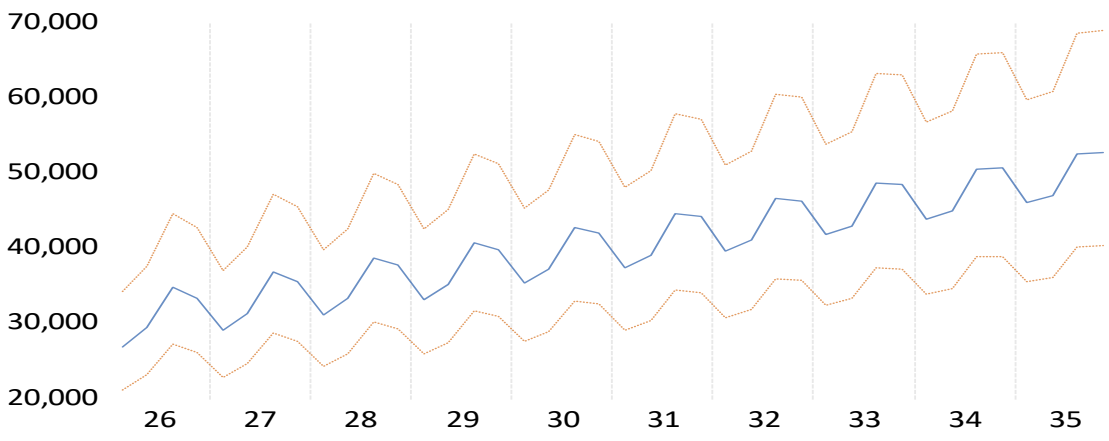
	(2,1,3) model	MoEDD
2026	377658.7	377200
2027	400783	406900
2028	423907.4	440200

Source: developed by the author.

It is notable that the GDP forecasts for 2026 and 2027 are almost identical. It is worth noting that the ARIMA model's forecasts become increasingly unreliable the further into the future the forecast horizon extends.

We now turn to using the quarterly forecasts of nominal GDP generated by the (2,1,3) ARIMA model and the econometric estimates of the log-linear model to produce quarterly forecasts of total budget revenues.

We reproduce below the graph of the out-of-sample forecast of revenues generated by the log-linear model of revenues.



Source: developed by the author

The point estimates of the forecasted evolution of total budget revenues from the first quarter of 2026 to the fourth quarter of 2028 are as follows:

2026Q1	26979.12
2026Q2	29538.03
2026Q3	34893.64
2026Q4	33421.12
2027Q1	29062.99
2027Q2	31436.84
2027Q3	36849.79
2027Q4	35569.11
2028Q1	31158.82
2028Q2	33345.57
2028Q3	38807.67
2028Q4	37720.25

The table below compares the annual estimates of our forecasted total budget revenues based on the log-linear model to the latest forecast of the Ministry of Finance.

Table 6

Comparison of the total budget revenue forecasts

	Log-linear model	Ministry of Finance
2026	124831.9	133456.7
2027	132918.7	143652.6
2028	141032.3	155405.5

Source: developed by the author

The forecasts derived from the log-linear model are more pessimistic than the forecasts of the Ministry of Finance.

CONCLUSION

The empirical work reported in the paper suggests that the buoyancy of total budget revenues in the Moldovan economy is close to 1.06. This finding is broadly consistent with international evidence and provides updated country-specific estimates based on recent quarterly data. It is notable that, in order finalise the forecasts of total budget revenues, the forecasters need to incorporate their professional judgement on the likely evolution of Moldova's macroeconomic indicators over the forecast's horizon and their impact on the budget, and also take into account the likely effect of any policy-induced changes in tax rates, the revenues base, the tax administration and compliance.

The analysis also suggests that model-based forecasts may differ from official projections, underscoring the importance of using alternative empirical approaches to complement institutional forecasting frameworks.

A natural area for further work is the regular updating of econometric estimates and forecasts over time for both monitoring and forecasting purposes.

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The author holds a PhD in Economics from the University of Cambridge and is currently the Economic Development Planning Expert of the EU-funded Technical Assistance project "Support the Moldovan Government in identifying and preparing projects linked to the implementation of the Association Agreement". The econometric estimates and forecasts in the paper have been generated using the EViews13 econometrics programme. The views expressed in the article are personal. E-mail: papaphilippou@4assist.eu

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STATISTICAL ANNEX

	GDP	Revenues		GDP	Revenues
2016Q1	33231.00	9925.0	2021Q1	48074.13	16698.8
2016Q2	37566.00	11103.0	2021Q2	56985.19	18234.4
2016Q3	45882.00	11443.1	2021Q3	70075.43	19143.6
2016Q4	42331.00	13482.8	2021Q4	66943.00	23296.2
2017Q1	36079.00	11993.2	2022Q1	56266.49	20075.9
2017Q2	40660.00	12916.0	2022Q2	64326.29	21627.4
2017Q3	51932.00	13516.3	2022Q3	77178.51	23865.2
2017Q4	47336.00	14953.9	2022Q4	76717.00	25936.9
2018Q1	37609.00	13291.6	2023Q1	64745.84	23968.2
2018Q2	44166.00	14495.6	2023Q2	71244.05	23095.4
2018Q3	57370.00	14858.6	2023Q3	80841.49	26810.8
2018Q4	49917.00	15350.1	2023Q4	86723.00	28424.8
2019Q1	41185.00	14128.3	2024Q1	68170.99	25346.4
2019Q2	49704.00	15338.9	2024Q2	75606.22	26832.5
2019Q3	64323.00	15811.4	2024Q3	91796.95	28925.9
2019Q4	51044.00	17670.6	2024Q4	88242.66	29233.7
2020Q1	43685.33	15029.6	2025Q1	72980.01	29151.5
2020Q2	44629.49	14008.1	2025Q2	82312.89	31380.0
2020Q3	61719.25	15597.6	2025Q3	102054.6	32397.9
2020Q4	49699.00	18014.7	2025Q4	94153.00	31450.7

Source: National Bureau of Statistics and Ministry of Finance

Note: The data are in millions of MDL. The estimates for the fourth quarter of 2025 are preliminary

A STRUCTURAL BRIDGE BETWEEN INPUT-OUTPUT ANALYSIS AND SEMI-STRUCTURAL MACROECONOMETRIC MODELLING: EVIDENCE FROM MOLDOVA

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SUMMARY

This paper develops a parsimonious structural bridge linking semi-structural macroeconometric estimation with input-output sectoral analysis for the Republic of Moldova, addressing the analytical gap between aggregate forecasting and sectoral diagnostics in small post-Soviet economies. The methodology proceeds in three steps: macroeconomic shocks are translated into expenditure-side aggregates using OLS elasticities; aggregate changes are distributed across 20 NACE Rev.2 sectors using two alternative weighting schemes (one IO-derived, the other derived independently from BNS customs export data); sectoral output impacts are obtained via Leontief multiplication. Aggregate impacts converge within ±2% across schemes despite substantial sectoral divergence, providing evidence that economy-wide results are robust to the choice of export weighting. Four counterfactual scenarios are examined: a 5% EU27 demand contraction generates a 9.8% reduction in total gross output, with 26% accruing to non-export sectors via supply-chain channels invisible in aggregate models; a 10% fiscal revenue increase yields a sub-unitary multiplier (1.03) reflecting import leakage; a 15% currency depreciation generates zero sectoral impact under strict elasticities; single-sector shocks reveal a duality of static IO under demand and supply interpretations. The methodology is reproducible from public data and transferable to comparable post-Soviet economies.

Keywords: input-output analysis, macroeconometric model, bridge methodology, small open economy, Leontief multipliers, counterfactual scenarios

INTRODUCTION

Macroeconomic policy analysis in small post-Soviet economies typically operates at one of two analytical levels. Aggregate-level work, exemplified by the Bayesian quarterly tradition of Pârţachi and Mija (2013, 2015a, 2024) for the Republic of Moldova, produces forecasts and elasticity estimates for GDP and its expenditure-side aggregates. Sectoral-level work, for which Moldova has gained an analytical foundation through recent reconstructions of the input-output series at 20-sector NACE Rev.2 disaggregation, produces structural diagnostics: Leontief multipliers, Rasmussen linkages, and structural decomposition. The two levels of analysis inform each other but rarely intersect within a unified analytical procedure. The methodological space between them, populated internationally by hybrid IO-econometric frameworks such as Cambridge Econometrics' E3ME, the HERMIN family, and GINFORS, is largely unoccupied for small post-Soviet economies, primarily because these frameworks require decades of quarterly disaggregated data that are not currently available for these economies.

This paper develops a parsimonious bridge methodology that fills this gap for the Moldovan case while remaining transferable to comparable post-Soviet economies. The methodology connects two analytical components currently under development for Moldova within a broader research programme on Moldovan macroeconomic infrastructure: (i) sectoral structural information from a recently reconstructed annual input-output series in the CAEM Rev.2 / NACE Rev.2 classification; and (ii) aggregate behavioural elasticities from a parsimonious annual semi-structural macroeconometric specification estimated by OLS on annual data for 2014-2024 (N = 11). The Bayesian quarterly tradition of Pârţachi and Mija addresses different questions (monetary transmission to inflation; aggregate forecasting via BVAR) and operates on confidential or semi-public quarterly data; the methodology developed here is therefore complementary rather than competitive, addressing the specific gap in sectoral resolution for macroeconomic shocks under public-data replicability constraints.

This paper makes four contributions. First, it develops a parsimonious three-step bridge: macroeconomic shock propagation through OLS elasticities yields aggregate ΔY; sectoral distribution via weighting schemes yields Δf; Leontief multiplication yields sectoral output $\Delta x = L\Delta f$. The methodology is transparent, reproducible, and computationally light. Second, it addresses the circularity concern raised by Dietzenbacher and Los (1998) by testing two alternative weighting schemes: one derived from the IO baseline, the other from independent BNS customs export data classified by SITC. Third, it produces four counterfactual, illustrative findings of policy relevance: external shock asymmetry, a sub-unitary fiscal multiplier, confirmed null exchange-rate transmission at the sectoral level, and a documented duality of static IO under demand- and supply-side single-sector shocks. Fourth, the methodology is transferable to other post-Soviet economies (Armenia, Georgia, Kyrgyzstan) confronting analogous data constraints. The remainder of the paper is organised as follows: the next section reviews the relevant literature; the methodology section presents the three-step bridge framework; the data section documents sources and unit conventions; the results section presents bridge validation and the four counterfactual scenarios; the discussion situates the findings; the conclusions identify policy implications and future work.

THEORETICAL FRAMEWORK

The integration of input-output analysis with macroeconometric estimation has a substantial international tradition, populated by full-integration models that simultaneously embed behavioural equations within an IO accounting framework. The Cambridge Econometrics' E3ME model (Barker, 1999; Mercure et al., 2018) combines IO analysis with a set of econometric equations that determine the components of aggregate demand, prices, and energy/emissions data. The GINFORS family (Meyer & Lutz, 2007; Lutz, Meyer, & Wolter, 2010) serves as a bilateral world trade model that links 64 countries using OECD input-output tables. The HERMIN family (Bradley & Untiedt, 2008; Bradley et al., 1995) was developed specifically for European convergence economies and has been adapted to the Czech, Hungarian, and Polish contexts. The Austrian ASCANIO and e3.at models (Kratena & Wüger, 2010; Sommer & Kratena, 2017) provide a partial bridge between sectoral IO data and separately estimated demand equations. Recent extensions include agent-based forecasting (Poledna et al., 2023; Hommes & Poledna, 2026), multi-sector inflation analysis (Garcia, 2024 extending Baqaee & Farhi, 2019), and Bayesian large-VAR approaches (Bańbura et al., 2023). The full-integration paradigm and its recent extensions deliver analytical richness at substantial data and computational costs: decades of quarterly disaggregated data, harmonised across 50+ sectoral identities, are required for robust estimation. The data environment for small post-Soviet economies, including the Republic of Moldova, does not currently support this level of integration.

A complementary tradition employs partial bridges or soft coupling, in which separately estimated macroeconometric and IO models communicate through specific information transfers without full simultaneous estimation. The foundational treatment is Pyatt and Round (1985) for the related case of social accounting matrices. Rose and Liao (2005) document a soft-coupled application for regional economic resilience analysis; Sommer and Kratena (2017) apply partial-bridge logic in the context of household consumption and environmental impact assessment. Miller and Blair (2022) provide the canonical methodological treatment of input-output analysis. A long-standing concern in IO-econometric integration is potential circularity: when weights derived from the same matrix being decomposed are used for the decomposition itself, the resulting attribution may simply reflect the structure of the input matrix rather than independent empirical content (Dietzenbacher & Los, 1998). The bridge methodology developed here explicitly addresses this concern through dual-scheme construction: one weighting scheme derived from the IO baseline and the other from an independent customs export benchmark.

The macromodelling literature for the Republic of Moldova has been developed primarily through the work of Pârţachi, Mija, and collaborators over the past fifteen years. Pârţachi and Mija (2013, 2015a, 2015b, 2024) and Mija et al. (2013) develop a monetary policy transmission framework using Bayesian VAR specifications on quarterly data to capture inflation responses to demand and exchange rate shocks. Mija (2022) consolidates this research line in a doctoral thesis. The IMF prepares Moldovan macroeconomic projections through internal Article IV procedures (most recently IMF, 2024) whose specifications are not publicly disclosed; the BNM operates a quarterly Bayesian VAR forecasting system similarly not in the public domain. Naval (2019) provides input-output-based optimisation modelling for Moldova at lower frequency. The bridge methodology developed here directly connects sectoral IO structure with aggregate macroeconometric elasticities, complementing the established Bayesian quarterly tradition rather than competing with it.

DATA AND METHODS

The bridge framework formalises the connection between aggregate and sectoral analysis through a three-step procedure. Given an exogenous macroeconomic shock, a contraction in foreign demand, a fiscal impulse, an exchange rate movement, or a sector-specific productivity change, the framework: (i) translates the shock into changes of expenditure-side aggregates using OLS-estimated elasticities; (ii) distributes these aggregate changes across the 20 NACE Rev.2 sectors using a weighting scheme derived from either the IO baseline (Schema A) or from independent customs export data (Schema B); (iii) multiplies the resulting sectoral final demand vector by the Leontief inverse to produce a sectoral output response. Formally, denoting the macroeconomic shock as Δz_macro and the OLS coefficients as β, Step 1 produces $\Delta Y = f(\beta, \Delta z\_macro)$ where ΔY is the vector $\{\Delta C, \Delta X, \Delta M, \Delta FBC, \Delta G\}$; Step 2 produces $\Delta f = W\Delta Y$ where W is a 20×5 weighting matrix; Step 3 produces $\Delta x = L\Delta f$ where $L = (I - A)^{-1}$.

The macroeconomic propagation in Step 1 uses five behavioural equations estimated by OLS on annual Moldovan data 2014-2024 (N = 11): $\log\_C = \alpha_1 + \beta_1 \cdot \log\_GDP + \varepsilon_1$ (consumption); $\log\_X = \alpha_2 + \beta_2 \cdot \log\_DEX + \varepsilon_2$ (exports); $\log\_M = \alpha_3 + \beta_{3,1} \cdot \log(GDP+X) + \beta_{3,2} \cdot \log\_RER + \varepsilon_3$ (imports); $\log\_FBC = \alpha_4 + \beta_4 \cdot \log\_GDP + \varepsilon_4$ (gross capital formation, where FBC = IFBCF + Δ_Stocks per ESA 2010); $\log\_G = \alpha_5 + \beta_5 \cdot \log\_VEN + \varepsilon_5$ (government consumption). The closure is the expenditure-side accounting identity GDP = C + C_NPISH + G + FBC + (X - M). The estimated elasticities are reported in Table 1; the parsimonious specifications follow the small-sample

tradition of Cogley and Sargent (2005) and Bańbura, Giannone, and Reichlin (2010). Given an exogenous shock, the propagation through the system follows iteratively until the closing aggregate ΔGDP is reached through the identity.

Table 1.

Behavioural elasticities used in the bridge methodology

Equation	Specification	Coefficient	Estimate	Std. Error	p-value
E1	log_C ~ log_GDP	*β_GDP_C*	0.7029	0.1201	0.0002
E2	log_X ~ log_DEX	*β_DEX_X*	1.9681	0.4752	0.0025
E3	log_M ~ log(GDP+X), log_RER	*β_GDPX_M*	1.3219	0.3891	0.0094
E3		*β_RER_M*	0.0390	0.1518	0.8039
E4	log_FBC ~ log_GDP	*β_GDP_FBC*	1.2880	0.4489	0.0185
E5	log_G ~ log_VEN	*β_VEN_G*	1.4071	0.1741	<0.0001

Source: authors' calculations on annual Moldovan data 2014-2024 (N = 11). All variables in natural logarithms of constant 2014 prices.

Step 2 distributes each aggregate change across the 20 NACE Rev.2 sectors. For component k ∈ {X, C, FBC, G}, the sectoral distribution is Δf_(k,i) = w_(k,i) · ΔY_k where w_(k,i) is the share of sector i in total final demand for component k. Two alternative schemes are tested for the export distribution. Scheme A uses export weights derived from the 2023 IO table itself: w_(X,i)^A = X_i^(2023) / Σ_i X_i^(2023). Scheme B uses an independent benchmark constructed from BNS customs export data classified by SITC and mapped to NACE Rev.2 using a 10×20 concordance matrix. The dual-scheme construction provides empirical evidence on the magnitude of the circularity concern. Step 3 multiplies the sectoral final demand change Δf by the Leontief inverse L to obtain the sectoral output response Δx = L · Δf. The Leontief inverse is derived from the reconstructed 2023 IO matrix as L = (I - A)$^{-1}$, where A is the 20×20 matrix of technical coefficients with elements a_(i,j) = z_(i,j)/VP_j. The matrix A is invariant under uniform deflation of the underlying flows.

Four scenarios are examined. S1 - External demand contraction: Δlog_DEX = -0.05, equivalent to a 5% reduction in EU27 real GDP. S2 - Fiscal impulse: Δlog_VEN = +0.10, equivalent to a 10% increase in fiscal revenues. S3 - Currency depreciation: Δlog_RER = +0.15, reported under two interpretations (S3_L1 strict estimates; S3_L2 with literature prior β_RER_X = 0.30 from Goldstein and Khan, 1985). S4 - Single-sector shock in Manufacturing: 10% magnitude under two interpretations (S4_L1: +10% final demand for sector C; S4_L2: -10% reduction in input requirements for sector C, modifying the column of A and computing L_modified). All scenarios are computed in constant 2014 prices.

The bridge methodology relies on three data layers. The Input-Output table for 2023 has been reconstructed by applying biproportional RAS updating (Junius & Oosterhaven, 2003) to the 2014 baseline Supply-Use Table published by the National Bureau of Statistics (BNS) of the Republic of Moldova, with annual marginal controls on gross output, intermediate consumption, and gross value added for 2015-2023. The OLS coefficients used in Step 1 are estimated on annual data 2014-2024 (N = 11) under the CAEM Rev.2 framework, with all variables transformed to natural logarithms of constant 2014 prices. Schema B uses the 2023 export totals by SITC section as published by BNS in the table "Comerțul Internațional al Republicii Moldova". All values in the bridge calculations are expressed in MDL billion at constant 2014 prices, with the Z matrix and VP vector converted from nominal 2023 prices through Y_2014 = Y_nominal × (1/10^6) × (1/2.0844), where 2.0844 is the GDP implicit deflator for 2023 with 2014 as the base year. The complete computational implementation is documented in a single Excel workbook (33 sheets) provided as supplementary material to support independent replication.

MAIN RESULTS

The bridge construction begins with verifying the Leontief inverse matrix L derived from the reconstructed 2023 input-output table. Computing L = (I - A)$^{-1}$ on the 20-sector matrix yields an economy-wide mean multiplier of 2.029 and Manufacturing forward linkage index FL_C = 5.629. The methodology applies the OLS coefficients to translate macroeconomic shocks into changes in aggregate components, then distributes those changes across sectors. Scheme A uses export weights derived from the 2023 IO table itself; Scheme B uses an independent benchmark constructed from BNS customs export data classified by SITC. The two schemes differ

substantially across sectors: Scheme B concentrates 66.0% of export weight in Manufacturing versus 58.4% in Scheme A, fully omits services such as Transport (0.1% versus 13.8%) and ICT (0% versus 4.9%), and reflects re-export through Energy (5.6% versus 0%) and Trade (7.2% versus 0%). The total absolute weight divergence between the schemes is 49.7 percentage points distributed across eight sectors. This divergence is methodologically valuable: the four scenarios reported below yield aggregate differences of less than 2% between the two schemes, providing evidence that economy-wide results are not highly sensitive to the choice of export weights; sectoral allocations remain sensitive to the choice of weights, however, and should be interpreted with caution.

Before presenting individual scenarios, it is worth explicitly emphasising two distinct quantities reported in the empirical results. Step 1 of the bridge produces aggregate ΔGDP, the change in value added measured by the expenditure-side identity. Step 3 produces the sum Σ Δx across all 20 sectors, the change in total gross output. The two quantities measure different but connected economic objects. For Moldova in 2023, the baseline values are GDP_real = 154.87 mld MDL and Σ VP_real = 237.33 mld MDL, with the difference (82.46 mld) representing intermediate consumption flows. The bridge methodology preserves both perspectives: ΔGDP captures the welfare-relevant outcome at aggregate level; Σ Δx captures the production-disruption profile distributed across sectors and supply chains.

Scenario S1 - External demand contraction. A 5% contraction in EU27 real GDP, equivalent to the magnitude of the 2020 pandemic shock. Step 1 produces ΔX = -5.10, ΔM = -5.69, ΔC = -2.99, ΔFBC = -1.29, ΔG = 0, with ΔGDP = -3.69 mld MDL (-2.4% of baseline). Step 3 yields an aggregate sectoral output impact Σ Δx_A = -23.16 mld MDL (at constant 2014 prices), corresponding to approximately 9.8% of baseline gross output. Manufacturing absorbs more than half of this impact (Δx_C = -12.84 mld), followed by Agriculture (-3.46), Transport (-1.47), Construction (-1.19), and Energy (-0.75). Under Scheme B, the aggregate impact is -23.44 mld, a difference of only 1.21% from Scheme A despite the substantial sectoral divergence in underlying weights. The decomposition into direct and indirect effects reveals that Manufacturing experiences an 81.4% direct and 18.6% indirect impact, reflecting its dominant share of the shock to export demand. Conversely, sectors not directly exposed to exports, Energy (100% indirect), Trade (100% indirect), Real Estate (96.6% indirect), Mining (100% indirect), absorb their entire share of the shock through supply chain connections to Manufacturing. The 26% figure quoted in the abstract is computed as the share of total |Δx| absorbed by sectors with zero or negligible direct export shock in Δf. This pattern is the central empirical contribution of the bridge methodology: aggregate models are blind to the indirect channel through which non-exporting sectors absorb external shocks.

Scenario S2 - Fiscal impulse via revenue increase. A 10% increase in fiscal revenues. Step 1 propagates the shock through E5 (β_VEN_G = 1.41) to obtain ΔG = +4.19 mld MDL, then through the closed model: ΔC = +2.51, ΔFBC = +1.11, ΔM = +2.45, ΔX = 0, with ΔGDP = +5.36 mld MDL (+3.46% of baseline). The implied fiscal multiplier (ΔGDP/ΔG = 5.36/4.19) is 1.28, sub-unitary when measured against revenues (5.36/5.22 = 1.03). This sub-unitary feature reflects import leakage: 46% of the additional government spending leaks abroad through the high import elasticity. The sectoral decomposition under Scheme A yields Σ Δx_A = +15.96 mld MDL with the largest impacts on Manufacturing (+6.22), Education (+1.54), Agriculture (+1.46), Health (+1.29), and Public Administration (+1.10). The convergence of Schema A and Schema B in S2 is exact at the aggregate level.

Scenario S3 - Currency depreciation. A 15% nominal depreciation of the Moldovan leu against the euro (Δlog_RER = +0.15), reported under two alternative elasticity assumptions. Under strict estimates (S3_L1), the export equation E2 contains no exchange rate term (β_RER_X dropped from the parsimonious specification given p > 0.5), and the import equation E3 yields β_RER_M = 0.039 (statistically indistinguishable from zero, p = 0.80). Applying these coefficients produces ΔX = 0, ΔM = +0.54 mld MDL, ΔGDP = -0.54 mld via identity, and Σ Δx_A = 0 across all 20 sectors. This null sectoral result confirms the macro-level finding at sectoral granularity. As a robustness check (S3_L2), imposing β_RER_X = 0.30 from the trade-elasticity literature (Goldstein & Khan, 1985; Hooper, Johnson, & Marquez, 2000) produces ΔX = +2.45 mld MDL, ΔM = +1.93, ΔGDP = +1.17, and Σ Δx_A = +11.49 mld with Manufacturing absorbing +6.37 and Agriculture +1.71. The contrast illustrates the sensitivity of policy conclusions to elasticity assumptions: structural features of the Moldovan economy, high import-price pass-through, EUR-denominated trade, remittance-driven consumption, suppress the standard Marshall-Lerner mechanism.

Scenario S4 - Single-sector shock in Manufacturing. A 10% shock concentrated in sector C, reported under two complementary interpretations. Under S4_L1 (demand-side), a 10% increase in final demand for sector C corresponds to Δf_C = +5.74 mld MDL; multiplying through the Leontief inverse yields Σ Δx_A = +27.21 mld MDL, with Manufacturing absorbing +20.14 (74% of total) and the remainder distributed across Agriculture (+2.95), Energy (+0.84), Transport (+0.55). Under S4_L2 (supply-side), a 10% reduction in input requirements modifies the column of A corresponding to C: A_modified[i, C] = 0.9 × A[i, C] for all i ≠ C; computing L_modified and applying to unchanged baseline final demand yields Σ Δx_A = -42.15 mld MDL. Under static IO interpretation at unchanged final demand, a reduction in input coefficients mechanically lowers gross-output requirements; this should not be interpreted as a welfare loss or real GDP contraction, but as a methodological illustration of how productivity

gains, in the absence of induced demand response, manifest themselves in the static IO framework. The opposite signs across all sectors (Table 2) illustrate a methodological property of static IO: the framework cannot endogenize the demand response to supply-side shocks. This dual analysis motivates extension to dynamic computable general equilibrium models.

Table 2.

Cross-scenario synthesis. ΔGDP from macroeconometric Step 1; Σ Δx_A from sectoral Step 3 (Schema A); Δx_A[C] is the impact on Manufacturing. All values in mld MDL at constant 2014 prices.

Scenario	Description	*ΔGDP*	*Σ Δx_A*	*Δx_A*[C]	Schema A vs B
S1	-5% EU27 GDP	-3.69	-23.16	-12.84	1.21%
S2	+10% fiscal revenues	+5.36	+15.96	+6.22	<0.5%
S3_L1	+15% RER (strict)	-0.54	0.00	0.00	n/a
S3_L2	+15% RER (β=0.30)	+1.17	+11.49	+6.37	<0.5%
S4_L1	+10% final demand C	n/a	+27.21	+20.14	<0.5%
S4_L2	-10% inputs C	n/a	-42.15	-24.69	<0.5%

Source: *authors' calculations using the structural bridge methodology.*

DISCUSSION

Five empirical findings emerge from the joint examination of the four scenarios, with three substantive policy implications and two methodological insights. First, external shock asymmetry: a 5% EU27 contraction generates a 9.8% reduction in total Moldovan gross output, with 26% accruing to non-export sectors via supply-chain channels. The Manufacturing direct/indirect decomposition (81.4%/18.6%) contrasts with the 100% indirect transmission to Energy, Trade, Real Estate, and Mining, supply-chain effects entirely invisible in aggregate models. Second, the sub-unitary fiscal multiplier (1.03, measured against revenues) reflects the import leakage documented in the macroeconometric companion specification: 46% of additional government spending leaks abroad due to the high import elasticity. Third, the null exchange-rate transmission is confirmed at sectoral granularity. The result is robust to the alternative interpretations of S3 and reflects structural features of the Moldovan economy.

On methodological grounds, the bridge methodology addresses the circularity concern raised by Dietzenbacher and Los (1998) explicitly through dual-scheme construction. The aggregate impact convergence between Schema A (IO-derived) and Schema B (independent customs benchmark) within ±2% across all four scenarios provides empirical evidence that economy-wide bridge results are not highly sensitive to the choice of export weights, while sectoral allocations remain sensitive and should be interpreted with caution. This is a genuinely informative finding because the schemes differ substantially in their underlying composition (a 49.7 percentage-point absolute weight divergence across eight sectors). The convergent aggregate impact, alongside divergent sectoral distribution, is the methodologically interesting finding: aggregate bridge predictions are robust to weighting choices; sectoral allocations are not. The dual-scheme construction, therefore, constitutes both a robustness check and a structural diagnostic distinguishing economy-wide from sectoral robustness.

In situating the present findings, the export elasticity β_DEX = 1.97 places Moldova at the upper end of the trade-elasticity literature for small open economies (Hooper, Johnson, & Marquez, 2000; Bussière et al., 2013). The asymmetric structure of Moldovan trade, 1.97 export elasticity coupled with 1.32 import elasticity to absorption, implies that external shocks are amplified rather than dampened. The null real-exchange-rate finding aligns with the post-Soviet pattern documented for several small open economies and complements the substantial price-level pass-through reported by Pârțachi and Mija (2015a) at quarterly frequency. The two findings are jointly consistent with a structural transmission environment in which exchange rate movements pass through to domestic prices rapidly, neutralising the relative-price effect on trade flows that the Marshall-Lerner mechanism would conventionally predict. The S4 duality finding, opposite signs across all sectors under demand-side and supply-side single-

sector shocks of equal magnitude, illustrates a known limitation of static input-output analysis: the framework cannot endogenise the demand response to supply-side shocks (Miller & Blair, 2022). Real-world productivity shocks involve both channels simultaneously, with the net direction determined by the elasticity of demand to price reductions, a parameter not present in the static IO framework. This motivates extension to dynamic computable general equilibrium frameworks. The methodology is fully reproducible from public data sources and the supplementary computational workbook; it is transferable to comparable post-Soviet economies (Armenia, Georgia, Kyrgyzstan) where annual IO and aggregate macromodels can plausibly be constructed.

Three limitations should be acknowledged. First, the macroeconometric estimation rests on N = 11 annual observations, a degrees-of-freedom margin that is uncomfortable by macroeconometric standards; the OLS specifications are deliberately parsimonious, and the static structure precludes dynamic feedback or error-correction representation. Second, the bridge methodology is itself static: it does not endogenise the demand response to supply-side shocks (S4_L2) or the dynamic adjustment path of sectoral output to a permanent shock. Third, the single-year IO baseline (2023) does not capture potential time variation in technical coefficients; as additional IO years accumulate under CAEM Rev.2, the bridge methodology should be re-estimated and structural decomposition tests applied across years. These limitations define the boundary of the current contribution and identify the natural paths for extension.

CONCLUSIONS

This paper has developed a parsimonious structural bridge methodology connecting semi-structural macroeconometric estimation with input-output sectoral analysis for the Republic of Moldova. The methodology proceeds in three steps: macroeconomic shocks are translated into changes of expenditure-side aggregates via OLS elasticities; aggregate changes are distributed across 20 NACE Rev.2 sectors using two alternative weighting schemes; sectoral output impacts are obtained through Leontief multiplication. The dual-scheme construction provides an empirical test of the circularity concern raised by Dietzenbacher and Los (1998): aggregate impacts converge within ±2% across schemes despite substantial sectoral divergence (49.7 percentage points across eight sectors), providing evidence that economy-wide results are robust to the choice of export weighting, while sectoral allocations remain sensitive.

The empirical findings carry three substantive policy implications for the Moldovan macroeconomic environment. The asymmetric external transmission identified by S1 (a 5% EU27 contraction generates a 9.8% reduction in total gross output, with 26% accruing to non-export sectors via supply chains) implies that fiscal stabilisation, rather than exchange rate management, must bear the primary burden of demand-side stabilisation against external shocks. The sub-unitary fiscal multiplier identified by S2 (1.03 against revenues) constrains the effectiveness of fiscal stimulus, with import leakage capturing 46% of any revenue expansion. The null exchange-rate transmission identified by S3, robust across alternative elasticity assumptions, narrows the operational scope of the BNM's existing managed-float regime: the trade channel of monetary transmission is structurally weak. The duality result of S4 motivates extension to dynamic computable general equilibrium frameworks for productivity-shock analysis, where the demand response is endogenously modelled.

Three extensions warrant attention as the analytical infrastructure matures. First, the integration of this static bridge with a dynamic CGE specification, when sufficient sectoral data accumulate, will permit endogenous demand response to supply-side shocks. Second, the methodology is directly transferable to other small post-Soviet economies confronting analogous data constraints: Armenia, Georgia, and Kyrgyzstan share with Moldova the combination of a small open economy, recent ESA-2010-compatible national accounts, and a paucity of public macroeconometric work, and the present framework adapts to these settings with minimal modification. Third, the bridge methodology can support routine policy applications: ex ante impact assessment of fiscal measures, scenario evaluation for IMF Article IV frameworks, and sectoral diagnostics for industrial policy design. The methodology is fully reproducible from the documented public data sources and the supplementary computational workbook.

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ECONOMIC INPUT INTENSITY, LAND PRODUCTIVITY, AND ECONOMIC SUSTAINABILITY IN EUROPEAN AGRICULTURE: A COMPARATIVE ANALYSIS

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SUMMARY

This study analyzes the relationships between the economic intensity of agricultural inputs, the economic productivity of land, and economic sustainability in selected European countries, using EUROSTAT data for the period 2014–2025. The comparative analysis was conducted for two sub-periods, 2014–2019 and 2020–2025, in the context of transformations driven by agricultural market volatility, rising input costs, and the energy crisis. The research methodology is based on derived indicators constructed using the Economic Accounts for Agriculture: the economic sustainability indicator (ESI), the land productivity indicator (LPI), and the input intensity indicator (III). The statistical analysis included descriptive statistics and Pearson's correlation coefficient. The results highlight the existence of significant structural differences between the agricultural systems analyzed. The positive correlation between the variation in economic input intensity and the variation in economic land productivity (r = 0.831) indicates that economic intensification is associated with increased agricultural productivity. In contrast, the negative correlation between the variation in economic intensity and the variation in economic sustainability (r = -0.593) suggests that an increase in intermediate consumption does not automatically lead to improved economic performance. Romania recorded simultaneous increases in land productivity (+35.0%) and economic sustainability (+10.4%), against a backdrop of a moderate intensification of input use (+23.5%). The results underscore the importance of an integrated assessment of the relationships between economic intensification, agricultural productivity, and economic sustainability in European agriculture.

Keywords: value of agricultural production, intermediate consumption, GVA, economic efficiency, agricultural convergence, European agriculture

INTRODUCTION

Agriculture plays a vital role in ensuring food security, managing natural resources, and developing rural areas. Over the past decade, European agriculture has been marked by accelerated processes of economic intensification, specialization, and technological modernization, which have contributed to increased production and the economic productivity of agricultural land. These transformations have increased agriculture's dependence on intermediate inputs and the volatility of input prices, amplifying economic pressures on European agricultural systems (EC, 2020; OECD, 2019; FAO, 2024).

Recent literature highlights that agricultural intensification processes have significantly contributed to increased agricultural productivity and the economic performance of European agriculture through the use of higher volumes of inputs, technological adoption, and agricultural specialization (Knoke et al., 2022; Yang et al., 2023). Other studies emphasize that the relationship between agricultural intensification and sustainability is complex and characterized by multiple economic and ecological trade-offs (Reidsma et al., 2023).

Comparative studies highlight significant structural differences between agricultural systems resulting from varying levels of intensification, farm structure, and the degree of technological modernization (Radlinska, 2025; Aleksandrini et al., 2024). However, in Central and Eastern European countries, processes of convergence and structural transformations associated with modernization and increased use of agricultural inputs continue to occur.

Other studies highlight that productivity is one of the main determinants of the economic performance of European agriculture and the competitiveness of agricultural systems (Hendricks et al., 2023; Vidali, 2025; Bilenko, 2022). Furthermore, significant regional disparities among European countries are highlighted regarding productivity levels, farm modernization, and the economic efficiency of agricultural resource use (Li et al., 2022; Hadelan et al., 2022).

One of the main indicators of economic performance in agriculture is gross value added (Kolodziejczak, 2020). Studies highlight that the relationships between agricultural production, intermediate consumption, and gross value added reflect the level of competitiveness and economic sustainability of European agriculture. European agriculture is shaped by the existence of differentiated processes of convergence and structural transformation between Western European and Central and Eastern European countries (Feher et al., 2017). Romania continues to undergo processes of modernization and economic restructuring characterized by increased productivity and intensified use of agricultural inputs (Ionițescu, 2023).

Intermediate consumption is the central element of the processes of economic intensification in agriculture, reflecting the level of input use, technological adoption, and capitalization of agricultural production (Donovan, 2021). An increase in intermediate consumption can contribute to higher productivity and economic performance in agriculture, but the effects on economic sustainability vary depending on the structure of the systems and the efficiency of agricultural input use.

Studies on agriculture in Central and Eastern European countries highlight that processes of agricultural modernization and convergence are associated with increased use of agricultural inputs and changes in the economic structure of agriculture (Feher et al., 2022;

Andrei et al., 2023). In Romania, the dynamics of intermediate consumption and agricultural production reflect the processes of restructuring and adaptation of agriculture to European economic and technological transformations.

Numerous studies frequently analyze agricultural productivity, economic efficiency, and the sustainability of European agriculture, but there is less comparative research that simultaneously examines the relationships between the economic intensity of inputs, the economic productivity of land, and economic sustainability, using derived indicators constructed on the basis of agricultural economic accounts.

Recent literature highlights that agricultural land productivity is one of the main indicators of the economic performance and competitiveness of European agriculture (Wimmer and Finger, 2026). Increasing agricultural productivity is particularly important both for ensuring food security and for maintaining the economic viability of European farms in the context of climate change, agricultural market volatility, and rising production costs (Khan et al., 2025; Varzaru, 2025). Research highlights that agricultural intensification, technological modernization, and the use of higher input volumes contribute to increased land productivity, but the effects on economic and ecological sustainability differ across the analyzed agricultural systems (Chiarella et al., 2023; Ewert et al., 2005).

Studies on European agriculture highlight structural differences between Western European countries and Central and Eastern European countries in terms of agricultural productivity levels, land use efficiency, and the degree of agricultural modernization (Ion and Creţu, 2025; Janus et al., 2023). Agricultural convergence processes in Eastern European countries are associated with intensified input use and increased economic productivity of agricultural land (Wimmer and Finger, 2026).

The economic performance of agriculture is a central element of analyses concerning the sustainability and competitiveness of European agricultural systems. Studies show that economic performance is influenced by the relationships between productivity, the efficiency of agricultural resource use, farm modernization, and agriculture's ability to create added value (Varzaru, 2026). At the same time, economic performance must be analyzed in relation to the processes of economic sustainability and structural adaptation in European agriculture (Cholet et al., 2026; Martín-García et al., 2026). European agriculture is marked by accelerated processes of structural transformation, driven by technological intensification, digitalization, climate change, and reforms of the Common Agricultural Policy (Tudor & Alexandri, 2015). Central and Eastern European agriculture, including Romania, is influenced by processes of economic convergence, modernization, and restructuring of agricultural holdings (Prigoreanu et al., 2025a; Ursu et al., 2023). In this context, the intensified use of agricultural inputs and increased economic productivity can contribute to improving the economic performance of agriculture, but the effects on economic sustainability differ among the agricultural systems analyzed.

The economic efficiency and adaptability of agricultural holdings in the context of increasing volatility in agricultural markets and rising production costs are also important (Ursu, 2024). At the same time, agricultural economic performance is influenced by the degree of capitalization, the use of modern technologies, and the level of investment in agriculture. These transformations highlight the need for an integrated assessment of the relationships between agricultural economic intensification, land economic productivity, and economic sustainability in European agriculture.

Agricultural sustainability is one of the main focuses of contemporary agricultural research and European agricultural policies, being associated with the need to balance the economic, social, and ecological performance of agriculture (Liu, 2025; Prigoreanu et al., 2025b). Assessing agricultural sustainability requires the use of complex indicator systems capable of capturing the relationships between productivity, the use of agricultural resources, economic efficiency, and environmental impact (Sinisterra-Solís et al., 2024; Xavier et al., 2025).

In this context, the development of agricultural sustainability indicators and comparative methodologies for evaluating agricultural performance has become a major concern for both academic research and European agricultural policy.

The sustainability of European agriculture, as highlighted in numerous studies, is influenced by processes of agricultural intensification, increasing dependence on agricultural inputs, and structural transformations in European agricultural systems (Mergoni et al., 2024). These studies highlight the fact that increased productivity and economic performance do not necessarily lead to improved agricultural sustainability, as there are often trade-offs between economic efficiency, intensive resource use, and long-term sustainability goals (Alves et al., 2022).

Recent research highlights significant structural differences among European agricultural systems regarding the level of economic sustainability and the capacity to adapt to transformations driven by the Common Agricultural Policy, climate change, and economic volatility (Manta et al., 2024; Hansson et al., 2024). Assessing economic sustainability has become an important component of analyses regarding the competitiveness and resilience of agricultural systems in European agriculture (Prigoreanu et al., 2025a; Boggia et al., 2023).

This study aims to analyze the relationships between the economic intensification of agriculture, the economic productivity of land, the economic productivity of agricultural labor, and economic sustainability for a group of European countries, using EUROSTAT data

for the period 2014–2025. This study is based on the following hypotheses: H1 – the economic intensification of agriculture contributes to an increase in the economic productivity of agricultural land; H2 – an increase in the economic intensity of agricultural inputs does not necessarily lead to an improvement in the economic sustainability of agriculture.

MATERIALS AND METHODS

To highlight the relationship between agricultural intensification, the economic productivity of land, and the economic sustainability of agriculture, EUROSTAT statistical data for the period 2014–2025 were used. The analysis was based on indicators included in the Economic Accounts for Agriculture, namely: utilised agricultural area (UAA, thousand ha), output of the agricultural sector (OAI, million euros), intermediate consumption (IC, million euros), gross value added at basic prices (GVA, million euros), and the agricultural labor force (thousand AWU).

The comparative analysis was conducted for a sample of 15 European countries: Italy, France, Spain, Germany, the Netherlands, Poland, Romania, Switzerland, Hungary, Austria, Portugal, Denmark, Belgium, Sweden, and Bulgaria. The selection of countries took into account the diversity of European agricultural models and structural differences in agricultural production intensity, economic productivity, and input use.

In order to capture the recent structural changes in European agriculture, the period under analysis was divided into two distinct sub-periods: 2014–2019 and 2020–2025. The first subperiod represents a relatively stable phase from an economic and agricultural perspective, while the second reflects the effects of the COVID-19 pandemic, volatility in agricultural markets, rising energy costs, increased prices for agricultural inputs, and heightened geopolitical tensions. For each indicator analyzed, average values were calculated for the two sub-periods to reduce annual fluctuations and highlight medium-term structural trends.

To characterize the variability and degree of heterogeneity of the analyzed indicators, descriptive statistics were calculated, namely the minimum and maximum values, the arithmetic mean, the standard deviation, and the coefficient of variation, which were used to assess the dispersion of the indicators among the analyzed European countries.

The research is based on the following working hypotheses:

H1: The economic intensification of agriculture contributes to an increase in the economic productivity of agricultural land.

H2: Increasing the economic intensity of agricultural inputs does not uniformly lead to improved economic sustainability, as there are significant structural differences among the agricultural systems analyzed.

Based on the available statistical indicators, three derived indicators were constructed for each of the two sub-periods analyzed.

The Economic Sustainability Indicator (ESI) is a dimensionless ratio of gross value added to intermediate consumption. The ESI measures the relative economic efficiency of agriculture:

$$ESI = \frac{GVA}{IC}$$

Where:

GVA – Gross value added at basic prices

IC – Intermediate consumption

The Land Productivity Index (LPI) measures the value of agricultural production relative to the area of land used for agriculture and is expressed in thousands of euros per hectare:

$$LPI = \frac{OAI}{UAA}$$

Where:

OAI – Output of the agricultural industry - Production value at basic price;

UAA - Utilised agricultural area

The Input-Output Intensity Index (III) measures agricultural intermediate consumption relative to the utilised agricultural area and is expressed in thousands of euros per hectare.

$$III = \frac{IC}{UAA}$$

Where:

IC – Intermediate consumption

UAA - Utilised agricultural area

Economic Labor Productivity Index (ELPI). To assess the economic efficiency of agricultural labor utilization, the Economic Labor Productivity Indicator (ELPI) was developed, calculated as the ratio of gross value added to the agricultural labor force expressed in annual work units (AWU).

$$ELPI = \frac{GVA}{AWU}$$

Where:

GVA – Gross value added at basic prices

AWU – Annual work units

The indicator is expressed in thousands of euros per AWU and reflects the agricultural sector's ability to generate value added relative to the labor force employed in agriculture.

To highlight the structural changes between the two sub-periods, the percentage changes in the analyzed indicators were calculated. The relationships between the derived indicators were assessed using Pearson's correlation coefficient (UBB, 2016):

$$r_{xy} = \frac{\frac{1}{n}\sum(x-\bar{x})(y-\bar{y})}{s_x s_y}$$

Where:

n = sample size;

x and y = the individual values of the x-variable and the y-variable;

$\bar{x}$ and $\bar{y}$ = the arithmetic mean of all x and y values;

$s_x s_y$ = the standard deviation of all x and y values.

The strength of the correlations was interpreted based on Pearson's correlation coefficients, in accordance with the thresholds used in the specialized statistical literature.

Statistical data processing, indicator calculation, and correlation analysis were performed using Microsoft Excel.

The indicators used are value-based, reflecting the economic dimension of agricultural intensification and sustainability. Consequently, the results obtained are influenced by both structural changes in agricultural production and price dynamics and the volatility of agricultural markets.

The literature analysis was carried out based on existing publications on the Web of Science Core Collection platform.

MAIN RESULTS

To assess the economic sustainability of European agriculture, the derived indicators calculated for the two sub-periods—2014–2019 (ESI1) and 2020–2025 (ESI2) were analyzed.

1.1 ANALYSIS OF THE ECONOMIC SUSTAINABILITY INDICATOR (ESI)

Table 1 presents the average values of the economic sustainability indicator (ESI) for the two sub-periods analyzed. The results highlight significant differences among the countries analyzed in terms of agriculture's ability to generate gross value added relative to intermediate consumption.

Table 1.
Economic Sustainability Indicator (ESI)

Countries	ESI1	ESI2	Δ ESI
Italy	1.21	1.17	-3.3
France	0.67	0.62	-6.7
Spain	1.21	1.13	-6.8
Germany	0.54	0.66	22.1
Netherlands	0.55	0.57	4.1
Poland	0.59	0.64	8.0
Romania	**0.78**	**0.86**	**10.4**
Switzerland	0.60	0.62	4.3
Hungary	0.70	0.60	-13.7
Austria	0.69	0.75	9.2
Portugal	0.64	0.61	-5.6
Denmark	0.33	0.39	18.9
Belgium	0.40	0.41	3.5
Sweden	0.38	0.48	25.7
Bulgaria	0.72	0.78	8.7
Minimum	**0.33**	**0.39**	**-13.7**
Maximum	**1.21**	**1.17**	**25.7**
Mean	**0.67**	**0.69**	**5.3**
SD	**0.26**	**0.23**	**11.3**
CV (%)	**38.40**	**33.00**	**215.2**

Source: Our own calculations based on EUROSTAT data

The highest average ESI values were recorded in Italy and Spain, with values exceeding 1.10 in both sub-periods analyzed, highlighting agriculture's strong capacity to generate economic value relative to intermediate consumption. In contrast, the lowest values were observed in Denmark, Sweden, and Belgium, countries characterized by high levels of agricultural economic intensification and intermediate consumption.

Regarding the variation of the indicator between the two sub-periods, the most significant increases in the economic sustainability indicator were recorded by Sweden (+25.7%), Germany (+22.1%), and Denmark (+18.9%). Romania recorded an increase of +10.4%, with the average value of the ESI rising from 0.78 in the 2014–2019 period to 0.86 in the 2020–2025 period. The result suggests an improvement in the ratio of gross value added to intermediate consumption in Romanian agriculture. At the same time, some countries saw declines in their ESI scores between the two sub-periods analyzed. The most significant declines were observed in Hungary (-13.7%), Spain (-6.8%), and France (-6.7%), highlighting the existence of uneven trends in economic sustainability among the countries analyzed.

The average ESI values for all analyzed countries rose slightly from 0.67 in the 2014–2019 period to 0.69 in the 2020–2025 period. At the same time, the standard deviation decreased from 0.26 to 0.23, and the coefficient of variation fell from 38.4% to 33.0%, indicating a moderate reduction in the indicator's heterogeneity across the countries analyzed. In contrast, the very high coefficient of variation of the indicator (CV = 215.2%) highlights significant differences among countries in changes in economic sustainability between the two sub-periods analyzed.

1.2 ANALYSIS OF THE LAND PRODUCTIVITY INDEX (LPI)

Table 2 presents the average values of the Land Productivity Index (LPI) for the two sub-periods analyzed.

Table 2.
Land Productivity Indicator (LPI)

Countries	LP11	LPI2	Δ LPI
Italy	4.14	5.21	26.1
France	2.58	3.18	23.1
Spain	2.09	2.69	28.7
Germany	3.42	4.44	29.9
Netherlands	17.29	22.13	28.0
Poland	1.69	2.65	57.5
Romania	**1.25**	**1.69**	**35.0**
Switzerland	6.6	8.09	22.5
Hungary	1.57	2.10	34.2
Austria	2.75	3.87	40.8
Portugal	2.05	2.97	44.6
Denmark	4.11	4.94	20.3
Belgium	6.33	8.40	32.7
Sweden	2.03	2.56	25.7
Bulgaria	0.81	1.10	35.0
Minimum	**0.8**	**1.1**	**20.3**
Maximum	**17.3**	**22.1**	**57.5**
Mean	**3.9**	**5.1**	**32.3**
SD	**4.1**	**5.2**	**9.7**
CV (%)	**104.2**	**102.1**	**30.1**

Source: Our own calculations based on EUROSTAT data

The highest average LPI values were recorded by the Netherlands, with values of 17.29 for the period 2014–2019 and 22.13 for the period 2020–2025, reflecting a very high level of economic intensification and agricultural land utilization. High values of land economic productivity were also observed in Belgium, Switzerland, and Italy, countries characterized by intensive and highly specialized agricultural systems.

In contrast, the lowest LPI values were recorded in Bulgaria, Romania, and Hungary, highlighting significant structural differences among the analyzed agricultural systems. Romania recorded average LPI values of 1.25 for the 2014–2019 period and 1.69 for the 2020–2025 period, corresponding to a percentage change of +35.0%.

Regarding the change in the indicator between the two sub-periods analyzed, the largest increases were recorded in Poland (+57.5%), Portugal (+44.6%), and Austria (+40.8%). Significant increases were also observed in Romania, Bulgaria, and Hungary, where the percentage changes exceeded 34%. The results suggest the existence of processes of increasing economic productivity of agricultural land, particularly in the Central and Eastern European countries analyzed.

The average value of the LPI indicator for all analyzed countries rose from 3.9 during 2014–2019 to 5.1 during 2020–2025, indicating a general increase in the economic productivity of agricultural land. At the same time, the standard deviation increased from 4.1 to 5.2, highlighting the widening of absolute differences among the analyzed countries. Nevertheless, the coefficient of variation showed a slight decrease, from 104.2% to 102.1%, suggesting that the indicator's heterogeneity remains very high across the analyzed countries.

The coefficient of variation for the LPI indicator (CV = 30.1%) indicates a moderate dispersion in the growth rates of land productivity across the countries analyzed, compared with the much more heterogeneous variations observed for the economic sustainability indicator.

1.3 ANALYSIS OF THE INPUT-OUTPUT INTENSITY (III) INDICATOR

Table 3 presents the average values of the input-output intensity (III) indicator for the two sub-periods analyzed.

Table 3.

Input Intensity Indicator (III)

Countries	III1	III2	Δ III
Italy	1.87	2.32	23.9
France	1.55	1.90	22.6
Spain	0.93	1.22	31.9
Germany	2.23	2.57	15.3
Netherlands	11.08	13.60	22.8
Poland	1.04	1.53	47.1
Romania	**0.70**	**0.87**	**23.5**
Switzerland	4.03	4.88	20.9
Hungary	0.91	1.26	38.0
Austria	1.58	2.11	33.4
Portugal	1.22	1.75	43.2
Denmark	3.06	3.51	14.6
Belgium	4.47	5.74	28.3
Sweden	1.47	1.67	13.4
Bulgaria	0.48	0.59	22.7
Minimum	**0.5**	**0.6**	**13.4**
Maximum	**11.1**	**13.6**	**47.1**
Mean	**2.4**	**3.0**	**26.8**
SD	**2.7**	**3.3**	**10.2**
CV (%)	**109.1**	**107.3**	**37.9**

Source: Our own calculations based on EUROSTAT data

The highest average values for Indicator III were recorded in the Netherlands, with values of 11.08 for the period 2014–2019 and 13.60 for the period 2020–2025, reflecting a very high level of economic intensification in agriculture. High values of the indicator were also observed in Belgium, Switzerland, and Denmark, countries characterized by intensive and highly technologized agricultural systems.

In contrast, the lowest values of Indicator III were recorded in Bulgaria, Romania, and Hungary, highlighting lower levels of agricultural intermediate consumption relative to the agricultural area utilized. Romania recorded average values for Indicator III of 0.70 during the 2014–2019 period and 0.87 during the 2020–2025 period, corresponding to a percentage change of +23.5%.

Regarding the change in the indicator between the two sub-periods analyzed, the largest increases were recorded by Poland (+47.1%), Portugal (+43.2%), and Hungary (+38.0%). Significant increases were also observed in Austria, Spain, and Belgium, where the percentage changes exceeded 28%. The results suggest an intensification of the economic growth of European agriculture during the 2020–2025 period compared to the 2014–2019 period.

The average value of Indicator III for all the countries analyzed rose from 2.4 during the 2014–2019 period to 3.0 during the 2020–2025 period, highlighting the overall increase in agricultural intermediate consumption relative to the area of land used for agriculture. At the same time, the standard deviation increased from 2.7 to 3.3, suggesting a widening of the absolute differences among the analyzed countries regarding the economic intensity of agricultural inputs.

The coefficient of variation decreased slightly, from 109.1% to 107.3%, indicating that the indicator's heterogeneity among the analyzed countries remains very high. At the same time, the coefficient of variation of indicator III (CV = 37.9%) highlights the existence of moderate differences among countries regarding the growth rate of the economic intensity of agricultural inputs between the two sub-periods analyzed.

1.4 ANALYSIS OF ECONOMIC LABOR PRODUCTIVITY IN AGRICULTURE (ELPI)

Table 4 presents the results regarding the economic productivity of agricultural labor, which highlight the existence of very significant structural differences among the European agricultural systems analyzed.

Table 4.
Economic Labour Productivity Indicator (ELPI)

Countries	ELPI1	ELPI2	Δ ELPI
Italy	27.19	36.43	9.23
France	39.93	47.70	7.76
Spain	31.14	39.95	8.81
Germany	41.74	61.86	20.13
Netherlands	71.37	88.93	17.55
Poland	4.94	10.12	5.18
Romania	**5.16**	**9.16**	**4.01**
Switzerland	42.41	56.03	13.62
Hungary	8.21	13.72	5.51
Austria	24.30	35.25	10.95
Portugal	11.83	18.77	6.94
Denmark	48.83	78.86	30.03
Belgium	43.24	63.61	20.38
Sweden	28.91	43.30	14.39
Bulgaria	7.12	13.93	6.81
Minimum	**4.94**	**9.16**	**4.01**
Maximum	**71.37**	**88.93**	**30.03**
Mean	**29.09**	**41.18**	**12.09**
SD	**19.34**	**25.28**	**7.28**
CV%	**66.48**	**61.39**	**60.24**

Source: Our own calculations based on EUROSTAT data

The ELPI values highlight significantly higher levels of economic efficiency in agricultural labor in Western European countries characterized by a high degree of capitalization and mechanization of agriculture, such as the Netherlands, Denmark, Belgium, and Germany.

During the 2020–2025 period, the highest ELPI values were recorded in the Netherlands (88.93 thousand euros/AWU), Denmark (78.86 thousand euros/AWU), and Belgium (63.62 thousand euros/AWU), while the lowest values were found in Romania (9.16 thousand euros/AWU), Poland (10.12 thousand euros/AWU), and Hungary (13.72 thousand euros/AWU). These differences highlight the existence of significant structural gaps in the efficiency of agricultural labor utilization within European agriculture.

Romania has seen an increase in the economic productivity of agricultural labor from 5.16 to 9.16 thousand euros per AWU between the two periods analyzed, suggesting a process of agricultural convergence and economic modernization. However, the indicator's level remains significantly below the average of the analyzed countries, reflecting the persistence of structural constraints associated with the fragmentation of agricultural holdings, low capitalization levels, and the high share of the labor force employed in agriculture.

The high values of the coefficient of variation - 66.48% for the 2014–2019 period and 61.39% for the 2020–2025 period—highlight a high degree of heterogeneity among the European countries analyzed regarding the economic productivity of agricultural labor.

1.5 ANALYSIS OF THE RELATIONSHIPS BETWEEN DERIVED INDICATORS

To highlight the statistical relationships among the derived indicators of agricultural economic performance, Pearson correlation coefficients were calculated, and the relationships between changes in the economic intensity of inputs, changes in the economic productivity of land, and changes in economic sustainability were plotted graphically.

1.5.1 ANALYSIS OF THE CORRELATIONS BETWEEN ECONOMIC SUSTAINABILITY (ESI) AND ECONOMIC INPUT INTENSITY (III)

The correlations between the economic sustainability indicator (ESI) and the economic input intensity indicator (III) are presented in Table 5. The results highlight the existence of distinct structural relationships between the level of economic intensification in agriculture and the economic sustainability of the analyzed agricultural systems.

Table 5.

Pearson Correlation Matrix

	ESI1	ESI2	III1	III2	LPI1	LPI2
ESI1	1					
ESI2	0.970	1				
III1	-0.310	-0.330	1			
III2	-0.301	-0.326	0.999	1		
LPI1	-0.214	-0.236	0.994	0.994	1	
LPI2	-0.216	-0.238	0.993	0.995	0.999	1

Source: Our own calculations based on EUROSTAT data

The Pearson correlation coefficient values indicate a strong positive correlation between the ESI indicator values for the two sub-periods analyzed (r = 0.970), highlighting a relatively high degree of stability in the economic sustainability patterns of the countries analyzed. Similarly, the values of indicator III show an almost perfect correlation between the two sub-periods (r = 0.999), suggesting the structural nature of the economic intensity of agricultural inputs within European agricultural systems.

The relationships between the economic sustainability indicator and the economic intensity of inputs indicator show moderate negative values of the Pearson coefficient, both for the 2014–2019 period and for the 2020–2025 period. The correlations obtained between ESI1 and III1 (r = -0.310) and between ESI2 and III2 (r = -0.326), respectively, suggest that high levels of economic input intensity are not uniformly associated with high values of economic sustainability.

1.5.2 ANALYSIS OF THE CORRELATIONS BETWEEN ECONOMIC SUSTAINABILITY (ESI) AND LAND PRODUCTIVITY (LPI)

The correlations between the economic sustainability indicator (ESI) and the land productivity indicator (LPI) are presented in Table 5. The results highlight the existence of weak and negative relationships between the two indicators, both for the 2014–2019 period and for the 2020–2025 period.

The Pearson correlation coefficients calculated between ESI1 and LPI1 (r = -0.214) and between ESI2 and LPI2 (r = -0.238), respectively, suggest that high levels of land economic productivity are not directly associated with high levels of economic sustainability. The results highlight the existence of structural differences between the agricultural systems analyzed, particularly in the case of countries characterized by a high level of economic intensification of agriculture.

The strong positive correlation between the LPI indicator values for the two sub-periods analyzed (r = 0.999) indicates that the structural differences among the analyzed countries persist and that the level of economic productivity of agricultural land remains relatively stable.

1.5.3 ANALYSIS OF THE CORRELATIONS BETWEEN THE ECONOMIC INTENSITY OF INPUTS (III) AND THE ECONOMIC PRODUCTIVITY OF LAND (LPI)

The correlations between the economic input intensity (III) indicator and the land productivity index (LPI) are presented in Table 5. The results highlight the existence of strong positive correlations between the two indicators for both sub-periods analyzed.

The Pearson correlation coefficients calculated between III1 and LPI1 (r = 0.994) and between III2 and LPI2 (r = 0.995), respectively, indicate a very strong direct relationship between the economic intensity of agricultural inputs and the level of land productivity. The results suggest that countries characterized by high levels of intermediate consumption relative to the utilised agricultural area generally also record high values of agricultural output relative to the utilised agricultural area.

The strong positive correlations between the values of Indicator III for the two sub-periods analyzed (r = 0.999) and between the values of the LPI (r = 0.999) highlight the structural and relatively stable nature of the differences between the agricultural systems analyzed in terms of economic intensification and the economic productivity of agricultural land.

1.5.4 ANALYSIS OF CORRELATIONS BETWEEN CHANGES IN INDICATORS

The correlations between the variations in the analyzed indicators are presented in Table 6, Figure 1, and Figure 2.

Table 6.

Correlations between changes in indicators

The relationship between changes in the indicators	Coefficient Pearson (r)	Correlation strength
ΔIII and ΔESI	-0,593	Moderată negativă
ΔLPI and ΔESI	-0,108	Foarte slabă negativă
ΔIII and ΔLPI	0,831	Puternic pozitivă

Source: Our own calculations based on EUROSTAT data

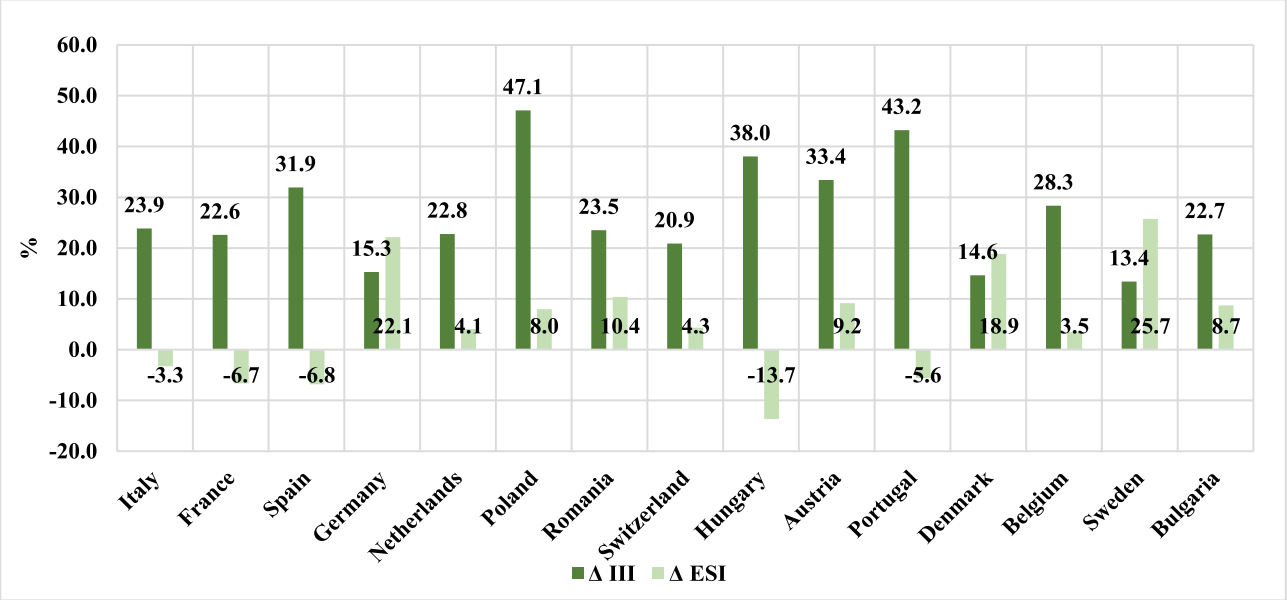
An analysis of changes in the indicators between the two sub-periods reveals a moderate negative correlation between changes in the economic intensity of inputs and changes in economic sustainability (r = -0.593). This result suggests that further economic intensification of agriculture does not necessarily lead to increased economic sustainability in all the countries analyzed.

The results regarding changes in indicators between the two sub-periods reveal a very weak and negative correlation between changes in the economic productivity of land and changes in economic sustainability (r = -0.108). This relationship suggests that an increase in the economic productivity of land does not necessarily lead to an improvement in the economic sustainability of agriculture in the countries analyzed.

The results regarding the variations in indicators between the two sub-periods highlight the existence of a strong positive correlation between the variation in the economic intensity of inputs and the variation in the economic productivity of land (r = 0.831). The result suggests that the economic intensification of agriculture contributes significantly to the increase in the economic productivity of agricultural land in the analyzed countries.

Figure 1.

Comparative evolution of input intensity (III) and economic sustainability (ESI) in European agriculture

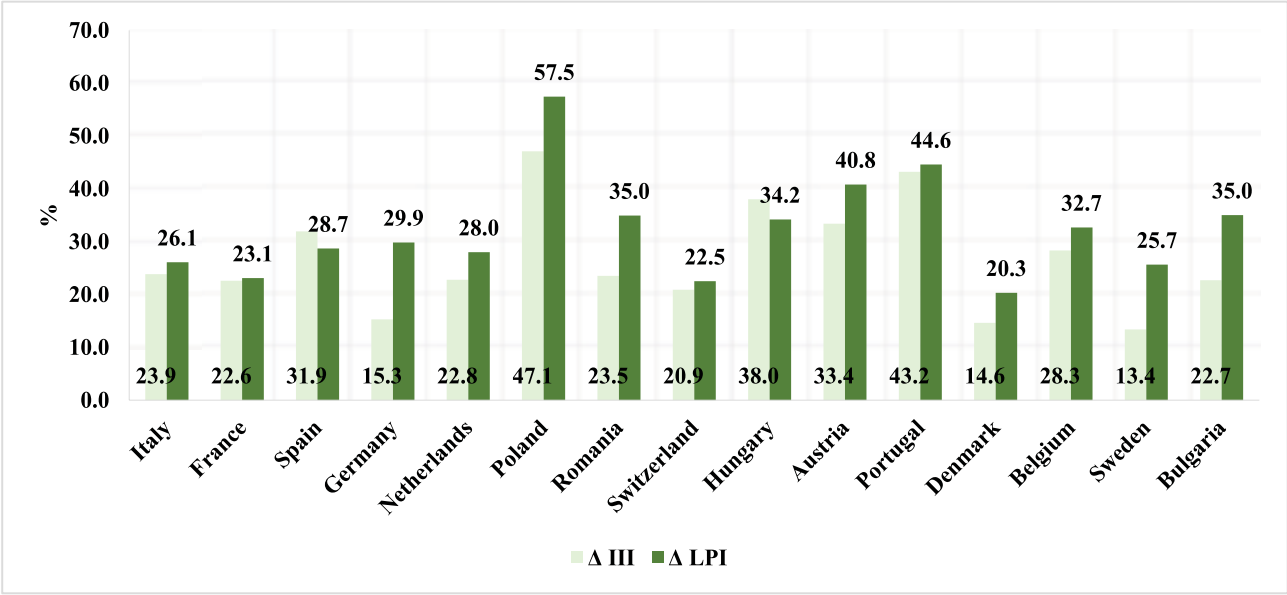


Source: Author's own calculations based on EUROSTAT data, averages for the period 2014–2025

Figure 1 highlights the negative relationship between changes in the economic intensity of inputs and changes in economic sustainability. The distribution of the data points reveals that European agricultural systems respond differently to processes of economic intensification, suggesting that the relationship between intensification and economic sustainability is not uniform.

Figure 2.

Comparative evolution of input intensity (III) and land productivity (LPI) in European agriculture



Source: Author's own calculations based on EUROSTAT data, averages for the period 2014–2025

Figure 2 highlights the existence of a strong positive relationship between changes in the economic intensity of inputs and changes in the economic productivity of agricultural land. The results suggest that an increase in agricultural intermediate consumption is associated with an increase in the economic productivity of land in most of the countries analyzed.

DISCUSSIONS

The comparative analysis conducted for the two sub-periods confirms that the processes of economic intensification in European agriculture accelerated between 2020 and 2025, against the backdrop of transformations driven by volatility in agricultural markets, rising energy costs, and higher prices for agricultural inputs. Similar findings are highlighted in recent literature, which emphasizes that European agriculture is undergoing a period of structural transformation associated with increasing dependence on agricultural inputs and pressures stemming from economic and geopolitical volatility *(European Commission, 2020; FAO, 2024; Donovan et al., 2021).*

Processes of agricultural productivity growth are influenced both by agricultural policies and investments in modernization, as well as by pressures arising from climate change, land use, and natural resource constraints (Chatzitheodoridis et al., 2025; Hua et al., 2025). In this context, assessing the relationships between economic intensification, economic productivity, and agricultural sustainability becomes relevant for analyzing the performance of European agricultural systems.

The economic productivity of agricultural land highlights the fact that processes of economic intensification and agricultural modernization contribute to improving the economic performance of European agriculture (Khan et al., 2025; Wang et al., 2020). The strong positive correlation identified between changes in the economic intensity of inputs and changes in the economic productivity of land confirms the role of agricultural input use and economic intensification in increasing the value of agricultural production relative to the area of agricultural land used.

High levels of economic land productivity, such as in the Netherlands or Belgium, are associated with highly intensive and specialized agricultural models, characterized by high use of agricultural inputs and a high level of agricultural capitalization. In contrast, the Eastern European countries analyzed, including Romania, continue to undergo processes of agricultural convergence, in which moderate growth in economic intensification is associated with significant increases in the economic productivity of agricultural land. These results are consistent with the conclusions drawn by Wimmer and Finger (2026) and by Ion and Creţu (2025), which highlight the existence of persistent disparities in agricultural productivity across Europe.

Increased agricultural productivity does not necessarily lead to improvements in the economic or environmental sustainability of agriculture (Chiarella et al., 2023; Khan et al., 2025). The research findings confirm this perspective, highlighting that the relationship between the economic productivity of land and economic sustainability is weaker compared to the relationship between economic intensification and agricultural productivity.

The economic performance of European agriculture is influenced by the relationships between the intensification of agricultural input use, economic productivity, and the efficiency of agricultural resource use (Varzaru, 2026). The strong positive correlation identified between changes in the economic intensity of inputs and changes in the economic productivity of land confirms that processes of economic intensification contribute to the growth of the economic performance of European agriculture.

High economic performance in agriculture is not necessarily associated with improved economic sustainability. The negative correlations between economic intensification and economic sustainability suggest that there are limits to highly intensive and specialized agricultural models. These results are similar to the conclusions drawn by Cholet et al. (2026) and Martín-García et al. (2026), who highlight that agricultural economic performance must be analyzed alongside resource use efficiency and the sustainability of agricultural systems.

The results obtained for Romania highlight the existence of a process of agricultural convergence and economic modernization, characterized by the simultaneous increase in the economic productivity of land and economic sustainability. These results are consistent with studies on the structural transformations of Romanian agriculture, which emphasize the role of farm modernization, investment, and increased capitalization in improving the economic performance of agriculture (Tudor and Alexandri, 2015).

The processes of agricultural intensification and economic performance growth must be linked to the efficient use of agricultural inputs and to agriculture's ability to generate sustainable long-term added value. The research results confirm this perspective and highlight the importance of a balanced approach to agricultural intensification within European agricultural policies (Varzaru, 2026).

The research results confirm the conclusions of recent literature regarding the complex and multidimensional nature of European agricultural sustainability (Liu, 2025; Sinisterra-Solís et al., 2024). The relationships identified between the economic intensification of inputs, the economic productivity of land, and economic sustainability highlight the fact that agricultural performance cannot be assessed solely by the level of agricultural production or economic productivity.

The negative correlations between economic intensification and economic sustainability confirm the conclusions drawn by Mergoni et al. (2024) and Alves et al. (2022), which highlight that agricultural intensification processes can have different effects on sustainability depending on the structure of agricultural systems and the efficiency of agricultural resource use. The results suggest that agricultural models characterized by very

high levels of economic intensification and agricultural input use do not necessarily exhibit higher levels of economic sustainability.

At the same time, the results obtained for Central and Eastern European countries, particularly Romania, Poland, and Bulgaria, highlight the existence of processes of agricultural convergence and economic modernization associated with simultaneous improvements in economic productivity and economic sustainability. These conclusions are consistent with recent literature on structural transformations and existing sustainability differences in European agriculture (Manta et al., 2024; Prigoreanu et al., 2025b).

The analysis highlights the importance of using derived indicators and comparative approaches to assess the economic sustainability of European agriculture. Recent literature emphasizes that assessing agricultural sustainability requires the simultaneous integration of the economic, social, and ecological dimensions of agriculture (Boggia et al., 2023; Xavier et al., 2025). In this context, the research contributes to the literature by highlighting the relationships between economic intensification, economic productivity, and economic sustainability in European agriculture.

An analysis of the economic productivity of agricultural labor reveals significant structural differences among European agricultural systems. Western European countries report high levels of gross value added per agricultural worker, reflecting high levels of capitalization, mechanization, and economic efficiency in agriculture. In contrast, Eastern European countries, including Romania, continue to record low levels of economic productivity of agricultural labor, a phenomenon associated with the fragmentation of agricultural holdings and the high share of the labor force employed in agriculture (Ursu, 2024).

Limitations of the study. The study uses purely value-based indicators, which means that the results may reflect both structural changes in agricultural performance and the influence of fluctuations in agricultural prices and inflation during the period under review. This aspect is particularly relevant for the 2020–2025 period, characterized by significant increases in energy costs, agricultural input prices, and agri-food product prices. Under these conditions, some of the variations in the analyzed indicators may be associated with value changes driven by price trends and not exclusively with changes in the economic efficiency or productivity of agricultural systems. Nevertheless, the use of the same statistical sources and a uniform methodology for all analyzed countries allows for relevant relative comparisons between European agricultural systems. Future research could complement the analysis by using indicators expressed in constant prices and by incorporating physical and ecological indicators of agricultural performance.

CONCLUSIONS

The research findings highlight the fact that the economic intensification of agriculture contributes significantly to increasing the economic productivity of agricultural land, a finding confirmed by the strong positive correlation identified between the economic intensity of inputs and the economic productivity of land. Thus, the first working hypothesis of the study is validated for the European countries analyzed.

At the same time, the results show that increasing the economic intensity of inputs does not uniformly lead to improved economic sustainability in agriculture. The negative correlations between the economic intensity of inputs indicator and the economic sustainability indicator highlight the existence of significant structural differences among European agricultural systems, confirming the second working hypothesis of the study. The high values of the coefficients of variation calculated for the analyzed indicators highlight a high level of heterogeneity among European agricultural systems, both in terms of economic intensification and economic sustainability.

The research highlights the existence of distinct agricultural models across Europe. Agricultural systems characterized by very high levels of economic intensification exhibit high levels of economic land productivity, but with fewer benefits in terms of economic sustainability. In contrast, some Eastern European countries undergoing a process of agricultural convergence continue to show simultaneous improvements in economic productivity and economic sustainability, against a backdrop of moderate intensification in the use of agricultural inputs.

The results support economic theories regarding the role of agricultural intensification in increasing productivity, but also highlight the fact that the relationship between intensification and economic sustainability depends on the structural characteristics of the agricultural systems analyzed. From this perspective, the research contributes to the literature by using indicators derived from economic accounts for agriculture and by analyzing the statistical relationships among the economic intensity of agricultural inputs, the economic productivity of land, and economic sustainability.

Future research directions may consider incorporating physical and ecological indicators to conduct a multidimensional assessment of the sustainability of European agriculture. Furthermore, expanding the analysis using econometric models and more detailed datasets could improve understanding of the relationships among agricultural intensification, economic efficiency, and the sustainability of European agricultural systems.

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FROM DIGITAL MARKETING TO DIGITAL MARKETING MANAGEMENT: EVOLUTION OF CONCEPTS AND MANAGERIAL LOGIC

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SUMMARY

The digitalisation of the economy has significantly transformed marketing theory and practice, leading to the rapid development of digital marketing as a set of tools, channels, platforms, and technologies for customer interaction. However, the growing complexity of digital environments, the increasing role of data, and the integration of marketing with sales, service, analytics, and digital platforms require a shift from an instrumental understanding of digital marketing toward the managerial concept of digital marketing management. This conceptual review systematises existing approaches to digital marketing and substantiates digital marketing management as an integrated data-driven management system. Based on the analysis of academic literature on digital marketing, marketing analytics, customer experience management, omnichannel communication, CRM, marketing automation, and digital transformation, the paper identifies the limitations of the tool-based approach and defines the key components of digital marketing management. The findings show that digital marketing management goes beyond the use of digital channels and includes goal-setting, strategic planning, organisation, coordination, performance control, and continuous optimisation of marketing activities. The study contributes to the literature by clarifying the distinction between digital marketing and digital marketing management and by offering a managerial logic for understanding marketing transformation in the digital economy.

Keywords: *digital marketing, digital marketing management, digital transformation, data-driven marketing, customer experience, omnichannel marketing*

INTRODUCTION

Over the past decades, digitalisation has significantly transformed the business environment, the nature of interactions between enterprises and consumers, and the methods used to promote goods and services (Kraus et al., 2022). Digital marketing has evolved rapidly through the increased use of digital channels, platforms, data, and technology for market communication, demand generation, and consumer relationship development. However, the further development of the digital economy has shown that digital marketing cannot be regarded solely as a set of promotional tools. The increasing complexity of consumer behaviour, the growth of data volumes, the development of omnichannel communications, and the integration of marketing with sales, service, analytics, and digital platforms have expanded the scope of marketing activities and changed the requirements for their management (Hanelt et al., 2021).

In practice, digital marketing has traditionally been understood as a set of digital tools and channels, including search engine optimisation, contextual advertising, social media, email marketing, targeted advertising, content marketing, and other forms of online communication. This instrumental interpretation played an important role in the early stages of digital marketing, enabling enterprises to adopt new channels for interacting with consumers and to improve the effectiveness of communication. In the current context, this interpretation is becoming insufficient, as it does not reflect the managerial nature of the ongoing transformations. Digital technologies are changing not only promotional methods but also decision-making processes, the organisation of marketing functions, the distribution of responsibilities, cross-functional interaction, customer experience management, and the mechanisms for monitoring and evaluating the effectiveness of marketing activities (Plangger, 2022; Cioppi et al., 2023).

In this regard, there is a need to clarify the scientific meaning of "digital marketing" and to develop it conceptually toward digital marketing management. Unlike the instrumental approach, digital marketing management treats marketing as a data-driven, strategic, coordinated system of digital processes, channel integration, performance control, and continuous optimisation of the company's interaction with the market. This approach reflects the transition from individual marketing campaigns to continuous processes, from intuitive decisions to data-driven management, from fragmented digital channels to integrated communication ecosystems, and from post-hoc evaluation of results to a continuous managerial framework.

Despite active research in digital marketing, the scientific literature still lacks sufficient conceptual clarity regarding digital marketing management. Therefore, it is relevant to theoretically examine the transition from digital marketing as a set of digital tools to digital marketing management as an integrated system for managing marketing activities. This served as the motivation for initiating the present study.

The aim of the study is to theoretically substantiate the conceptual transition from an instrumental understanding of digital marketing to digital marketing management as a holistic system for managing marketing activities in the context of the economy's digital transformation. To achieve this aim, the article systematises existing approaches to interpreting digital marketing, identifies the limitations of the instrumental paradigm, and reveals the key managerial principles that shape the development of marketing in the digital environment.

METHODOLOGICAL FRAMEWORK

This study is conducted as a conceptual review article, with the aim of providing a theoretical understanding of the evolution of digital marketing and substantiating the transition toward digital marketing management as an integrated managerial system. The choice of a conceptual review approach is determined by the fact that the research problem is less about quantitatively assessing publication activity and more about identifying the substantive logic underlying the development of scientific approaches to digital marketing, its managerial functions, and the organisational consequences of digital transformation.

The empirical basis of the study comprises scientific publications on digital marketing, marketing management, business digital transformation, marketing analytics, customer experience management, CRM systems, omnichannel interaction, marketing automation, and data-driven marketing. The selection of sources was based on their thematic relevance to the study's aim. The methodological basis of the study includes theoretical analysis, a comparative approach, logical generalisation, and the systematisation of scientific concepts. Particular attention is paid to research areas that most fully reflect the transition from the use of individual digital tools to the formation of an integrated marketing management system.

DIGITAL MARKETING IN SCIENTIFIC LITERATURE

Digital marketing is a complex phenomenon that involves using digital technologies, channels, and platforms, along with data, to perform marketing functions. In its broadest sense, digital marketing encompasses communication with markets and consumers, the promotion of goods and services, demand generation, the management of a company's online presence, and the development of interactions with target audiences (Chaffey, Ellis-Chadwick, 2022; Tarazona-Montoya et al., 2024).

Within the instrumental approach, digital marketing is interpreted primarily as a set of digital channels and tools used to achieve marketing objectives, including search marketing, content marketing, social media, online advertising, email marketing, mobile applications, and partner-based digital communications (Chaffey, Ellis-Chadwick, 2022; Tarazona-Montoya et al., 2024). This approach reflects the applied dimension of digital marketing and demonstrates its role as a means of promotion and consumer interaction in the digital environment.

A broader approach links digital marketing to the development of digital marketing orientation, in which digital technologies become part of a company's marketing strategy. In this case, the emphasis shifts to the use of online channels and digital platforms to increase awareness, engagement, and conversion among target audiences, as well as to data collection and analysis, communication personalisation, and the automation of consumer interaction (Pașcalău et al., 2024). At the same time, this approach still retains a predominantly applied logic, since digital technologies and tools are viewed primarily as means of achieving marketing results.

Recent studies increasingly emphasise an approach in which digital marketing is considered not only a means of communication but also a new model of interaction between a company and the market, based on data, omnichannel engagement, and customer experience management. Digital marketing communications are increasingly interpreted as a system for managing multiple customer touchpoints, while the growing availability of data enables companies to make more informed decisions, personalise communications, and continuously optimise interaction with consumers (Shankar et al., 2022). The analysis of customer data, the application of artificial intelligence algorithms, and automated marketing solutions allow companies to better understand consumer preferences, develop more accurate marketing offers, and increase the likelihood of conversion (Shankar et al., 2022; Antczak, 2024).

Despite the diversity of approaches, most interpretations of digital marketing retain a pronounced focus on technologies, channels, data, personalisation, and promotional tools. This makes it possible to speak of the dominance of an instrumental perspective, within which digital marketing is most often understood as a set of online communication tools and technological solutions. However, in the context of the increasing complexity of the digital environment and the growing demands of marketing management, this approach has several significant limitations. One of them is the fragmentation of management. When digital marketing is reduced to individual channels, marketing activities risk losing their integrity. The effectiveness of digital marketing depends not only on the set of tools used but also on the quality of strategy, the coherence of actions, market conditions, and the company's ability to integrate digital solutions into the overall management system (Sharabati et al., 2024).

Within instrumental logic, digital marketing is often reduced to promotion and consumer interaction, while the functions of analysis, planning, organisational coordination, and performance control remain insufficiently developed. Meanwhile, digital transformation goes beyond the simple use of digital technologies and requires changes in a company's strategy, structure, and business processes (Verhoef et al., 2021). The digital environment also increases the need for coordination among marketing, sales, and service, as customer interaction becomes an end-to-end, cross-functional process (Enyinda et al., 2020).

Moreover, there is an overestimation of the role of technologies and an underestimation of managerial processes. The digitalisation of marketing should not be reduced solely to implementing new platforms, software solutions, or advertising tools. The effectiveness of digital technologies becomes evident only when they are embedded in the company's strategy, supported by organisational changes, and used within a holistic decision-making system. This argument is consistent with the view that strategy, rather than technology, is the key driver of digital transformation (Kane et al., 2015).

It should be noted that there is a lack of systematic data management. The digital environment generates large volumes of information on consumer behaviour, communication channels, campaign results, and interaction effectiveness. However, within the instrumental approach, data often remain fragmented, are used inconsistently, and are not integrated into a unified marketing management system. The absence of a common customer database, unified measurement standards, end-to-end analytics, and centralised data processing means that managerial decisions continue to be made primarily on the basis of intuition or isolated performance indicators (Kupreichik, 2024).

Thus, the analysis of academic interpretations shows that digital marketing is gradually evolving from being understood as a set of digital tools toward a more complex managerial logic. However, the instrumental paradigm still limits the possibilities for both theoretical explanation and practical application of digital marketing amid the economy's digital transformation. The identified limitations — fragmented management, the dominance of the communication function, the overestimation of technology, and the absence of systematic data management — justify moving toward digital marketing management as a more mature model for managing marketing activities in the digital environment.

"DIGITAL MARKETING" VERSUS "DIGITAL MARKETING MANAGEMENT"

In academic literature, digital marketing management is considered a marketing management system based on digital technologies, data, and platform infrastructure, ensuring the planning, organisation, coordination, and control of an enterprise's interactions with the market (Gryshchenko, 2023).

Unlike digital marketing, understood as a set of channels, digital marketing management describes a managerial framework: who makes decisions, what data these decisions are based on, how roles are distributed, how results are measured, and how the continuous improvement of marketing processes is ensured *(Table 1)*.

Table 1. "Digital marketing" versus "Digital marketing management"

Criterion	Digital marketing (instrumental approach)	Digital marketing management (managerial approach)
Focus	Channels, tools, and promotion tactics	Marketing management system in the digital environment
Role of technologies	Technologies as a means of promotion and communication	Technologies as an infrastructure for managing processes and data
Object of management	Advertising campaigns and communications	Processes of interaction with the market and customers (end-to-end)
Management horizon	Mostly short-term (campaigns)	Continuous (processes, customer lifecycle)
Key resource	Content and channel budget	Data, customer database, platforms, and competencies
Decision-making	Often intuitive or based on simple metrics (reach/clicks)	Based on data, analytics, and testing (data-driven)
Performance metrics	CTR, reach, CPM, CPC, followers	CAC, LTV, stage-by-stage conversion, retention, ROMI, process KPIs
Structure of activities	Fragmented activities across channels	Integrated system: strategy → processes → control → optimization
Work organization	Specialists in individual channels	Cross-functional team: marketing + analytics + sales + IT/product
Customer experience management	As an additional element (not always systematic)	Central object of management (customer journey, CX)
Tools	SMM, SEO, PPC, email, banners, blog	CRM, CDP/data, analytics, automation, omnichannel approach, KPI framework

Criterion	Digital marketing (instrumental approach)	Digital marketing management (managerial approach)
Control and improvement	Post-hoc evaluation of campaigns	Continuous monitoring and optimisation (PDCA cycle/tests)
Risks	Strong dependence on individual platforms/ channels	Risks are managed through diversification, data standards, and processes
Result	Communication effect/leads	Managed marketing system and measurable contribution to business goals

Source: developed by the author based on literature analysis

The presented model reflects a qualitative transition from an instrumental understanding of digital marketing to a managerial one. Within the instrumental approach, digital marketing is viewed as a set of channels and promotional tactics, such as SEO, PPC, SMM, and email marketing, in which technologies serve as communication tools, while individual advertising campaigns are the objects of management. Management in this case is predominantly short-term and fragmented; decisions are often based on simplified metrics, such as reach and clicks, while results depend on individual platforms and channels. In contrast, digital marketing management operates at a systemic level, where marketing functions as an integrated mechanism for managing customer interactions in the digital environment. In this context, technologies serve as an infrastructure that enables the management of data, processes, and customer experience at all stages of the lifecycle. The object of management shifts to end-to-end processes, while decision-making is based on analytics and data-driven principles. Performance metrics shift toward business outcomes, such as CAC, LTV, and ROI, while the organisational model moves toward cross-functional interaction and continuous optimisation.

The transition from digital marketing to digital marketing management is driven by the growing complexity of the digital environment, changes in consumer behaviour, the increasing role of data, and the need to integrate marketing with other business functions. In contemporary conditions, digital marketing can no longer be understood merely as a set of promotional channels, since the effectiveness of market interaction depends on the coherence of strategy, processes, data, communications, and control mechanisms.

One of the key conditions for this transition is the increasing complexity of consumer behaviour. The digital environment has made the customer journey more complex: a purchase decision is no longer determined by a single advertising communication but is shaped by accumulated experience, information search, comparison of alternatives, reading reviews, and interaction with a brand across various digital channels. The customer journey comprises multiple touchpoints across platforms, channels, and stages of interaction (Lemon & Verhoef, 2016; Shankar et al., 2022). Therefore, digital marketing management should focus on coordinating the entire customer journey. Digital transformation also requires firms to develop new managerial approaches to understanding and managing consumer behaviour in digital environments (Cioppi et al., 2023).

Another important precondition is the growing role of data in marketing decision-making. Digital transformation has shown that data is becoming one of the key resources of marketing. Data-driven approaches enable companies to improve segmentation, personalise communications, forecast consumer behaviour, and optimise marketing budgets. For example, Sahni, Wheeler, and Chintagunta (2018) demonstrated that even simple personalisation of email communication increased the probability of opening an email by 20%, increased the number of potential customers by 31%, and reduced unsubscribes by 17%. This confirms that data are not only an analytical resource, but also a basis for managerial decision-making in digital marketing.

The transition to digital marketing management is also associated with the shift from individual campaigns to continuous marketing processes. Digital channels require a company's constant presence in the information space and continuous optimisation of marketing actions. As a result, marketing becomes a process that requires regular monitoring, adaptation, and improvement. Social media and big data contribute to the development of multichannel interactions and increase the need for systematic analytics (Sivarajah et al., 2017). At the same time, platform solutions, centralised data management, and end-to-end analytics create conditions for optimising customer experience (Nuseir et al., 2023).

In the digital environment, the boundaries between marketing, sales, and customer service are increasingly blurred, as a unified digital customer journey requires coordination among these functions. The study by Enyinda et al. (2020) shows that the alignment of marketing, sales, and service — the "marketing-sales-service interface" — contributes to a better understanding of customer behaviour and improves the effectiveness of organisational processes. This confirms the need for a common management system that integrates marketing activities with sales, service, analytics, and digital infrastructure.

Thus, the transition to digital marketing management is determined not only by the development of digital channels, but also by a change in the very logic of marketing management. The growing complexity of

consumer behaviour, the increasing volume of data, the need for omnichannel coordination, and the integration of marketing with sales and service require the formation of a holistic managerial system. Such a system should ensure goal-setting, planning, the organisation of marketing processes, data management, performance control, and the continuous optimisation of decisions.

Based on the literature analysis, digital marketing management can be understood as a management system that integrates strategy, marketing processes, data, digital infrastructure, and performance evaluation. Contemporary studies show that digital transformation requires a holistic managerial model that covers the organisational, technological, and analytical components of marketing (Amalia et al., 2026). This logic is also reflected in digital marketing maturity models, which identify strategy, process organisation, data management, and performance evaluation as key elements of digital marketing development.

The main objective of marketing management is to achieve measurable business results; that's why digital marketing should be embedded in the company's overall strategy and evaluated through specific KPIs (Tiago & Veríssimo, 2014). The use of digital tools can positively influence company performance when they are strategically integrated and aligned with measurable objectives (Pașcalău et al., 2024).

In the context of digitalisation, the organisational structure of marketing is also changing. New roles are emerging that focus on technologies, data, and digital processes, including performance marketing specialists, marketing analysts, content managers, CRM managers, and marketing automation specialists. Research shows that digital transformation requires new skills from marketing professionals, particularly managerial, analytical, and technological competencies, to interact effectively with customers and improve company performance. (Homburg & Wielgos, 2022).

Digital marketing management also requires consistency across channels and messages, since customers perceive a brand through a combination of touchpoints. Studies on integrated marketing communications show that the perceived consistency of communications across different tools influences customer–brand relationships. Therefore, the management of content, advertising, websites, social media, and other digital platforms should be organised as a unified and coordinated system (Luxton et al., 2015; Suay-Pérez et al., 2022).

An important element of digital marketing management is the management of data and digital infrastructure. This includes creating a unified customer database, integrating information from various sources, and using CRM systems, web analytics, end-to-end analytics, and automation tools. Such an approach enables companies to gain a deeper understanding of customer behaviour, personalise communications, and optimise digital marketing processes. CRM systems and analytics enable the accumulation of customer information and the more effective management of customer requests (Martinho et al., 2025; Jabado, Jallouli, 2024).

Control and performance evaluation in digital marketing management acquire a continuous character. They include ongoing monitoring of indicators, analysis of channel effectiveness, assessment of marketing's contribution to business results, and adjustment of marketing actions based on data. The use of digital analytics and metric systems enables companies not only to measure the results of individual marketing campaigns but also to improve their effectiveness through continuous testing, feedback, and optimisation of managerial decisions (Järvinen & Karjaluoto, 2015; Chaffey & Ellis-Chadwick, 2022).

RETHINKING MARKETING FUNCTIONS IN A DIGITAL MANAGEMENT PARADIGM

The transition from digital marketing to digital marketing management entails transforming and redefining marketing functions. Contemporary studies show that digital transformation affects not only promotional tools but also the nature of marketing activities as a whole (Verhoef et al., 2021).

In the digital environment, customer experience management and the management of customer touchpoints become central tasks of marketing (Lemon & Verhoef, 2016; Verhoef et al., 2021). Marketing ceases to be exclusively communication-oriented and becomes a system for managing customer interactions, in which communications are integrated with data analytics, service, and sales. The role of marketing in managerial decision-making is also increasing. Due to digitalisation and analytics, marketing becomes not only a means of promotion but also a source of market knowledge, including information about customer preferences, channel effectiveness, and consumer responses to changes. This enables the use of marketing data in managerial decision-making (Wedel & Kannan, 2016).

This transformation can also be interpreted through the lens of dynamic capabilities, which explain how organisations adapt to rapidly changing environments by sensing opportunities, seizing them, and transforming internal processes (Teece, 2007). In digital marketing management, sensing refers to the use of AI-based analytics, big data and digital monitoring tools to detect market signals, changes in consumer behaviour and emerging customer needs. Seizing involves mobilising technological, analytical and organisational resources to respond to these opportunities through personalised offers, CRM systems, automated communication and omnichannel interaction. Transforming reflects the renewal of marketing routines, as data-driven decision-making, continuous optimisation and cross-functional integration reshape the way marketing is planned, coordinated and controlled.

The time horizon of marketing is also changing, shifting from short-term advertising campaigns toward long-term customer relationship management based on data, personalisation, and continuous interaction with consumers (Lemon & Verhoef, 2016). The object of marketing management represents a shift from individual campaigns to the real-time management of the customer lifecycle. Predictive models and AI-based analytics enable firms to monitor customer behaviour, anticipate needs and optimise interactions across all stages of acquisition, engagement, retention and loyalty. Digital marketing management requires technological and analytical skills. Thus, marketing management combines marketing activities, data management, digital technologies, and organisational processes (Homburg & Wielgos, 2022).

Digital transformation changes the role of marketing within the organisation. It is no longer only a promotional tool, but a system for managing customer interactions based on data, analytics, and integration with other business functions. This underscores its importance as a managerial function and lays the foundation for the development of digital marketing management.

The transition from an instrumental understanding of digital marketing, based on the use of individual digital channels and promotion tactics, to a managerial model in which marketing is viewed as a holistic management system means that digital channels are not isolated tools, but elements of a unified managerial cycle. This cycle includes planning, implementation, data collection and analysis, performance control, and subsequent process improvement (Fig. 1). Such an approach ensures the integration of marketing activities with the company's business goals and forms the basis for continuous optimisation and improved marketing effectiveness in the digital environment.

Figure 1.
Digital marketing management framework

Source: developed by the author based on literature analysis

DISCUSSION AND CONCLUSION

Despite the active development of the literature, the distinction between digital marketing and digital marketing management remains a subject of discussion. In many publications, these terms are used interchangeably, complicating the development of a unified scientific framework.

One promising direction for future research is the development of maturity criteria for digital marketing management, which would enable the assessment of the level of managerial integration of digital tools within an enterprise. Another important direction is the analysis of organisational models for digital marketing, including how enterprises form teams, allocate responsibilities, and implement analytical controls. Further research is also needed in the field of ethics and regulation of digital marketing, since the growth of personalisation and data management intensifies issues related to privacy, transparency, and consumer trust.

Digital marketing management requires deeper theoretical reflection as an independent field that goes beyond the traditional understanding of digital marketing. Its development is associated with the need to integrate marketing theory with managerial approaches and digital technologies, thereby enabling the consideration of marketing as a system for managing interaction with the market in the context of digital transformation. The formation of such a concept contributes to a more holistic understanding of marketing's role and its place within an organisation's overall management system.

The literature review indicates that, in contemporary practice and research, digital marketing is increasingly moving beyond an instrumental approach and requires a shift toward digital marketing management. Unlike digital marketing as a set of channels and technologies, digital marketing management is a managerial system that includes goal-setting, process organisation, communication coordination, data management, and performance control.

The digitalisation of marketing leads to the transformation of marketing functions: the role of analytics is strengthened, integration with sales and service increases, and marketing shifts toward a process-based logic and continuous optimisation. The scientific significance of this approach lies in the formation of a more mature conceptual framework that reflects real changes in marketing activities in the digital economy. Prospects for further research include developing maturity models for digital marketing management, clarifying its structural elements, and studying organisational mechanisms for its implementation.

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DRINKING PATTERNS AND FACTORS ASSOCIATED WITH HEAVY EPISODIC DRINKING AMONG ADULTS IN MOLDOVA

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SUMMARY

Alcohol consumption is a prominent feature of everyday social life in the Republic of Moldova, yet empirical evidence on how alcohol is consumed and which population groups are most exposed to risky drinking remains limited. Using nationally representative data from the 2021 WHO STEPwise approach to Surveillance (STEPS) survey (N = 4,097 adults aged 18–69 years), this study examines patterns of alcohol consumption and the prevalence and determinants of heavy episodic drinking. Drinking patterns were described using survey-weighted estimates, and associations with heavy episodic drinking (six or more drinks on one occasion in the previous 30 days) were assessed using complex-sample logistic regression models. Alcohol consumption is common in the adult population, with 76% of past-year drinkers reporting alcohol use in the previous 30 days. Heavy episodic drinking was reported by 22% of current drinkers and was considerably more common among men than among women. Drinking patterns also differed across social and regional groups. In the adjusted analysis, heavy episodic drinking remained strongly associated with male sex, region of residence, smoking, and recent consumption of unrecorded alcohol. The findings suggest that alcohol-related risks in Moldova are shaped less by the prevalence of drinking itself than by the social and behavioural contexts in which alcohol is consumed.

Keywords: alcohol consumption, drinking patterns, heavy episodic drinking, correlates

INTRODUCTION

Alcohol consumption is a prominent aspect of daily social life in the Republic of Moldova, where alcoholic beverages are commonly incorporated into social interactions across a broad spectrum of private and public occasions. The long-standing tradition of alcohol production and its widespread availability, especially of wine, at both household and industrial levels continue to influence the cultural meanings and normative expectations surrounding alcohol use, granting social legitimacy and intergenerational continuity. This cultural and normative transmission is further reinforced through the public ritualisation of wine consumption during national and local celebrations, where wine is closely linked with tradition, hospitality, and collective identity (Bîrlădeanu, 2013). From this perspective, alcohol use is better understood as a socially patterned behaviour shaped by shared norms, meanings, and situational contexts, with considerable variation across social groups (Savic et al., 2016; Sudhinaraset et al., 2016; Lo Monaco et al., 2019).

In the Republic of Moldova, these socio-cultural features coexist with high levels of population alcohol exposure, as reflected in aggregate consumption indicators. According to the World Health Organisation (WHO), total alcohol consumption per capita reached approximately 14.1 litres of pure alcohol per adult aged 15+ in 2022, placing the country among those with the highest levels of alcohol consumption globally (WHO, 2022b).

However, aggregate consumption measures alone do not capture how alcohol is consumed or how alcohol-related risks are distributed within populations. Countries with similar levels of per capita consumption may differ substantially in drinking patterns, particularly with respect to the frequency and intensity of drinking occasions, which are closely linked to acute alcohol-related harm (Rehm et al., 2010). Accordingly, indicators capturing drinking frequency, quantities consumed per occasion, and high-risk drinking behaviours offer a more differentiated understanding of population risk profiles.

This perspective is especially relevant in the Republic of Moldova. Although levels of alcohol consumption and alcohol-related mortality have been documented in international monitoring reports and comparative studies (WHO, 2018; Penina, 2017), evidence on current drinking patterns, population groups most exposed to risk, and factors linked to high-risk drinking remains limited and fragmented.

Using data from the 2021 World Health Organization STEPwise approach to Surveillance (STEPS) survey, this study examines alcohol consumption among adults in the Republic of Moldova by describing key drinking patterns and analysing heavy episodic drinking (HED). The analysis contributes to the limited empirical literature on alcohol consumption in Moldova by providing nationally representative evidence on drinking patterns and the social distribution of heavy episodic drinking.

LITERATURE REVIEW

WHO monitoring reports highlight significant regional differences in alcohol consumption and drinking habits, with the WHO European Region recording the highest levels of per capita alcohol intake worldwide, including in several Eastern European nations such as Moldova. Alcohol consumption patterns also differ systematically across socio-demographic groups, with notable gender disparities and broader socioeconomic and contextual factors shaping alcohol use (WHO, 2018; WHO, 2024).

Among the drinking patterns observed in the region, heavy episodic drinking remains a major concern, as its prevalence has shown limited decline at the population level despite reductions in overall alcohol consumption in several European countries (Probst et al., 2020)

Evidence from the WHO STEPS surveys indicates that this pattern is also found in the Republic of Moldova, where heavy episodic drinking continues to characterise a significant segment of the drinking population (WHO, 2022a).

Beyond differences in overall levels of alcohol consumption, a substantial body of research has documented the significance of drinking patterns in influencing alcohol-related harm. In particular, the concentration of alcohol intake into high-volume drinking occasions has been recognised as a key factor associated with increased risks of both acute and chronic health outcomes (Rehm et al., 2007; Rehm et al., 2010).

Evidence from Central and Eastern Europe has been crucial in demonstrating how hazardous drinking patterns contribute to alcohol-related mortality. Early analyses of mortality trends in the region highlighted alcohol consumption's role in the high levels of premature mortality observed among men (McKee & Shkolnikov, 2001). Later studies provided strong empirical evidence linking episodic heavy drinking and irregular consumption of large amounts of alcohol with mortality risks, especially among working-age men (Leon et al., 2007; Popova et al., 2007). Population-based cohort studies have further confirmed that hazardous drinking, including heavy drinking occasions, is associated with increased mortality risks (Bobak et al., 2016). More recent evidence indicates that excessive alcohol consumption continues to be a significant factor in high male mortality in Eastern Europe and suggests that regulatory measures can reduce alcohol-related harms, though overly restrictive policies may lead to increased use of unrecorded or surrogate alcohol (Yakovlev, 2021).

Evidence from Moldova broadly reflects these regional patterns. Comparative mortality analyses show that Moldova has a unique alcohol-related mortality profile within a mainly wine-drinking culture. Unlike several neighbouring post-Soviet countries, alcohol-related deaths in Moldova are characterised by a lower incidence of deaths from acute intoxication and a smaller gender gap (Penina, 2017).

Understanding these patterns requires attention not only to mortality outcomes but also to the social distribution of drinking behaviours. Cross-national survey research has documented strong social stratification in hazardous drinking across post-socialist countries in Eastern Europe. Heavy episodic drinking is disproportionately concentrated among men, middle-aged adults, and individuals with lower levels of education, with substantial variation across countries (Pomerleau et al., 2008). Drinking patterns are further shaped by the social context in which alcohol is consumed, with certain drinking settings associated with higher risks of heavy episodic drinking and other indicators of problematic alcohol use (Stickley et al., 2007). Evidence from Moldova is consistent with these dynamics. One of the few systematic national analyses of alcohol consumption documented a high prevalence of infrequent but high-volume drinking occasions, often linked to social celebrations and facilitated by the widespread availability of home-produced alcohol (Expert-Grup, 2008).

The structure of alcohol availability also significantly influences drinking patterns in Eastern Europe, notably through the widespread presence of unrecorded alcohol. Evidence from WHO STEPS surveys conducted in nine newly independent states shows that unrecorded alcohol accounts for a substantial part of alcohol consumption in the region, with over one-third of current drinkers reporting its use. The findings also indicate that the Republic of Moldova has relatively high levels of unrecorded alcohol consumption, mainly driven by home-produced beverages (Probst et al., 2021). The broad availability of informal and home-made alcohol further shapes drinking habits and alcohol-related risks in the area. Policy and epidemiological analyses suggest that informal alcohol markets can affect consumption patterns and may weaken the effectiveness of traditional alcohol control policies when regulatory measures are not paired with targeted efforts to address unrecorded alcohol production and distribution (Neufeld et al., 2020).

In this context, Moldova is a significant setting for studying alcohol consumption patterns given its long-standing alcohol-related health issues and unique drinking environment. However, systematic population-based studies exploring drinking patterns and high-risk alcohol use in Moldova are still limited. As a result, empirical data on the prevalence and social distribution of heavy episodic drinking based on nationally representative surveys remains rare.

Against this background, the present study investigates two main research questions. First, what are the patterns of alcohol consumption among the adult population in Moldova? Second, which socio-demographic and behavioural traits are associated with heavy episodic drinking?

Drawing on earlier evidence from Central and Eastern Europe, heavy episodic drinking is likely more common among men, varies across regions, and is linked to behavioural factors such as smoking and the use of unrecorded alcohol.

METHODS

Data source and study population. This study uses cross-sectional data from the World Health Organization's STEPwise Approach to Surveillance (WHO STEPS) survey carried out in the Republic of Moldova between August 2021 and January 2022. The survey employed a three-stage, stratified cluster sampling design based on the household sampling frame of the National Bureau of Statistics. Census enumeration areas were selected with probability proportional to size, followed by random selection of households and, within each household,

random selection of one eligible adult aged 18–69 years.

A total of 4,097 individuals aged 18–69 years were interviewed from 5,760 selected households, resulting in an overall response rate of 71.1%. The analytical sample included 1,774 men and 2,323 women. By age group, 340 respondents were aged 18–29 years, 1,099 were aged 30–44 years, 1,408 were aged 45–59 years, and 1,250 were aged 60–69 years. Overall, 2,487 respondents lived in rural areas and 1,610 in urban areas. The present analysis utilised anonymised secondary data from the national STEPS survey, which was approved by the relevant national ethics committee.

Measures. The analysis employed a stepwise approach to distinguish between descriptive drinking patterns, bivariate associations, and independent correlates of HED. It proceeded in three stages: (1) descriptive analysis of alcohol consumption patterns within the population; (2) exploration of unadjusted links between sociodemographic and behavioural traits and HED; (3) development of multivariable models to identify factors independently related to HED after controlling for confounding.

Drinking patterns. Alcohol consumption indicators were derived from the WHO STEPwise approach to Surveillance (STEPS) instrument and analysed using survey-weighted population estimates. Participants were classified as: (i) ever drinkers (those who have ever consumed alcohol; yes/no), (ii) past-12-month drinkers (any alcohol use in the previous 12 months; yes/no), and (iii) current drinkers - any alcohol use in the preceding 30 days; yes/no). Among current drinkers, the mean number of standard drinks per drinking occasion was examined. A standard drink was defined according to WHO STEPS guidance as containing 10 g of pure alcohol.

Among current drinkers, drinking intensity over the past 30 days was categorised as low, intermediate, or high using WHO sex-specific thresholds for average pure alcohol intake per drinking occasion (men: <40 g, 40–59.9 g, ≥60 g; women: <20 g, 20–39.9 g, ≥40 g). These categories were used solely for descriptive analyses of drinking patterns and were not included as predictors in regression models to prevent conceptual overlap with the heavy episodic drinking outcome.

Unrecorded alcohol consumption was also evaluated. Consistent with the WHO definition, unrecorded alcohol refers to alcohol not included in official taxation or sales data because it is produced, distributed, and/or consumed outside government-regulated channels, including homemade or informally produced alcohol, smuggled alcohol, alcohol not intended for drinking, and cross-border purchases recorded somewhere else (WHO, 2018).

Outcome. Heavy episodic drinking was defined as the consumption of six or more standard drinks on at least one occasion in the previous 30 days and was analysed as a binary outcome (yes/no). This definition follows the standard WHO STEPS indicator and captures episodic spikes in alcohol intake rather than average volume, which is particularly relevant for assessing acute alcohol-related risks.

Covariates. Covariates were specified beforehand based on theoretical considerations and evidence linking sociodemographic characteristics and health-related behaviours to risky alcohol consumption. The following variables were included: sex; age group (18–29, 30–44, 45–59, 60–69 years [reference]); place of residence (urban [reference] vs rural); region of residence (Chișinău [reference], Centre, North, South); educational attainment (low, medium, high [reference]); employment status (government/non-government employee [reference], self-employed, economically inactive, retired, unemployed); and marital status (married/cohabiting [reference], never married, previously married). Current smoking status (yes/no) and unrecorded alcohol consumption in the past seven days (yes/no) were included as behavioural covariates.

An economic status indicator available in the STEPS dataset was evaluated but excluded from multivariable models due to significant item non-response and limited variability, which could compromise model stability and the interpretability of adjusted estimates.

Statistical analysis. All analyses were carried out using SPSS Statistics (version 29) Complex Samples procedures to account for the multistage stratified cluster sampling design of the WHO STEPS survey, incorporating sampling weights, stratification, and primary sampling units. Weighted prevalence estimates and means were used to describe alcohol consumption patterns and the prevalence of heavy episodic drinking. Group differences in descriptive analyses were assessed using survey-adjusted, design-based tests.

Initial associations between each covariate and heavy episodic drinking were first analysed using bivariate complex-sample logistic regression models, resulting in crude odds ratios. Afterwards, all covariates were entered together into a multivariable complex-sample logistic regression model to calculate adjusted odds ratios and evaluate independent links with heavy episodic drinking.

Variance estimation was performed using Taylor series linearisation to account for the complex survey design. Analyses were based on complete-case data.

MAIN RESULTS

Table 1 summarises the prevalence and intensity of alcohol use among adults in the Republic of Moldova, overall and by sex. Alcohol consumption was highly common in the adult population, with 94.3% of respondents reporting lifetime alcohol use. This proportion decreased to 88.2% when limited to alcohol consumption within the past 12 months. Among those who drank in the past year, 76.0% reported alcohol use within the last 30 days, corresponding to 2,446 current drinkers in the analytical sample. These figures suggest that while lifetime exposure to alcohol is almost universal, a slightly smaller proportion of adults engage in recent and regular alcohol consumption.

Across measures of alcohol use based on time since last consumption, prevalence was consistently higher among men than women, with the gender difference becoming more noticeable for more recent drinking. Among past-year drinkers, 83.5% of men reported alcohol consumption in the previous 30 days compared to 67.7% of women. Among current drinkers, the average number of standard drinks consumed per drinking occasion during the past 30 days was 2.74 (95% CI: 2.60–2.89). The volume consumed per occasion was higher among men, who reported a mean of 3.26 standard drinks (95% CI: 3.04–3.47), compared to 2.03 among women (95% CI: 1.94–2.13).

When drinking intensity was classified using WHO sex-specific thresholds for mean pure alcohol intake per drinking occasion, as described in the methods, 52.9% of current drinkers were categorised as low-level drinkers, 38.6% as moderate drinkers, and 6.7% as high-level drinkers. The distribution across these categories also varied by sex. Women were predominantly concentrated in the moderate drinking category (61.2%), whereas men were more often represented at both the lower (68.3%) and higher (7.1%) ends of the drinking intensity spectrum.

Unrecorded alcohol was a significant part of drinking habits among current drinkers. Nearly half of respondents (47.4%) reported consuming unrecorded alcohol in the past week. The occurrence was higher among men (53.5%) than women (39.1%).

Heavy episodic drinking, defined as consuming six or more standard drinks on at least one occasion in the past 30 days, was reported by 22.1% of current drinkers. This drinking pattern was significantly more common among men, with 33.9% reporting at least one such episode during this period, compared to 5.9% of women.

Table 1.

Patterns of alcohol consumption among adults

	Men	Women	Total
Ever consumed alcohol (yes)	1712 (97.0)	2145 (91.5)	3857 (94.3)
Consumed alcohol within the past 12 months (yes)	1527 (90.3)	1760 (85.9)	3287 (88.2)
Consumed alcohol within the past 30 days among 12-month consumers (yes)	1265 (83.5)	1181 (67.7)	2446 (76.0)
Average number of standard drinks per drinking occasion in the past 30 days	3.26 (95 CI: 3.04–3.47)	2.03 (95 CI: 1.94–2.13)	2.74 (95 CI: 2.60–2.89)
Drinking level based on the average number of standard drinks per occasion within the past 30 days			
Low: men < 40 g of pure alcohol on average per drinking occasion; women: < 20 g.	837 (68.3)	368 (31.7)	1205 (52.9)
Moderate: men 40–59.9 g of pure alcohol on average per drinking occasion; women 20–39.9 g.	259 (22.2)	694 (61.2)	953 (38.6)
High: men ≥ 60 g of pure alcohol on average per drinking occasion; women ≥ 40 g.	137 (7.1)	89 (5.4)	226 (6.7)
Consumed unrecorded alcohol in the previous 7 days, yes	817 (53.5)	523 (39.1)	1340 (47.4)
Heavy episodic drinking (≥6 drinks at least once in the past 30 days), yes	475 (33.9)	73 (5.9)	548 (22.1)

Note: N = unweighted sample size. Percentages and means are survey-weighted estimates with 95% confidence intervals, accounting for the complex sampling design of the WHO STEPS survey.

Source: developed by the author

Table 2 also illustrates how drinking patterns and heavy episodic drinking vary across different sociodemographic and behavioural characteristics among current drinkers. Across age groups, the prevalence of alcohol consumption in the past 30 days remained fairly consistent, ranging from 74.0% to 78.0%. Differences between age groups became more noticeable when examining the intensity of drinking. Higher proportions of high-level drinking were observed among younger and middle-aged adults, whereas this pattern was less common among respondents aged 60–69 years. Heavy episodic drinking showed a similar age distribution, with its highest prevalence among adults aged 45–59 years (25.9%), compared to 20.1% among those aged 18–29 years and 19.1% in the oldest age group.

The area of residence also influenced patterns of alcohol use. Alcohol consumption in the past 30 days was more common among urban residents than among those living in rural areas (79.4% versus 72.2%). However, the distribution of drinking intensity showed a slightly higher proportion of heavy drinking in rural areas (9.5% compared with 7.8% in urban areas). A similar difference was seen in heavy episodic drinking, which was reported more frequently by rural residents (25.8%) than by those living in urban settings (19.2%).

Regional differences highlight the uneven distribution of drinking behaviours. Recent alcohol consumption was most common in Chișinău (81.9%), while the proportions of high-level drinking (2.2%) and heavy episodic drinking (11.2%) remained comparatively low. In the North region, recent drinking was less widespread (69.6%), yet this area recorded the highest levels of both high-level drinking (27.3%) and heavy episodic drinking (39.2%). The Centre region had an intermediate position, with relatively high levels of recent alcohol consumption (78.0%) alongside more moderate levels of high-level drinking (3.4%) and heavy episodic drinking (18.6%). In the South region, recent drinking was also less frequent (67.3%), but heavy episodic drinking remained relatively high (29.5%), despite a low proportion of high-level drinking (1.9%).

Differences by educational attainment were also clear in the distribution of drinking patterns. Recent alcohol consumption was fairly similar across educational groups, although it was somewhat more common among respondents with lower levels of education (80.8%). Educational gradients were more pronounced in the intensity of drinking. High-level drinking was most common among individuals with low education (13.3%), while lower proportions were seen among those with medium (7.3%) and higher education (8.6%). At the same time, the proportion of low-level drinkers increased with educational attainment, from 47.5% among individuals with low education to 58.6% among those with higher education. Heavy episodic drinking showed a similar pattern, decreasing from 30.0% among respondents with low education to 22.7% among those with medium education and 16.6% among individuals with higher education.

Employment status also influenced differences in drinking behaviour. Recent alcohol consumption was most common among the unemployed (82.4%) and the self-employed (80.5%), while lower levels were seen among economically inactive respondents (69.1%) and retirees (71.3%). The differences were more noticeable when looking at drinking intensity. High-level drinking was most prevalent among the unemployed (23.7%) and remained higher among the self-employed (10.6%) than among employees (7.2%), economically inactive respondents (7.1%), or retirees (3.1%). Heavy episodic drinking followed a similar pattern, with the highest rates among the unemployed (37.0%) and the self-employed (31.6%), and significantly lower levels among employees (19.9%), retirees (16.7%), and economically inactive respondents (14.5%).

Across marital status groups, recent alcohol consumption varied only slightly, ranging from 72.1% among previously married respondents to 77.8% among those who had never married. Differences in drinking intensity were somewhat more evident, with the highest proportion of high-level drinking among respondents who were previously married (13.1%). Heavy episodic drinking, however, remained at similar levels across the three groups, ranging from 21.9% to 22.5%.

Smoking status marked one of the most pronounced contrasts in drinking behaviour. Recent alcohol consumption was reported by 88.3% of smokers, compared with 70.4% of non-smokers. The distribution of drinking intensity also differed substantially, as high-level drinking was reported by 14.0% of smokers and 5.4% of non-smokers. Heavy episodic drinking showed the same pattern, being reported by 37.7% of smokers compared with 13.3% among non-smokers.

Table 2.

*Alcohol consumption patterns and heavy episodic drinking by sociodemographic characteristics**

Characteristics	N	Current drinkers - consumed alcohol in the past 30 days (%)	Drinking level among current drinkers (%)			**Heavy episodic drinking (%)**
			Low	Moderate	High	
Sex						
Men	1527	83.5	68.3	22.2	9.6	33.9
Women	1760	67.7	31.7	61.2	7.1	5.9
Age						
18-29 years	276	74.0	51.8	37.4	10.8	20.1
30-44 years	936	77.7	50.7	39.2	10.1	21.9
45-59 years	1158	74.3	53.8	39.3	6.9	25.9
60-69 years	917	78.0	58.0	37.5	4.6	19.1
Residence						
Urban	1332	79.4	53.0	39.3	7.8	19.2
Rural	1955	72.2	52.8	37.6	9.5	25.8
Region						
Chisinau	900	81.9	61.0	36.8	2.2	11.2
Center	1042	77.8	52.9	38.8	8.3	23.3
North	753	69.6	29.6	43.1	27.3	39.2
South	592	67.3	61.0	37.1	1.9	29.5
Education						
Low	520	80.8	47.5	39.2	13.3	30.0
Medium	2031	75.0	51.6	41.1	7.3	22.7
High	736	75.8	58.6	32.7	8.6	16.6
Marital status						
Never married	272	77.8	58.8	31.6	9.6	22.5
Married / cohabitating	2372	76.1	53.8	38.6	7.6	21.9
Previously married	639	72.1	35.6	51.3	13.1	22.2
Work status						
Employee, government & non-government	1529	76.80	54.2	38.6	7.2	19.9
Self-employed	529	80.5	52.6	36.7	10.6	31.6
Economically inactive	416	69.1	50.2	42.6	7.1	14.5
Retired	597	71.3	58.0	38.9	3.1	16.7
Unemployed	213	82.4	43.0	33.3	23.7	37.0
Currently smoking						
Yes	2435	88.30	58.0	28.0	14.0	37.7
No	852	70.40	50.1	44.5	5.4	13.3

Note: *N = unweighted sample size. Percentages and means are survey-weighted estimates with 95% confidence intervals, accounting for the complex sampling design of the WHO STEPS survey.*

Source: *developed by the author*

Table 3 displays the results of logistic regression analyses investigating factors linked to heavy episodic drinking among current drinkers. In the unadjusted models, heavy episodic drinking was connected to a fairly wide range of sociodemographic and behavioural factors, including sex, place of residence, region, educational attainment, employment status, current smoking, and recent consumption of unrecorded alcohol. After adjusting for all covariates simultaneously in the multivariable model, some of these associations were weakened, and only a

few characteristics remained statistically significant. Overall, the adjusted model shows that heavy episodic drinking was primarily differentiated by sex, region of residence, and selected behavioural characteristics.

Sex remained the factor most strongly associated with heavy episodic drinking. Compared to women, men had substantially higher odds of reporting heavy episodic drinking (OR 5.86; 95% CI: 3.91–8.79). Geographic differences also persisted after adjustment. Relative to residents of Chisinau, the odds of heavy episodic drinking were higher in all other regions of the country. The highest adjusted odds were observed among respondents living in the North (OR 7.74; 95% CI: 3.98–15.06), followed by those residing in the South (OR 4.05; 95% CI: 2.24–7.31), and the Centre (OR 3.10; 95% CI: 1.69–5.69). Behavioural characteristics were also associated with heavy episodic drinking in the multivariable model. Current smokers had higher odds of heavy episodic drinking than non-smokers (OR 2.03; 95% CI: 1.49–2.78). Similarly, respondents who reported consuming unrecorded alcohol in the previous seven days were more likely to report heavy episodic drinking (OR 2.72; 95% CI: 1.97–3.75). Marital status showed a more limited pattern of association. Although overall differences by marital status remained statistically significant in the adjusted model, the elevated odds were concentrated among respondents who were previously married (OR 1.84; 95% CI: 1.25–2.70) compared to those who were married or cohabiting. By contrast, several characteristics associated with heavy episodic drinking in the unadjusted analysis did not remain statistically significant after adjustment. Specifically, age group, place of residence, educational attainment, and employment status were not associated with heavy episodic drinking in the multivariable model, suggesting that the crude differences observed for these characteristics were largely explained by other sociodemographic and behavioural factors included in the analysis.

Table 3.

Covariates associated with "heavy episodic drinking"

		Unadjusted Odds Ratio (95% CI)	P-value	Adjusted Odds Ratio (95% CI)	P-value
Sex (ref. category = women)	Men	8.20 (5.82–11.56)	<0.001***	5.86 (3.91–8.79)	<0.001***
Age group (ref. = 60–69 years)	18–29 years	1.06 (0.65–1.75)	0.051	1.45 (0.75–2.79)	0.592
	30–44 years	1.19 (0.87–1.61)		1.17 (0.75–1.84)	
	45–59 years	1.48 (1.11–1.97)		1.29 (0.85–1.96)	
Residence (ref. category = Urban)	Rural	1.47 (1.05–2.04)	0.023*	0.69 (0.44–1.10)	0.119
Region (ref. = Chisinau)	Center	2.41 (1.53–3.81)	<0.001***	3.10 (1.69–5.69)	<0.001***
	North	5.13 (3.13–8.40)		7.74 (3.98–15.06)	
	South	3.33 (2.03–5.47)		4.05 (2.24–7.31)	
Education (ref. = High)	Low	2.15 (1.36–3.39	0.005**	0.91 (0.54–1.53)	0.639
	Medium	1.47 (1.05–2.07)		0.84 (0.58–1.22)	
Marital status (ref. = Married/cohabiting)	Never married	1.03 (0.66–1.61)	0.986	0.99 (0.54–1.81)	0.008**
	Previously married	1.02 (0.75–1.37		1.84 (1.25–2.70)	
Work status (ref. = Employed, government and non-government)	Self-employed	1.86 (1.31–2.64)	<0.001***	1.35 (0.89–2.05)	0.123
	Economically inactive	0.69 (0.44–1.08)		0.68 (0.40–1.18)	
	Retired	0.81 (0.55–1.18)		0.92 (0.54–1.57)	
	Unemployed	2.37 (1.48–3.79)		1.18 (0.67–2.06)	
Current smoking (ref. = No)	Yes	3.92 (3.04–5.06)	<0.001***	2.03 (1.49–2.78)	<0.001***
Consumed unrecorded alcohol in the past 7 days (ref. = No)	Yes	3.13 (2.35–4.16)	<0.001***	2.72 (1.97–3.75)	<0.001***

[a] *Analyses conducted among current drinkers (N = 2,446)*

Both unadjusted and adjusted odds ratios were estimated using complex-sample logistic regression, accounting for the multistage stratified cluster sampling design and survey weights of the WHO STEPS survey.

*Statistical significance is indicated as follows: *p < 0.05; **p < 0.01; ***p < 0.001*

Source: developed by the author

DISCUSSION

This study investigated alcohol consumption patterns and heavy episodic drinking among adults in the Republic of Moldova using nationally representative data. The findings show that alcohol use is widespread in the population, reflecting the long-standing cultural and social presence of alcoholic beverages in the country. Simultaneously, the results suggest that differences across population groups are mainly expressed through the intensity and patterns of alcohol consumption rather than simply whether individuals participate in drinking. Heavy episodic drinking and high-intensity drinking occasions were unevenly distributed across socio-demographic groups, particularly by sex, region of residence, and certain behavioural characteristics. These findings should also be viewed within the broader regional context, as countries in Central and Eastern Europe are characterised by relatively high levels of alcohol consumption and drinking patterns frequently involving episodic heavy drinking (Popova et al., 2007).

Sex differences were clear in both drinking patterns and in the prevalence of heavy episodic drinking. Among current drinkers, men reported consuming more drinks per session, were more often classified in the high-intensity drinking category, and had significantly higher odds of engaging in heavy episodic drinking. In contrast, women were mainly grouped in the intermediate drinking category defined by the sex-specific WHO thresholds. Similar gender differences in alcohol consumption have been observed across Central and Eastern Europe, where heavy and episodic drinking are still disproportionately common among men (Popova et al., 2007; Pomerleau et al., 2008; WHO, 2018). However, the female drinking profile should not be viewed as insignificant. Comparative studies of alcohol-related harm in Moldova indicate that the effects of alcohol, particularly wine, are not limited to men alone and that alcohol-related risks among women also merit attention (Penina, 2017).

Regional differences emerged as one of the most notable findings of the analysis. Although alcohol consumption was common in Chisinau, respondents living in the capital were less likely to report high-intensity drinking and heavy episodic drinking than those in other parts of the country. These differences remained in the adjusted logistic regression model after accounting for the sociodemographic and behavioural characteristics included in the analysis. One possible explanation relates to the ongoing role of unrecorded alcohol, particularly home-produced beverages, which remain widespread in Moldova (WHO, 2018; Probst et al., 2021). Such forms of alcohol availability may be more prevalent outside large urban centres and could contribute to the higher concentration of alcohol intake during high-volume drinking occasions. Differences in the social composition of the capital, including higher levels of education and more stable employment structures, may also influence drinking patterns in ways that set Chisinau apart from the rest of the country, although these mechanisms cannot be directly examined with the available survey data.

The descriptive analysis showed clear differences in drinking patterns based on smoking status. Smokers reported significantly higher levels of recent alcohol consumption, high-intensity drinking episodes, and heavy episodic drinking compared to non-smokers. These patterns were confirmed in the multivariable analysis, where smoking remained independently linked to heavy episodic drinking. In this context, smoking appears less as an isolated behavioural trait and more as part of a broader cluster of health-risk behaviours. Similar clustering between tobacco use and risky alcohol consumption has been widely documented in epidemiological research. For example, studies have demonstrated that smokers are considerably more likely to engage in frequent binge drinking than non-smokers (Gubner et al., 2016). Evidence from systematic reviews and meta-analyses further supports a consistent relationship between current smoking and binge drinking across adult populations (Molaeipour et al., 2023), indicating that heavy episodic drinking often occurs within wider patterns of harmful lifestyle choices rather than as an isolated behaviour.

The association with unrecorded alcohol is analytically distinct and particularly significant in the Moldovan context. Respondents reporting consumption of unrecorded alcohol had markedly higher odds of heavy episodic drinking even after adjusting for other sociodemographic and behavioural factors. This finding is especially pertinent in a setting where home-produced beverages remain a substantial part of alcohol intake and significantly contribute to overall alcohol exposure (WHO, 2018; Probst et al., 2021). Rather than simply serving as an additional source of alcohol, unrecorded alcohol seems to be integrated into drinking habits that are more likely to involve concentrated and high-volume consumption. Previous research in Central and Eastern Europe has also emphasised that drinking patterns characterised by episodic heavy drinking play an important role in shaping alcohol-related health risks in the region (Popova et al., 2007).

Marital status showed a more complex relationship with heavy episodic drinking. While no clear differences were seen among never-married individuals, those who had been previously married had higher odds of engaging in heavy episodic drinking after adjusting for other factors. Previous studies have linked marital disruption, including divorce and widowhood, with increased alcohol consumption, often explained by the loss of social regulation within partnerships and exposure to social stressors (Power et al., 1999; Leonard & Eiden, 2007).

Educational and employment disparities were evident in the descriptive distribution of drinking patterns, although these associations did not remain statistically

significant in the adjusted model. Respondents with lower levels of education were more frequently found in higher-intensity drinking and heavy episodic drinking categories, whereas those with tertiary education were more often positioned in lower-intensity patterns. A similar gradient was observed across employment groups, with higher levels of heavy episodic drinking seen among unemployed and self-employed respondents. Although these associations were reduced after adjustment, they remain important from a sociological perspective in the Moldovan context, where lower educational attainment and more precarious forms of labour market attachment may influence exposure to riskier drinking practices. More broadly, previous research indicates that unemployment and unstable employment conditions are often linked to adverse health behaviours and outcomes, including alcohol misuse (Vancea & Utzet, 2017; Crismaru et al., 2017).

Overall, the findings emphasise that alcohol-related risks in the Moldovan population are influenced more by how alcohol is consumed than by whether individuals drink. Differences in drinking patterns, especially heavy episodic drinking, seem to be shaped by a combination of socio-demographic and behavioural factors, including sex, region of residence, smoking habits, and exposure to unrecorded alcohol. In this way, hazardous alcohol use should be viewed as part of wider social and behavioural contexts that determine alcohol-related risks within the population.

LIMITATIONS

This study has several limitations that should be considered when interpreting the findings. First, the cross-sectional design of the STEPS survey does not allow causal inference regarding the relationship between the examined characteristics and heavy episodic drinking. Second, alcohol consumption was self-reported and may therefore be affected by recall bias or underreporting, particularly for high-intensity drinking occasions. In population surveys, individuals with the most harmful drinking patterns are also less likely to participate or to report their alcohol consumption accurately, which may lead to an underestimation of heavy episodic drinking. Third, the survey data do not capture the broader social contexts in which alcohol is consumed, such as drinking settings or social norms, which may influence drinking behaviour. Finally, the measure of unrecorded alcohol consumption reflects recent exposure and may not fully capture longer-term drinking patterns.

CONCLUSIONS

This study offers nationally representative evidence on alcohol consumption patterns and heavy episodic drinking among adults in the Republic of Moldova. Heavy episodic drinking was reported by more than one in five current drinkers and was strongly linked to male gender, region of residence, smoking, and the consumption of unrecorded alcohol. These findings add to the limited empirical data on alcohol use in Moldova by illustrating the social distribution of high-risk drinking patterns. Future research should further investigate the social and regional contexts of drinking practices in Moldova, including the role of unrecorded alcohol and the clustering of alcohol use with other health-risk behaviours.

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TEMPORAL AND GROUP-SPECIFIC INSTABILITY OF SELF-RATED HEALTH IN 2020

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SUMMARY

Self-rated health (SRH) is a widely used indicator for policy evaluation due to its consistency, reliability, and ease of administration. Since the index is evaluated subjectively, there are known socio-demographic biases in the evaluation. In this article, the next step is taken, and the instability of the SRH of different socio-demographic groups is investigated. To evaluate the changes, multiple corrected Chi-squared tests were applied to the data from the 2020 Gender and Generation Survey. For exploratory purposes, uncorrected tests were also reviewed. Since the pandemic's effects must have varied over time, temporal aspects are also taken into account. The results show that SRH was mostly stable or increased after the 2020 lockdown, depending on sex-age group. For some groups, temporal dynamics existed, but present theories cannot explain them. The changes significantly and substantially depended on the socio-demographic and socio-economic position of the individuals. Some classical inequalities (e.g., gender) were validated, but most could not explain the changes. Finally, curvilinear effects were also observed. This paper thus fills an important niche in scientific literature on SRH evaluation and SRH stability. It also gives better perspectives for its usage in policy analysis.

Keywords: *Self-rated health, interoception, social bias, COVID-19, lockdown, Moldova*

INTRODUCTION

Self-rated health (SRH) is a useful indicator for health scientists and policy-makers. It has several undeniable advantages, especially low management costs and the usage of hard-to-measure organism characteristics. The indicator also has several pitfalls that stem from the process of SRH evaluation. In this paper, the influence of the global health crisis is discussed. Previous studies have already observed that during the COVID-19 pandemic, SRH indicators usually *grew* among the non-affected population, although most researchers concluded that, objectively, SRH must have declined. Several suggested explanations that refer to changes in objective health status as well as changes in the SRH evaluation process. This paper disentangles these explanations and evaluates them on the data provided by the Gender and Generation Survey in Moldova (Ministry Health et al., 2021).

By coincidence, the Gender and Generation Survey started in January 2020, before the seriousness of COVID-19 was widely known, and was paused from April to July due to the restrictions. The dataset is divided into two parts. The survey is abundant with questions on the socio-economic, demographic, and health status of respondents. As a result, multiple previously suggested hypotheses can be tested, which is done in the first part of the analysis section. In the second one, new hypotheses are generated, and unrestricted multiple Chi-squared tests are done. While researchers typically approach data-driven subgroup analysis with caution (see Lipkovich et al., 2017, for a great discussion on this issue). The corrected Chi-squared tests for ten sex-age subsamples are the benchmark for such exploration, but the uncorrected Chi-squared tests are also considered. This method maintains the complexity of the five-point scale of SRH, which is especially important since the benchmark for health can differ for different sex-age groups. The study suggests that the primary driver of the increase in SRH was linked with the process of SRH evaluation (including changes in health benchmarks and attention to bodily sensations) rather than changes in objective health or socio-economic status.

LITERATURE REVIEW

Self-rated health (SRH) is widely used in health research, policy architecture, policy evaluation, and large-scale international surveys (Bombak, 2013; Cislaghi & Cislaghi, 2019; Garbarski, 2016; Jylhä, 2009; Martinussen & Rydland, 2020; Paul et al., 2021). It has two major advantages. First, it is very simple to collect. Generally, respondents are asked to evaluate their health on a five-point scale from "very unhealthy" to "very healthy". Second, it consistently reflects the objective health properties (Feenstra et al., 2020; Inkrot et al., 2016; Wu et al., 2013). According to Jylhä (2009), the evaluation process involves multiple stages and sources of information. First, the person evaluates what bodily sensations and facts are more or less important in their overall health status evaluation. Then, this information is integrated with different systems bearing different importance and their states having different weights. Finally, the integrated rating is compared against the benchmarks that the person has for different levels of health.

At the same time, SRH has systemic imbalances in evaluation. For example, a chronic condition or functional disability has a greater negative influence on SRH of the younger individuals (Idler & Cartwright, 2018). Similarly, women report worse SRH while also having higher life expectancy. SRH is also distributed unequally among socio-economic classes (Akanni et al., 2022; Hulsegge et al., 2023). Country, a proxy for climate, culture, language, etc., also has a sizeable effect (Jürges, 2007; Lazarevič, 2023).

COVID-19 had a negative effect on health, especially if infected (Lüdecke & Von Dem Knesebeck, 2023) or had limited physical activity during the lockdown (Reigal et al., 2021). Negative SRH trajectories were also reported (Elran-Barak & Mozeikov, 2020; Lüdecke & Von Dem

Knesebeck, 2023). However, if compared directly, the post-pandemic SRH were usually higher (Cheung et al., 2023; Hulsegge et al., 2023; Jeon et al., 2024; Torrado et al., 2022).

The literature offers several intersecting explanations for the change in self-rated health during the lockdown that had a predictable or previously detected effect. A set of explanations referred to the negative effects of lifestyle changes (for example, among housekeepers, who faced additional home chores, and those who could not work from home, H1). Two explanations linked the changes with changes in objective health parameters, including a greater attention to respiratory diseases (H2) and getting COVID-19 (H3). There is an explanation linked with the changes in SRH evaluation: the "Eye of the hurricane" effect, H4. Finally, one paper suggested that the SRH was due to better mood among younger British cohorts. This paper aims to disentangle the explanations and test their effectiveness.

DATA AND METHODS

The data comes from the Generation and Gender Survey conducted in Moldova in 2020 (Ministry for Health et al., 2020). The survey was launched in January, ended in December, and was suspended from April to June. In 2020, the lockdown lasted for two months from March 17 to May 15. After omitting individuals younger than 18, 2984 observations are in the first, pre-lockdown part of the survey, and 7050 are in the second, post-lockdown part. The data for four months (with 1 to 88 observations) were included in the other months' data, as there are reasons to believe that the data were collected at the end (or the beginning) of the month.

Contacting COVID-19 affected the SRH evaluation, but GGS does not provide such data. As of November 30th, 2020, 2265 Moldovans died with COVID-19 being the primary or secondary disease, which means roughly seven potential participants of the second part of the survey passed away because of it (Ministry for Health, 2023). As of November 30th, 2020, 107'364 cases were registered. This means that around 330 potential participants contracted COVID-19.

GGS offers a variety of questions, including a five-level question on SRH ("very bad" to "very good"). Since the benchmark state of health changes over time, it was chosen to preserve the complexity of this variable. Hence, Chi-squared tests were chosen for the variable description and hypothesis tests. First, the temporal changes were studied. 210 Chi-squared or Fisher tests are done on their similarity. The gap between the end of the lockdown and the relaunching of the survey was over a month and a half. The suspension allows us to test the hypothesis on post-lockdown relief. Based on previous literature, we could expect the SRH to be higher for the younger cohorts in July than in March, when it was suspended, and this jump must follow a dip afterward. Second, the group-specific effect will be studied, with special attention to the person's employment status, household composition, and objective health characteristics. Finally, in the exploratory part, the variables are ranked by the number of sex-age subgroups that have a significant change in SRH.

A substantial problem with the multiple test algorithms is their increased vulnerability to Type I, false positive errors. Several correcting procedures exist for such vulnerability, with every procedure suggesting stricter alphas to count a test as significant. Benjamini-Hochberg (1995) procedure is at the centre as the more balanced procedure, but reference, the results for two stricter procedures, Bonferroni and Holm-Bonferroni (Holm, 1979), are also given. The Bonferroni correction uses a stricter alpha, $\alpha_{Bonferroni}=\alpha_0/n$, where $\alpha_o=0{,}05$, and n is the number of tests (each sex-age subgroup has a separate number of subgroups). The Holm-Bonferroni procedure rejects null-hypotheses with the smallest p-values until the p-value i is larger than $\alpha_o / (n - i + 1)$. Finally, the Benjamini-Hochberg procedure finds the largest p-value i that is smaller than $\alpha_o * i/n$ and rejects every null-hypothesis with a stronger p-value.

Originally, it had 1787 variables, but only a minority were meaningful in this context. Overall, 902 categories were used in total to conduct 5818 Chi-squared or Fisher tests on differences in each subsample with enough observations. The description statistics for the selected variables are presented in Table 1.

Table 1. Descriptive Statistics for the Sample Overall and the Sex-Age Groups Separately.

	Female 18-34	Male 18-34	Female 35-44	Male 35-44	Female 45-54	Male 45-54	Female 55-64	Male 55-64	Female 65-79	Male 65-79	Over-all
Number of observations	1259	721	931	562	838	622	1356	930	1715	863	9797
Mean self-rated health	3.88	3.97	3.64	3.66	3.25	3.39	3.02	3.09	2.74	2.91	3.29
Post-lockdown respondents, %	73,8	76,4	73	68,3	70,2	68,6	70,6	68,6	67,7	64,8	70,2
Urban residents, %	43,1	46,5	39,5	39,7	32,1	27,2	30,5	28,4	31	29	34,3
School education, %	45,3	53	50,6	49,5	41,5	38,6	46,2	36,8	56,4	42,2	46,8
Professional education, %	31,1	28,6	25,9	32,4	44,3	52,7	43,4	53	31,3	43,8	37,9

	Female 18-34	Male 18-34	Female 35-44	Male 35-44	Female 45-54	Male 45-54	Female 55-64	Male 55-64	Female 65-79	Male 65-79	Over-all
Employed, %	30,2	52,1	49,6	57,5	54,9	48,9	20,2	35,5	2,7	1,5	30,3
Unemployed, %	7,7	18	12,9	22,6	14,4	23,5	4,2	15,5	0	0,5	9,7
Partner living in the household, %	64,7	46	72,3	66,5	67,7	63,2	56,7	65,6	32,8	62,2	57,5
Children living in the household, %	72,5	35,4	85,3	64,4	42,2	42,6	22,9	20,9	17,2	16,5	39,7
At least one significant illness, %	11,5	13	24	17,3	46,9	34,4	71,2	51,4	83,4	68,1	47,2
Some difficulties by WGD, %	2,4	2,4	3,7	4,1	8,7	8,8	14	14,1	26,9	24,2	12,5

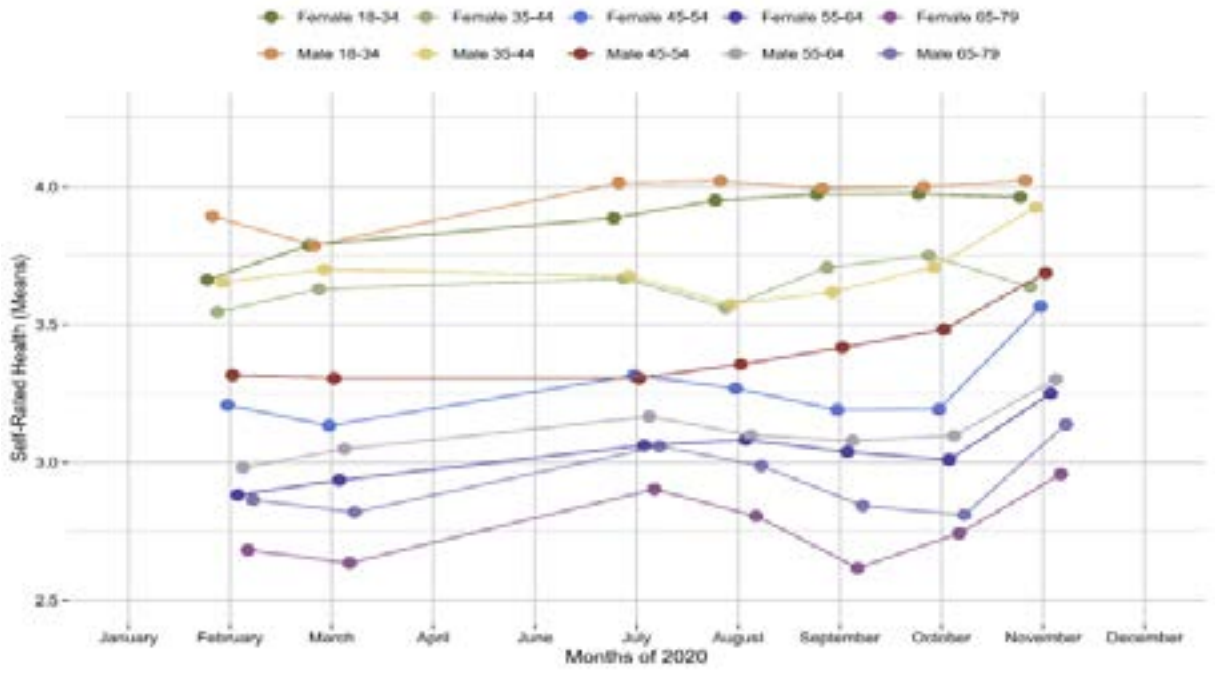
Source: author's calculations based on GGS Moldova 2020.

MAIN RESULTS

SRH TRENDS

The average monthly SRH levels were taken for the sex-age group (see Figure 1). Overall, the difference between February and November was significantly positive for every sex-age group older than 45 and for women aged 18-34, with significance varying between 0.1% and 5%. The increase during the lockdown was only significant for women aged 65-79 (5% significance level). While some commonalities in the groups' month-to-month SRH dynamics are noticeable, few month-to-month differences were significant. The fall from February to March was significant for men aged 65-79, and the fall from August to September was significant for women aged 65-79. The difference between October and November was significant for men aged 65-79 (1%) and women aged 45-54 (5%), 55-64 (5%), and 65-79 (5%). Finally, the September dip is noticeable, but it is significant for the same four groups (1% each). So SRH increased only for one group, and after the lockdown, it fell for the group and several others.

Figure 1. Temporal changes in Self-Rated Health.



Source: author's calculations based on GGS Moldova 2020

The post-lockdown relief hypothesis struggles to explain these dynamics. Following past literature, the effect can be expected primarily among the youngest cohorts. However, they neither experience a significantly better SRH nor do they experience the September dip. At the same time, the September dip was experienced by four sex-age groups out of ten, and it is possible that this was due to the shift in the sampling over time.

GROUP-SPECIFIC CHANGES IN THE WAY OF LIFE

In this subsection, the changes in four specific groups are considered: by age, employment, education, and objective health problems. The data partially confirms these links.

Table 2 below suggests that age has a curvilinear association with the change in SRH. The increase was larger in the youngest cohorts and in the pre-pension age threshold. It can also be complemented by the fact that SRH increased for women more than for men, which would explain the lack of a significant increase for male 18-34 and 65-79 cohorts. This contradicts the previous suggestion that the pandemic was harsher for the youngest and easier for the oldest cohorts.

Table 2. The Chi-square test for the association between the lockdown and the self-rated health (five-point scale) for ten sex-age groups.

	Female 18-34	Male 18-34	Female 35-44	Male 35-44	Female 45-54	Male 45-54	Female 55-64	Male 55-64	Female 65-79	Male 65-79
Total	0.27***	0.14	0.1	0	0.09	0.11	0.18**	0.13*	0.11*	0.09
Employed	0.28***	0.08	0.04	0.03	0.17	0.08	0.1	0.19		
Unemployed	0.37	0.21	0.17	-0.06	0.02	-0.03	0.42	0.31		
Outside LF	0.24***	0.18	0.19*	0.01	-0.01	0.37	0.18**	0.04	0.09	0.1
School education	0.2**	0.12	0.1	-0.02	-0.02	-0.08	0.15*	0.09	0.1	0.06
Vocational education	0.28**	0.21	0.12	0.07	0.16	0.24	0.22*	0.19**	0.15	0.1
Higher education	0.42***	0.05	0.07	-0.09	0.2	0.19	0.14	-0.07	0.06	0.13
Not diagnosed with a significant illness	0.27***	0.07	0.14	-0.04	0.2	0.17*	0.17	0.13	0.16**	0.15
Significant illness	0.11	0.23	-0.14	-0.07	-0.08	-0.14	0.15*	0.08	0.05	0.05
Significant non-CVD or non-RD illness	-0.1		-0.08		-0.21	0.02	0.15	0.02	0.12	-0.05
CVD or RD	0.28	0.03	-0.17	0.02	-0.02	-0.22	0.15	0.09	0.04	0.08
CVD	0.14		-0.15		-0.02	-0.19	0.15	0.1	0.05	0.12
RD							0.07	0.13	-0.03	-0.39
No CVD or RD	0.26***	0.13*	0.13	-0.05	0.11	0.16	0.19	0.11	0.18**	0.09
No CVD	0.27***	0.13*	0.12	-0.04	0.1	0.15	0.2	0.11	0.15*	0.06
No RD	0.26***	0.14	0.1	-0.01	0.08	0.13	0.17**	0.13*	0.11*	0.13
No regular sports							0.24**	0.21**	0.14**	0.08
Regular sports							0.02	-0.01	0.02	0.12

Source: author's calculations based on GGS Moldova 2020.

The increases in SRH were unequally distributed by employment status and education. The increase was the most often among women not in the labor force aged 18-34 (0.1%), 35-44 (5%), and 55-64 (1%). Among the employed, the SRH increased only among women aged 18-34 (0.1%), and no subgroup of the unemployed had a significant increase. This also contradicts previous suggestions that housekeepers were among the most vulnerable, whereas the workers switching to work from home have the greatest opportunities to increase their SRH. The more educated strata also had a dimmer increase in SRH compared with those with a school or vocational education, especially in the older age groups. This also contradicts previous observations that those with higher education have a greater increase in SRH during the pandemic.

The absence of cardiovascular or respiratory system illnesses led to significant increases in SRH for three groups — men and women aged 18-34 and women aged 65-79 — whereas the absence of respiratory illnesses alone led to increases for the four aforementioned groups. This generally coincides with the hypothesis that individuals started to pay greater attention to the state of the cardiovascular and respiratory systems. The groups with significant illnesses, generally, did not see their SRH increased apart from women aged 55-64. Overall, forty sex-age groups with significant illnesses were tested, which means that the detected change was a false positive. In other words, individuals with significant illnesses have a more stable appreciation of their self-rated health than the general public. Similarly, one can observe that individuals who regularly practice sports have a more stable appreciation of their health than those who do not.

Overall, this section highlights that the previous findings on the SRH instability have a poor standing in the Moldovan context. The increase in SRH was more pronounced among the female housekeepers and those with vocational and school education. Employed individuals, as well as those with higher education, saw a less omnipresent increase in SRH. The exception to this is the unemployed, who did not see an increase in SRH at all. The objective health status and practices also highlighted that the individuals who pay attention to their bodily sensations have a more stable SRH compared to their peers. While this does not contradict the previous findings, it is a different formulation compared to them.

EXPLORATION SUBGROUPS OF SEX-AGE GROUPS

In this subsection, the rest of the questionnaire is considered to detect other variables with a stable association with or patterns of increase in SRH. See Table 3 for the performance of the variables by sex-age groups. The distribution of tests with statistically significant results supports the suggested curvilinear relationship between age and the change in SRH during the lockdown, as well as greater instability of women's SRH.

As mentioned above, the Benjamini-Hochberg correction was chosen as the benchmark for the analysis as it balances the avoidance of Type I error while being less restrictive than the Bonferroni or Holm-Bonferroni corrections. The last two corrections also highlight that the increase in SRH was more pronounced among the youngest female group, while some groups around the pension age also had a robust increase. Most of these groups refer to consumption possibilities and the distribution of chores. These results circle back to the questions of privilege and housekeeping, but suggest that practices rather than status are the appropriate, although non-universal, explanatory factor. The most notable subgroup is women aged 65-79 who speak Gagauz at home. This is a rare example of the significance of an ethnolinguistic group.

Table 3. The Number of Subgroups Inside Sex-Age Groups with the Significant SRH Changes By Correction.

Group	Female 18-34	Male 18-34	Female 35-44	Male 35-44	Female 45-54	Male 45-54	Female 55-64	Male 55-64	Female 65-79	Male 65-79
Total number of tests	724	568	666	545	595	505	626	568	602	489
Bonferroni correction	205	0	0	0	0	1	3	0	3	0
Holm-Bonferroni correction	210	0	0	0	0	1	3	0	3	0
Benjamini-Hochberg correction	432	0	0	0	0	1	68	0	3	0

Group	Female 18-34	Male 18-34	Female 35-44	Male 35-44	Female 45-54	Male 45-54	Female 55-64	Male 55-64	Female 65-79	Male 65-79
Non-corrected significant	452	49	37	6	35	75	196	79	104	10
Non-corrected negative significant	0	0	2	4	1	0	0	0	4	4

Note: the significance is based on chi-squared tests.

Source: author's calculations based on GGS Moldova 2020.

Of the 902 categories, 449 categories yielded at least one subgroup with a statistically significant change. 88% of them had only one sex-age subgroup with a statistically significant change, 11.8% had two subgroups, and one (affording no pocket money) had three. Most of the variables that were significant for women aged 55-64 were also significant for women aged 18-34. They do not yield an overall pattern. The most significant groups among the 68 variables were values of the individual (8), consumption possibilities (7), and subjective well-being (5).

When taking the uncorrected Chi-squared tests, 546 categories yielded at least one subgroup with a statistically significant change. 45.6% of them had one sex-age subgroup with a statistically significant change, 27.1% had two subgroups, 19.2% had three subgroups, and the rest had four or five subgroups. Several variables yielded five sex-age subgroups with statistically significant changes. These include living in a city, living in a nuclear household, having a partner, receiving no financial transfers inside or outside the household, having enough people with whom they feel close, and the inability to afford leisure activities.

In several cases, sex-age groups have a specific subgroup with significant changes in SRH distributions. For women aged 35-44, SRH grew among housekeeping mothers whose partners have a stable job, and who are struggling to pay for heating and unexpected expenses. For women aged 45-54, the SRH grew among government employees with permanent contracts. For men aged 18-34, the SRH grew among those who equally participate in household and childcare chores, do not have a fixed work schedule, and come home too tired several times a year. Other sex-age groups seem to have a greater number of points of SRH growth, and grouping them is harder. For men aged 35-44 and 65+, such groups virtually do not exist, and for the youngest women, the changes are universal. As discussed in the previous section, these results should be considered with reservations. Generally, they also highlight that the changes in SRH were curvilinear and different for men and women.

DISCUSSION

This study disentangled and tested several hypotheses on SRH instability that were raised in past literature. While it shows temporal changes, it rejects the hypothesis that they can explain the increase in SRH. It also showed that, in the Moldovan context, using employment or educational status to study the influence of lifestyle on health is less productive than using conditions per se. Past research highlighted housekeepers and manual workers with non-tertiary education as groups with declining SRH, which was explained by their greater workload due to the changed lifestyle and greater vulnerability to COVID-19. In this study, if any, a positive change in SRH was registered among these groups. Finally, more ground is given in this study to the model of Jylhä (2009), as it shows that individuals who pay attention to their bodily sensations have a more stable SRH compared to their peers.

The exploratory part highlights several important issues. First, it shows for the first time that Moldovan ethnolinguistic groups had varying levels of SRH increase, specifically, with the Gagauz women aged 65-79 having a very robust increase in SRH. Previous studies show that benchmark state varies from language to language (Palosuo et al., 1998), and it is possible that the Gagauz have different standards for SRH levels compared to the rest of the population.

Second, the uncorrected tests suggest that different sex-age groups have different socio-economic groups with the SRH increase. Among the second youngest female group, only the most vulnerable housewives reported an increase. This contrasts strongly with the youngest female group, who had an overarching increase, as well as the middle-aged female group, among whom state-employed bureaucrats had such an increase. It is possible that the mechanisms differed among these three. For example, while for women aged 18-34 and 45-54 the chief mechanism could be a change in their benchmarks, for women aged 35-44, it could be an example of stoicism (see Moore et al., 2013 for discussion of this term). However, since these results are only supported by the uncorrected Chi-squared tests, they should be treated with caution.

There are three substantial problems with this study. First, the impact of COVID-19 itself on the health of the surveyed could not be measured. Some groups must have been exposed to COVID-19 more than others, and these groups' SRH must have fallen accordingly. This leaves

the benchmark hypothesis hanging. Second, the pre- and post-lockdown subsamples have systemic differences, as reported by the data collectors (Cristei, 2020). Further research should consider matching the observations and creating a more comparable sample, although this will reduce the size of both pre- and post-lockdown subsamples. Finally, the method assumes the stability of the subgroups. This could also be solved with matching.

CONCLUSIONS

It was previously noted that self-rated health (SRH) increased during the COVID-19 pandemic in a dozen countries. Several overlapping explanations related to the changes in the actual health and health practices, environment, and SRH assessment were proposed. In this study, these explanations were evaluated on the Moldovan GGS, a survey conducted in 2020 in two parts with nearly three thousand people surveyed before the lockdown and seven thousand people surveyed after it. As in other countries, the Moldovan data also show that the SRH increased, although the changes were not equally distributed across ages, genders, and their subgroups.

This study has two chief scientific contributions. First, it classified and evaluated the previously suggested explanations. They had varying performance. The SRH dynamics by month did not support the explanations via a relief due to the end of the lockdown. The classical socio-economic measurements of disadvantage were not associated with a decrease and proved themselves to be proxies that do not work in the Moldovan context. The study confirmed that the respiratory and cardiovascular systems acquired greater weights in SRH measurement, with the respiratory diseases alone being a more consistent predictor. However, generally, any variable on regular interoception had an association with a more stable self-rated health.

Second, a further analysis of the GGS also offers the following interpretation. Age has a curvilinear effect on the SRH instability, with SRH being the most unstable in the earliest ages and in the cohorts aged 55-64. Women had a greater increase than men. Several socioeconomic factors stimulated the increase in SRH. These include living in a city, having a partner, a good respiratory system, a social support system, and financial independence. The exploratory analysis also suggests that such stimulating variables can vary by gender and age groups. Specifically, it found that such groups with growth were different for women aged 35-44 and those aged 45-54. As mentioned in the discussion section, these changes may be driven by changes in the SRH evaluation process, with different groups experiencing distinct changes. While we can suggest that different socio-economic groups have different inclinations to change (e.g., housekeeping mothers from disadvantaged households becoming more 'stoic', unlike other women), they seem to be unpredictable overall. Thus, the study showed that SRH is a rather inconsistent index during a health crisis such as the COVID-19 pandemic, and should be used with great caution to evaluate policy efficiency.

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THE COMPETITIVENESS OF ROMANIAN TOURISM IN EU CENTRAL AND EASTERN EUROPE: A COMPARATIVE PERSPECTIVE

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SUMMARY

Tourism is one of the economic sectors with significant growth potential for Romania, but its performance remains moderate relative to the country's available natural and cultural resources. The paper analyses the competitiveness of Romanian tourism in a regional context, drawing on the economies of Central and Eastern Europe within the European Union, aiming to highlight Romania's position and the typologies of tourism development in the region. The originality of the paper lies in the integrated use of the Travel & Tourism Development Index (TTDI) 2024 and economic indicators to assess both tourism competitiveness and the sector's economic contribution. The analysis is based on the Travel & Tourism Development Index (TTDI) 2024 indicators and a set of relevant economic variables, including tourism's contribution to gross domestic product, the sector's share of employment, and the structure of tourism demand. To identify tourism development models, the study employs hierarchical cluster analysis to group economies by structural similarities in the tourism sector. The results highlight three distinct clusters of tourism development: economies oriented towards domestic tourism, economies strongly dependent on tourism, and high-performing, diversified tourism economies. Romania is included in the cluster of economies predominantly oriented towards domestic tourism, characterised by a relatively modest sector contribution to the economy, limited integration into international tourism flows, but a high degree of internal demand. In this context, strengthening the sector's competitiveness depends on investments in infrastructure, the development of human capital, and the implementation of coherent strategies for destination management and international promotion. The study is limited by its static nature and by the fact that the cluster analysis provides a classification of countries rather than causal explanations.

Keywords: tourism competitiveness, Travel & Tourism Development Index, cluster analysis, Central and Eastern Europe, tourism performance, domestic tourism

INTRODUCTION

Romanian tourism occupies an ambivalent position within the regional tourism economy. The country benefits from diverse natural and cultural resources, a rich tourism heritage, competitive costs, and a relatively robust domestic market. Yet these assets are only partly reflected in the sector's economic contribution or in Romania's share of international tourist flows. According to TTDI 2024, Romania scores 4.19, with tourism accounting for 1.6% of GDP and 1.7% of total employment. The core challenge, then, is linking tourism assets more effectively with infrastructure, destination management, and international promotion. However, the dynamics of recent years show clear signs of maturation: the consolidation of domestic tourism, the diversification of products, and the emergence of regional destinations capable of competing at the European level.

The objective of the paper is to analyse the competitiveness of Romanian tourism within the economies of the European Union's Central and Eastern Europe, to evaluate its regional positioning, and to identify the main directions for consolidating the performance of the tourism sector.

In order to achieve this general objective, the paper pursues the following specific objectives:

(1) Assessing Romania's position within the TTDI 2024 and comparing it with the performance of other EU economies in Central and Eastern Europe;

(2) A comparative analysis of economic and market indicators relevant to tourism competitiveness - the contribution of tourism to GDP, the sector's share in employment, and the structure of tourism demand;

(3) Identifying regional typologies of tourism development by applying hierarchical cluster analysis to the economies analysed and highlighting Romania's position within the resulting clusters.

The paper addresses a gap in the literature: tourism competitiveness and the economic contribution of tourism are frequently examined in isolation, yet their relationship is rarely tested comparatively. This study brings them together by pairing TTDI 2024 scores with GDP, employment, and demand-structure indicators across Central and Eastern European economies in the EU. The analytical contribution lies in constructing a comparative regional database and applying cluster analysis to situate Romania within a broader typology of tourism development.

The paper is structured into several sections. After the introduction, the second section presents the specialised literature on tourism competitiveness, the main conceptual approaches, and the methods used to assess it. The third section describes the research methodology, including the selected indicators and the clustering procedure used. The fourth section presents the results of the analysis, including the assessment of Romania's position within TTDI 2024 and the cluster analysis of EU economies in Central and Eastern Europe. The last section is dedicated to the conclusions, methodological limitations, and implications for strengthening Romanian tourism's competitiveness.

LITERATURE REVIEW

Tourism competitiveness is a central concept in the analysis of tourism sector development, as it reflects a destination's capacity to attract visitors and generate sustainable economic benefits. The specialised literature highlights the multidimensional nature of this concept, which integrates economic, social, cultural, and institutional factors, and there is no universally accepted definition, as a destination's performance is determined by a complex combination of interdependent factors (Allahverdi et al., 2025). From this perspective, competitiveness is often associated with a destination's ability to create value and maintain its position in the tourism market by efficiently using available resources (Băbăt et al., 2023).

Classical frameworks for destination competitiveness (Ritchie and Crouch, 2003; Dwyer and Kim, 2003) converge on a key insight: resources alone do not produce competitiveness. Their economic value depends on how well they are supported by infrastructure, destination management, and public policy, and on a country's capacity to convert comparative advantages into sustainable competitive ones.

Theoretical approaches distinguish among perspectives on tourism competitiveness, highlighting both the internal dimensions of the sector (such as performance, resource management, and innovation) and external factors, including the economic, social, and institutional environment that influences tourism development (Allahverdi et al., 2025). This distinction highlights the complexity of the competitiveness assessment process and the need to use integrated analytical frameworks.

Regarding the measurement of competitiveness, a widely used tool in the literature is the Travel and Tourism Development Index (TTDI), developed by the World Economic Forum, which enables comparisons of countries across dimensions and pillars relevant to tourism development (Özdemir, 2025; Marti & Puertas, 2025; Maráková & Očkaik, 2026).). This index is frequently used in comparative analyses between countries, facilitating comparisons between destinations and highlighting differences between them (Feridun et al., 2025).

However, the literature highlights the limits of using TTDI as a single indicator of competitiveness. Empirical studies show that variations in index scores are not always correlated with tourism performance indicators, suggesting the need to use additional indicators for a more comprehensive assessment (Kunst & Ivandić, 2021). In this sense, indicators such as tourism's contribution to gross domestic product (GDP) and tourism revenues are considered relevant for analysing the sector's performance (Vašaničová et al., 2023).

Comparative analyses at the European level highlight significant differences between countries in tourism competitiveness, both in overall performance and in the structure of its determinants. Some countries register consistent competitive advantages, while others face limitations related to infrastructure, public policies, or resource utilization (Ozkaya & Demirhan, 2022). These differences are highlighted in studies using TTDI indicators, which enable analysis of the relative positioning of destinations and the identification of competitive advantages and disadvantages (Feridun et al., 2025).

In the South-Eastern, Central, and Eastern European regions, the literature highlights the heterogeneity of tourism development. The use of multivariate statistical methods, such as cluster analysis, enables the classification of countries into homogeneous groups based on competitiveness levels and structural characteristics of the tourism sector (Jovanović et al., 2014). Such approaches facilitate the identification of development typologies and provide support for the formulation of differentiated tourism strategies.

Cluster methods are used in empirical analyses of tourism competitiveness to classify countries into homogeneous groups, based on relevant economic and tourism indicators (Bulin, 2014). Research also highlights that tourism infrastructure is an essential determinant of competitiveness, sometimes having a greater influence than tourism resources themselves (Popescu et al., 2018).

The assessment of tourism competitiveness is closely linked to the analysis of the sector's performance and efficiency and is often conducted using specific quantitative methods. In this context, efficiency analysis methods, such as Data Envelopment Analysis (DEA), highlight significant differences between countries in resource use and outcomes (Ciocoiu et al., 2025). These approaches offer a complementary perspective on competitiveness, focusing on the ratio between inputs and outputs. At the same time, the literature highlights the link between tourism competitiveness and the socio-economic development of destinations. Factors such as infrastructure, the business environment, and sustainability influence both tourism performance and the level of development. At the same time, research shows that the availability of tourism resources does not automatically guarantee competitiveness; competitiveness largely depends on how those resources are exploited and integrated.

METHODOLOGY

The study follows a quantitative, cross-sectional, and exploratory design, drawing exclusively on secondary data. To identify typologies of tourism development among EU economies in Central and Eastern Europe, the research employed hierarchical cluster analysis. The aim of this analysis was to highlight structural models of tourism development and to determine Romania's position relative to other economies in the region.

Rather than testing causal relationships, it is guided by three research questions: RQ1. Where does Romania rank within TTDI 2024 relative to other EU Central and Eastern European economies? RQ2. To what extent does Romania's TTDI 2024 score align with its economic contribution indicators? RQ3. What tourism development typologies emerge at the regional level, and where does Romania fit within them?

The analysis was carried out on the basis of four economic and market indicators, considered relevant for characterising the competitiveness and structure of the tourism sector:

(1) Travel & Tourism Development Index (TTDI) 2024, a composite index that reflects the overall conditions for tourism development and competitiveness;

(2) Share of tourism in GDP, as an indicator of the economic contribution of the tourism sector to the national economy (% of GDP);

(3) Share of tourism in employment, which highlights the sector's capacity to generate jobs (% of the total employed population);

(4) Share of domestic tourism in total tourism demand, an indicator that captures the structure of the tourism market and the degree of dependence on domestic demand (% of total tourism consumption).

TTDI 2024 was chosen as the primary competitiveness benchmark given its recency and its systematic coverage of structural tourism conditions across countries. Since the index does not directly capture economic outcomes, it was supplemented with indicators for GDP contribution, employment, and tourism demand structure.

The selected indicators capture both the potential competitiveness (TTDI) and the actual economic performance of the tourism sector, facilitating analysis of the gap between structural capacity and the economic results generated.

The analysed sample included 11 economies from the European Union belonging to Central and Eastern Europe: Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia.

For clustering, the Ward hierarchical method was used based on Euclidean distance. The optimal number of clusters was determined by analysing the dendrogram produced by the hierarchical procedure. The three-cluster solution was retained based on both the dendrogram structure and the interpretability of the resulting groups. A two-cluster partition would have essentially isolated Croatia without revealing meaningful regional patterns; the three-cluster solution draws a clearer distinction between domestically oriented economies and those with a more diversified, internationally integrated tourism base. Cluster analysis is exploratory and highlights similar tourism development profiles without implying causal relationships among the variables included. Therefore, the results obtained should be interpreted as a basis for the structural comparison of the analysed economies and for the positioning of Romania in the regional context.

RESULTS AND DISCUSSION

ROMANIA'S TOURISM COMPETITIVENESS

The publication of the Travel & Tourism Development Index (TTDI) 2024 (the successor to the Travel & Tourism Competitiveness Index - TTCI - launched in 2007) provides a comprehensive picture of the capacity of states to build sustainable, resilient, and competitive tourism (World Economic Forum, 2024). In the post-crisis context, which has heightened the importance of sustainability and resilience, TTDI evaluates 119 economies using a revised methodology based on 17 pillars grouped into five dimensions, totalling 102 standardised indicators on a scale from 1 to 7. In this evaluation, Romania ranks 43rd worldwide, with an overall score of 4.19 out of 7. The country is thus in the upper half of the global ranking, but remains in the second half of the European hierarchy. In the Europe and Eurasia region - the best-performing global area in terms of tourism competitiveness - Romania is placed in the median segment, in 43rd place, alongside Slovenia (42) and Bulgaria (40). Potentially competing countries, such as Poland (27) or the Czech Republic (33), are better positioned, benefiting from more coherent public policies, sustained infrastructure investments, and tourism branding campaigns better calibrated to the international market. The differences do not necessarily derive from existing resources, but from the capacity to convert them into competitive advantages: predictable infrastructure, balanced distribution of flows, specialised workforce, and functional public-private partnerships.

To better understand Romania's positioning and the nature of its competitive challenges, we considered it appropriate to conduct a comparative analysis with

countries in Central and Eastern Europe (CEE), a region marked by similar economic profiles, regional competition, and varying tourism performance. This approach allows for the development of an integrated picture of the performance and structure of the tourism market across the region's economies.

Table 1.

Regional comparative analysis (EU CEE) - economic tourism indicators

Country	TTDI	Share of tourism in GDP (% of total)	Share of tourism in the employed population (% of total)	Share of domestic tourism in total tourism demand (%)
Poland	4.4	1.7	2.1	31.2
Czechia	4.31	1.7	4.6	71
Estonia	4.28	3.6	3.1	38.2
Hungary	4.27	2.3	4.2	25.1
Bulgaria	4.25	1.8	2.7	17.2
Slovenia	4.22	4	5.3	39.5
Romania	4.19	1.6	1.7	53.2
Lithuania	4.17	1.9	1.6	58.6
Croatia	4.13	12.2	12.5	13.1
Slovakia	4	1.8	2.5	73.6
Latvia	3.88	3.1	4.2	53.5

Source: World Economic Forum - Interactive Data and Economy Profiles (World Economic Forum, 2024b)

The comparative analysis of the 11 Central and Eastern European economies confirms Romania's position in the middle of the regional competitiveness range, with a TTDI score of 4.19, just below Slovenia (4.22) and Bulgaria (4.25), but above Lithuania, Croatia, Slovakia, and Latvia.

From an economic contribution perspective, the share of tourism in GDP (1.6%) confirms the sector's still modest role in the national economy, far from the levels recorded in Slovenia (4%) or, especially, in Croatia (12.2%). This under-sizing is coupled with a low contribution to employment (1.7%), which indicates a tourism industry with low added value and limited integration into local economic chains.

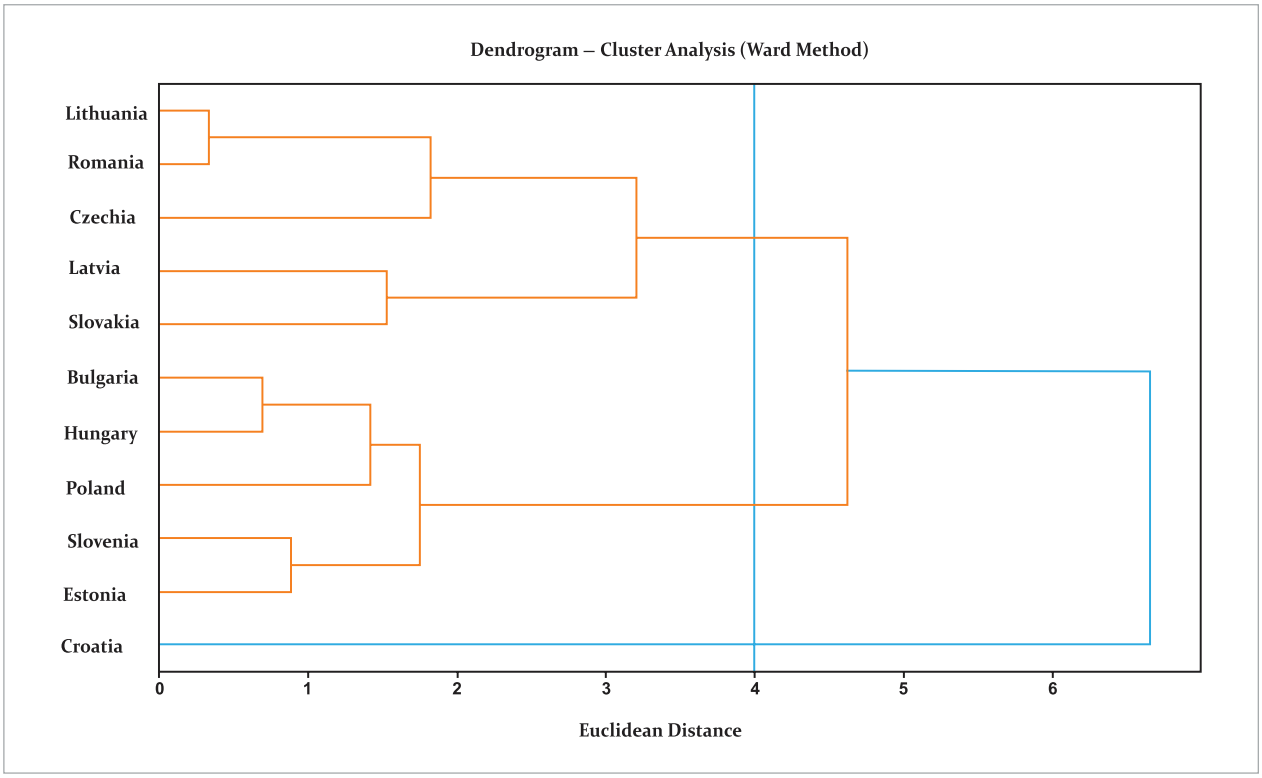
On the other hand, the high share of domestic tourism (53.2%) constitutes an element of resilience and stability, so that domestic demand remains the main pillar of support for the market, mitigating the impact of external volatility and providing a solid basis for sustainable development. However, the low share of international tourism poses challenges for Romania's positioning within global tourist flows. Overall, Romania's profile indicates a weak economic conversion of competitiveness in tourism potential. Strengthening the country's position in the region depends on the ability to transform comparative advantages into competitive advantages. In the absence of these elements, Romania risks remaining with the image of having poorly exploited potential and of being a modest performer in economic terms.

CLUSTER ANALYSIS

The dendrogram resulting from the application of the Ward method highlights the degree of similarity among the analysed economies, with distances between branches reflecting the level of structural differentiation of the region's tourist profiles. At the lower levels of the dendrogram, groupings of countries with similar characteristics emerge, such as the Czech Republic–Slovakia and Lithuania–Latvia, suggesting comparable economic and tourism structures. As the level of aggregation increases, these initial groupings consolidate into three distinct clusters, corresponding to different models of tourism development.

Figure 1.

Dendrogram of clustering of tourism economies in Central and Eastern Europe



Source: made by the author, based on processing in Python.

Note: The vertical line indicates the retained three-cluster solution.

The separation threshold used indicates the existence of three regional typologies of tourism development in Central and Eastern Europe, associated with different levels of maturity and economic integration of the sector: Cluster 1 - balanced economies, oriented towards domestic tourism; Cluster 2 - economies dependent on tourism; Cluster 3 - performing and diversified economies.

Despite some intra-cluster differences, especially in the share of tourism in employment, the clusters' composition and general features highlight distinct models of tourism development at the regional level.

Table 2.

Composition and characteristics of clusters

Cluster	Countries	Characteristics
Cluster 1: Balanced, domestically oriented economies	Czechia, Latvia, Lithuania, Romania, Slovakia	High share of domestic tourism, modest contribution of tourism to GDP, and medium to low competitiveness;
Cluster 2: Tourism-dependent economies	Croatia	Very high contribution of tourism to GDP and employment; high dependence on international tourist flows; vulnerability to external shocks;
Cluster 3: High-performing, diversified economies	Bulgaria, Estonia, Poland, Slovenia, Hungary	Relatively high tourism competitiveness, moderate economic contribution of tourism, and a more diversified structure of tourism demand;

Source: by the author, based on research results

To better understand the structural differences between the identified groups, the average values of the indicators used in the clustering were analysed.

Table 3.

Average values of indicators by clusters (centroids)

Cluster	TTDI	Tourism in GDP (%)	Tourism in employment	Domestic tourism (%)
Cluster 1: Balanced, domestically oriented economies	4.11	2.02	2.92	61.98
Cluster 2: Tourism-dependent economies	4.13	12.2	12.5	13.1
Cluster 3: High-performing, diversified economies	4.284	2.68	3.48	30.24

Source: by the author, based on research results

CLUSTER CHARACTERISTICS

CLUSTER 1: BALANCED, DOMESTICALLY ORIENTED ECONOMIES

This cluster includes the Czech Republic, Latvia, Lithuania, Romania, and Slovakia and is characterised by a relatively modest contribution of tourism to the national economy. In most of these countries, the share of tourism in GDP is relatively low, and the sector's participation in employment is also limited.

The distinctive feature of this group is the relatively high importance of domestic tourism, which functions as the main driver of tourism demand. Such a structure provides the market with a degree of stability, reducing its vulnerability to fluctuations in international demand. At the same time, this predominantly domestic orientation can limit the economic growth potential associated with attracting foreign tourist flows.

Romania clearly fits into this pattern. With tourism contributing only 1.6% to GDP and 1.7% to employment, the sector remains relatively modest compared to other economies in the region. At the same time, the high share of domestic tourism (53.2%) indicates a relatively stable domestic market, but also limited integration into international tourist flows. Overall, this cluster can be interpreted as bringing together economies with relevant tourism potential but limited capacity to translate it into consistent economic results.

CLUSTER 2: TOURISM-DEPENDENT ECONOMIES

Cluster 2 is represented exclusively by Croatia, highlighting the distinctive profile of this economy within the analysed region.

Croatia stands out for its very high dependence on the tourism sector, reflected both in tourism's contribution to GDP (12.2%) and in its share in employment (12.5%), values significantly higher than those recorded in the other economies included in the analysis. This profile indicates a pronounced economic specialisation in tourism, supported mainly by international tourist flows.

Although this specialisation generates substantial economic benefits, it also implies a high level of vulnerability to external shocks, such as economic crises, pandemics, or geopolitical tensions. From this perspective, Cluster 2 illustrates a model of intensive tourism development, characterised simultaneously by high economic performance and increased structural risk.

CLUSTER 3: HIGH-PERFORMING, DIVERSIFIED ECONOMIES

Cluster 3 brings together Bulgaria, Estonia, Poland, Slovenia, and Hungary, economies characterised by relatively higher levels of tourism competitiveness and a more efficient integration of the tourism sector into the national economy.

These countries present a more balanced profile, combining a relatively high level of competitiveness, as measured by TTDI, a moderate economic contribution from tourism, and a more diversified structure of tourism demand, in which international tourism has a higher share than in the cluster predominantly oriented towards the domestic market.

In many of these economies, the development of the tourism sector has been supported by more coherent public policies, infrastructure investments, and more consolidated tourism promotion and branding strategies. These elements have favoured the transformation of available tourism resources into more consistent competitive advantages and a more efficient economic valorisation of the sector.

ROMANIA'S POSITIONING WITHIN CLUSTERS

The composition of the clusters confirms that Romania occupies an intermediate position in the tourism landscape of Central and Eastern Europe. Although the level of overall competitiveness, as reflected by the TTDI score of 4.19, is relatively close to that of some of the more performing economies in the region, the tourism sector's effective economic contribution remains low.

This discrepancy suggests a gap between the competitive potential of Romanian tourism and its actual economic results. From a structural point of view, Romania can be characterised as a tourism economy predominantly oriented towards domestic demand, still some distance from the model of more integrated and diversified tourism economies.

In this context, strengthening the competitiveness of Romanian tourism depends on the capacity to transform existing comparative advantages - natural resources, cultural heritage and competitive costs - into sustainable competitive advantages. This process involves investments in infrastructure, the development of human capital, and the professionalisation of tourism destination management, so that the existing potential can be exploited more efficiently economically.

CONCLUSIONS

The analysis of the competitiveness of Romanian tourism in a regional context highlights a significant gap between the country's tourism potential and the sector's actual economic performance. Although Romania has valuable natural and cultural resources, these are only partially exploited, limiting tourism's contribution to the national economy and its integration into international tourist flows.

The research objectives were addressed by mapping Romania's TTDI 2024 position, benchmarking its tourism and economic indicators against regional peers, and identifying development typologies through hierarchical cluster analysis.

The results of the comparative analysis indicate that Romania is in the middle of the range for tourism competitiveness in Central and Eastern Europe. At the same time, the low share of tourism in GDP and employment confirms the sector's underdeveloped nature relative to its potential. In contrast, the high share of domestic tourism highlights a stable domestic demand base, which contributes to the sector's resilience and can serve as a point of support for future development.

The cluster analysis highlighted three distinct models of tourism development in the region: economies oriented towards domestic tourism, economies dependent on tourism, and high-performing, diversified tourism economies. Romania's inclusion in the cluster of economies oriented towards domestic tourism indicates a model characterised by stability, but also by limited integration into international tourist flows.

From a strategic perspective, strengthening the competitiveness of Romanian tourism depends on the capacity to transform existing comparative advantages into sustainable competitive advantages. This process involves the modernisation of transport infrastructure and tourist services, the development of human capital in the hospitality sector, the consolidation of destination management, and the implementation of coherent promotional strategies in international markets. In this context, emerging segments such as sustainable tourism, slow travel, creative tourism, and digital nomadism offer realistic avenues for diversifying Romania's tourism offer, provided they are embedded in coherent destination management and promotion strategies. These directions follow directly from Romania's placement in the domestically oriented cluster: rather than emulating highly tourism-dependent economies, the country's more realistic path is a gradual shift toward greater diversification and international integration.

Comparing the average profiles of the clusters highlights that the differences between the tourism development models in the region are determined not exclusively by the level of tourism competitiveness, but especially by the degree of economic integration of the sector and the structure of tourism demand. In this sense, Romania's positioning suggests the potential for convergence towards the model of diversified tourism economies, conditional on the implementation of public policies aimed at increasing competitiveness and more efficient use of tourism resources.

Research limitations. Although cluster analysis provides a relevant perspective on the typologies of tourism development in the Central and Eastern European region, the results must be interpreted in light of certain methodological limitations. First, the analysis is based on a relatively limited set of economic and market indicators, given that tourism competitiveness is a multidimensional phenomenon influenced by many variables. Second, the exploratory nature of the clustering method implies a certain dependence of the results on the selection of indicators, the aggregation

method used (Ward method), and the criterion for establishing the number of clusters. In addition, the analysis is static, based on data from a specific period, and does not capture the dynamics of developments over time.

Future research could extend this analysis using panel data and a broader set of indicators, such as international arrivals, overnight stays, tourism receipts, and accommodation capacity, and test the robustness of the cluster solution with alternative methods. Dedicated work on slow travel, ecotourism, creative tourism, and digital nomadism, examined through both destination-level and demand-side lenses, would further enrich the picture.

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PROPAGATION OF ECONOMIC SHOCKS IN HIERARCHICAL STRUCTURES AND NETWORKS. THE CASE OF THE EUROPEAN UNION

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SUMMARY

In this paper, we propose an analytical framework for understanding economic shocks from the perspective of systems theory and complexity. Unlike approaches that view shocks primarily as exogenous disturbances, this article argues that they should be understood as processes that emerge within the economic system through interactions among the triggering event, the system's structure, and transmission mechanisms. In this regard, the economic system is analysed as a structure of interdependencies that can take the form of hierarchical or network-type architectures. The analysis thus highlights that the way these interdependencies are organised influences the dynamics of shocks. In hierarchical structures, propagation tends to be more sequential and easier to localise. At the same time, in networks, the propagation of shocks occurs through multiple channels, making it more sensitive to feedback mechanisms, thresholds, and cumulative effects. The analytical framework developed is applied to the case of the European Union, interpreted as a system of interdependencies characterised by high levels of trade and financial integration but incomplete fiscal integration. The analysis shows that this configuration favours the rapid and differentiated propagation of shocks, accentuating asymmetries among Member States. The paper contributes to the literature on economic shocks by integrating a systemic perspective, highlighting the role of the system's architecture in their dynamics, and formulating implications for economic policy in interdependent systems.

Keywords: *economic shocks, complex systems, network structure, shock propagation, hubs, European Union*

INTRODUCTION

The analysis of economic shocks and their propagation is a central topic in the economic literature, as such shocks recur within economic systems and constitute a primary source of economic change. Depending on their nature, they may affect production, employment, trade, investment, or financial stability, generating effects that extend beyond the components initially affected.

An important aspect in understanding these processes is how economic shocks are transmitted within the economic system. In an economic system, there are multiple interdependencies among economic agents, institutions, sectors, and national economies, and shocks are transmitted through these relationships, which influence their effects. From this perspective, economic shocks can be understood as processes influenced not only by the characteristics of the triggering event but also by the structure of the system in which they occur. This aspect is of particular importance because economic systems may be organised in different ways, and the architecture of relationships among their components influences how information, resources, and the effects of disturbances circulate within them. In this context, hierarchical structures and network structures represent two fundamental forms of organisation, each associated with distinct mechanisms of coordination, interdependence, and transmission of economic effects. As a result, the same disturbance may generate different propagation trajectories and effects depending on the structure of the system in which it occurs.

In this paper, we develop a framework that enables analysis of the propagation of economic shocks in relation to the type of structure that characterises the system in which they emerge. Within this framework, we conduct a comparative study of hierarchical and network structures, which represent forms of organisation of the relationships established among the components of the economic system. This approach highlights how differences in system architecture influence propagation trajectories, feedback mechanisms, the degree of predictability, and the distribution of effects generated by economic shocks.

To empirically demonstrate the relevance of this perspective, the analysis is applied to the case of the European Union (EU), understood as a multilevel economic system characterised by a high degree of interdependence yet institutionally incomplete in terms of integration. From this perspective, the EU can be viewed as a set of interconnected national subsystems, coordinated through supranational institutional mechanisms. This configuration provides an appropriate framework for investigating how shocks propagate through hierarchical structures and complex networks, and how these mechanisms may amplify asymmetries among Member States.

All these aspects, along with this introduction and the conclusions section, are developed throughout five sections: the second section reviews the relevant literature on economic shocks, transmission mechanisms, and hierarchical and network-type economic structures; the third section introduces the conceptual delimitations employed in the analysis and clarifies the main concepts underpinning the proposed theoretical framework; the fourth section develops the analytical framework for the propagation of economic shocks and comparatively examines the transmission mechanisms specific to hierarchical and network structures; the fifth section applies the framework to the European Union, with particular emphasis on trade, financial, and institutional interdependencies and their implications for the propagation of economic shocks; finally, the last section summarizes the main conclusions and implications arising from the analysis.

LITERATURE REVIEW

ECONOMIC SHOCKS AND TRANSMISSION MECHANISMS

Traditionally, in economic literature, shocks are analysed as disturbances that affect key macroeconomic variables and cause the economic system to deviate from equilibrium. In this regard, much of the research focuses on identifying shocks and estimating their effects using macroeconomic and econometric models, such as VAR, SVAR, and DSGE (Blanchard & Quah, 1989; Cochrane, 1994; Smets & Wouters, 2007; Ramey, 2016). From this perspective, shocks are treated as exogenous factors stemming from technological changes, fiscal and/or monetary policies, shifts in aggregate demand, etc., and the emphasis is placed on their effects and on the mechanisms through which they are transmitted within the economy. Furthermore, some authors have shown that, in most approaches, the identification of shocks depends on the theoretical and methodological framework employed (Duarte & Hoover, 2012), whereas the nature of shocks and the role of economic systems in shaping their propagation are rarely examined. As regards the transmission of shocks, the literature identifies multiple transmission channels, including financial, monetary, and credit channels, which play a significant role in explaining how the effects of a disturbance propagate among the various components of the economic system (Mishkin, 1995; Bernanke & Gertler, 1995).

One aspect worth noting is that a specific strand of the literature focuses on asymmetric shocks in integrated economies and monetary unions. From this perspective, however, the focus of research is not on analysing the shocks *per se* but rather on how the economic system can counteract their effects. In this regard, many studies, primarily those concerning the Economic and Monetary Union (EMU) of the EU, clearly demonstrate that the same disturbance may generate different effects across Member States, due to differences in economic structure, institutional rigidities, exposure to shocks, and adjustment capacities (Theodoropoulos, 2005; Rosati, 2017). Furthermore, the literature emphasises the importance of absorption and adjustment mechanisms, such as labour mobility, economic policy coordination and risk-sharing mechanisms, in limiting the divergences caused by asymmetric shocks (Nchor, 2020).

Beyond these contributions, there is a body of literature relevant to our study that addresses shocks from the perspective of systems theory and complexity theory. In ecology, for example, many studies analyse disturbances from the perspective of how the events that trigger them influence the structure and functioning of ecosystems, emphasising that their effects depend not only on the characteristics of the disturbance but also on the properties of the affected system (Odum et al., 1979; Rykiel, 1985). Research on socio-ecological systems further develops this perspective by highlighting the role of feedback mechanisms, interdependencies, and adaptive processes in shaping the effects of disturbances (Filatova & Polhill, 2012). Similarly, the literature on complex systems shows that responses to disturbances are influenced by the system's internal organisation and by the interactions among its components (Grimm et al., 1992). These contributions suggest that the analysis of shocks can benefit from a perspective that pays greater attention to the system's structure and the mechanisms by which the effects of disturbances propagate.

HIERARCHICAL AND NETWORK STRUCTURES IN ECONOMIC SYSTEMS

The literature on systems theory suggests that the functioning of a system generally depends not only on the characteristics of its components but also on how the relationships within it are organised. In this context, hierarchical structures and networks represent fundamental forms of organisation in complex systems. With regard to hierarchical structures, Simon (1962) argues that many natural and social systems are organised into successive levels, with relationships distributed across layers of coordination and control. Similarly, von Bertalanffy (1968) emphasises that a system's properties do not depend exclusively on its components, but also on how the relationships among them are organised. Based on this, a number of studies in economics and organisational theory conceptualise firms, institutions, and governance mechanisms as hierarchical structures characterised by relatively stable relationships coordinated across different levels of the system. Williamson (1975), for example, views hierarchies as organisational mechanisms through which complex economic activities can be coordinated. More recently, Aoki (2001) highlights that organisational structures play an important role in information processing and the coordination of economic decisions.

Besides hierarchical structures, networks and the analysis of their role in the functioning of economic systems have become a significant body of specialised literature. From this perspective, economic systems are understood as sets of nodes with multiple connections, through which information, resources, goods, or financial flows circulate. Barabási and Albert (1999) demonstrate that the distribution of connections in many real-world economic networks is highly uneven, resulting in nodes with a disproportionately large number of links, known as hubs. Similarly, Barabási (2016) has highlighted that the positions of nodes and

the configuration of connections significantly influence the flow of information and resources within the economic system.

It is worth noting that, when applied to economics, these general ideas have formed the basis of specialised literature on production networks, financial networks, systemic risk, and related topics. Acemoglu et al. (2012) show that the structure of production networks influences the transmission of shocks from the local to the aggregate level, while Battiston et al. (2012) highlight the role of financial interdependencies in amplifying systemic risk. Likewise, Elliott et al. (2014) demonstrate that the position occupied by different components within a network can significantly influence the magnitude of contagion effects.

Although the literature offers numerous contributions regarding the functioning of hierarchical structures and economic networks, as well as their role in the transmission of information, resources, and disturbances, explicit comparisons between hierarchical and network-type structures as distinct channels for the propagation of economic shocks remain relatively limited. This observation is particularly relevant because the architecture of relationships among components may influence both the trajectories and the distribution of the effects generated by economic shocks.

RESEARCH GAP AND CONTRIBUTIONS

The existing literature, as discussed above, has helped explain economic shocks, transmission mechanisms, and the role of interdependencies in the propagation of their effects. Research in this field has contributed to the development of analytical tools for identifying shocks and assessing their effects (Blanchard & Quah, 1989; Smets & Wouters, 2007; Ramey, 2016), while studies on asymmetric shocks have highlighted how structural differences among economies influence the distribution of their effects. Likewise, research on hierarchical structures and networks has demonstrated how the organization of relationships among components shapes the circulation of information, resources and disturbances in complex systems (Simon, 1962; von Bertalanffy, 1968; Barabási & Albert, 1999). However, these approaches present a number of limitations:

- most of the literature treats shocks as exogenous disturbances, and attention is focused on the effects produced on the economic system rather than on the shock itself. As a result, the relationship between shock characteristics and the structure of the system through which it propagates is examined only to a limited extent.
- although the literature on asymmetric shocks shows that effects vary across economies, the explanations are general, being associated primarily with the characteristics of the affected economies and less with how the structure of relationships among components influences the distribution of effects.
- the literature on the internal organisation of economic systems focuses largely on specific transmission channels or specific network configurations. There are few analyses that compare hierarchical and network structures as distinct environments for the propagation of economic shocks and explore the differences between them.

Consistent with the limitations identified above, this paper aims to contribute to the literature on economic shocks by analysing the role of system structure in their propagation. While much of the existing research focuses on the nature of shocks, their transmission channels, or their effects, the present analysis shifts attention to the architecture of relationships among the components of the economic system and its role in the propagation of shocks. From this perspective, the study introduces a framework that allows for a comparison of how economic shocks propagate in two fundamental forms of system organisation, hierarchical structures and network-type structures.

CONCEPTUAL DISTINCTIONS

To clarify the analytical framework employed in the following sections, it is useful to introduce some conceptual distinctions that reflect how an economic system is organized and the nature of the relationships that may exist among its components. These conceptual distinctions are formulated in accordance with the perspective developed by Dinga (2015) and are as follows:

- *economic aggregate* vs. *economic system*. What they have in common is that both are assemblies of elements (economic agents, firms, institutions or, in the case of macrosystems, even the economic systems). The distinction between them, however, lies in the presence or absence of connections between these elements. An aggregate, for example, represents a simple collection of elements assembled together without any connections among them. By contrast, a system is a collection of elements connected to one another and functioning to achieve a common goal.
- *economic system* vs. *economic network*. A system, as defined above, allows for both hierarchical and non-hierarchical relationships among its constituent elements. A network is a set of elements connected exclusively through non-hierarchical, horizontal relationships. From this perspective, a network is a specific type of system characterised by a decentralised structure. In a network, the constituent elements are referred to as *nodes*.

- *economic network* vs. *economic hub*. In a network, connections among elements may be unevenly distributed, meaning that some nodes accumulate more links than others, thereby becoming more important within the network structure. These nodes, with a higher number of connections, are referred to as *hubs*.

From these distinctions, two broad types of architectures that may characterise an economic system can be identified:

a) *hierarchical structures*. Their main characteristic is the distribution of the elements that compose the economic system across different levels, resulting in "vertical" relationships. Thus, certain categories of elements may occupy higher levels (for example, the state with its institutions and related regulations), while others are subordinated (such as firms, households). From this perspective, hierarchical systems appear as centralised structures, with command and control centres and, thus, the possibility of direct intervention at lower levels. The connections they describe are generally standardised, and flows tend to follow relatively predictable trajectories.

b) *network-type structures*. As noted above, networks predominantly integrate "horizontal" relationships. Consequently, they operate in a decentralised manner, without hierarchies among the system's constituent elements. This does not imply the absence of coordination or control; rather, these functions emerge from the interactions among the elements that compose the network and are distributed across them. It should be noted that within an economic system, networks may operate autonomously as self-contained structures or may be connected to other structures, whether network-based or hierarchical.

The structures presented are not mutually exclusive, meaning that both hierarchical configurations and networks may coexist within the same system. Moreover, certain elements may belong simultaneously to both structures, being part of a hierarchical arrangement and a network. Nevertheless, in an economic system, there is an ordering relationship, as follows:

$$S \supseteq N \supseteq H$$

where, S = the economic system; N = the economic network; H = the set of hubs associated with a given economic network.

ORGANISATION OF THE ECONOMIC SYSTEM AND THE PROPAGATION OF SHOCKS: HIERARCHICAL STRUCTURES AND NETWORKS

Traditionally, economic shocks are analysed through the changes they induce in economic variables, typically attributed to factors exogenous to the economic system, while their effects are studied in terms of the deviations, they generate from a given reference state (Duarte & Hoover, 2012; Hoover, 2015). A consequence of this approach is that the analysis makes a clear distinction between the shock and the affected economic system, without attributing any role to the system's structure in the distribution of effects. This limits how economic shocks can be analysed, as their effects on economic systems cannot be fully explained without considering how these systems are internally organised.

Adopting the view that the economy functions as a system helps overcome these limitations. From this perspective, an economic shock is no longer identified exclusively with either the event that triggers it or the effects it produces, but is understood as a process resulting from the interaction between that event (to the extent that it is relevant to the economic system), the system's structure, and its transmission mechanisms. An event is relevant to the economic system insofar as it can generate impulses that propagate through the system's network of relationships and significantly alter its state.

FORMAL REPRESENTATION OF ECONOMIC SHOCK PROPAGATION

To formally represent the propagation of economic shocks, we will consider a systemic framework consisting of a triggering event, the structure of the economic system, and the transmission mechanisms activated by that event. The economic shock thus emerges from their interaction. The variables employed in the economic shock propagation model are presented in Table 1.

Table 1.
Definitions of Variables

Symbol	Definition
E	Triggering event
S	Structure of the economic system
T	Transmission structure
ε	Initial stimulus generated by the event
ΔY	Changes in relevant economic variables
A	Matrix of interactions among transmission channels

Source: developed by the author.

Within this framework, the observed effects of an economic shock can be expressed as follows:

$$\Delta Y = f(E, S, T)$$

where E represents the triggering event, S the structure of the economic system, and T the set of activated transmission channels. This representation highlights that the impact of an economic shock is not determined solely by the initial event but also by how it interacts with the system's structure and the mechanisms through which its effects are propagated.

The structure of the economic system (S) plays a central role in this process, as it influences both the channels through which the effects are transmitted (T), and the way in which they interact during propagation. From this perspective, the structure of the system not only provides the context in which the economic shock manifests but also shapes the magnitude, distribution, and dynamics of the resulting effects.

Two important consequences follow from this relationship:

- the same event may generate different effects in systems characterised by different structural configurations;
- two systems may respond differently to the same disturbance, depending on where it is introduced into the structure of interdependencies.

In this context, transmission channels play a specific role in the propagation of economic shocks. They constitute the functional pathways through which the impulse generated by the triggering event is introduced into the system and produces changes in relevant economic variables. Transmission channels partially overlap with existing economic flows, but also include additional mechanisms, such as price adjustments, institutional reactions, changes in expectations, or changes in the behaviour of economic agents.

To meet the needs imposed by the proposed model, depending on their nature, the channels through which economic shocks are transmitted can be grouped into the following categories:

- real channels (trade, value chains, energy, the labour market);
- financial channels (banks, capital markets, credit);
- institutional channels (economic policies, regulations, constraints);
- expectations and confidence channels (anticipations, perceptions, confidence).

The set of channels identified above, considered as a transmission structure, can be represented as follows:

$$T = \{t_1, t_2, t_3, t_4\}$$

where t_1 = trade channels; t_2 = financial channels; t_3 = institutional channels; t_4 = expectations channels.

An important aspect to note is that, within an economic system, these transmission channels do not operate in isolation but are continuously interconnected. Thus, the activation of one of these channels can alter the functioning of the others, generating cumulative propagation processes. To highlight these interdependencies, the transmission structure can be represented by an interaction matrix:

$$A = [a_{ij}]$$

where ε each element a_{ij} expresses the intensity of the influence exerted by channel i on channel j.

Based on this structure, the propagation of the shock can be expressed as follows:

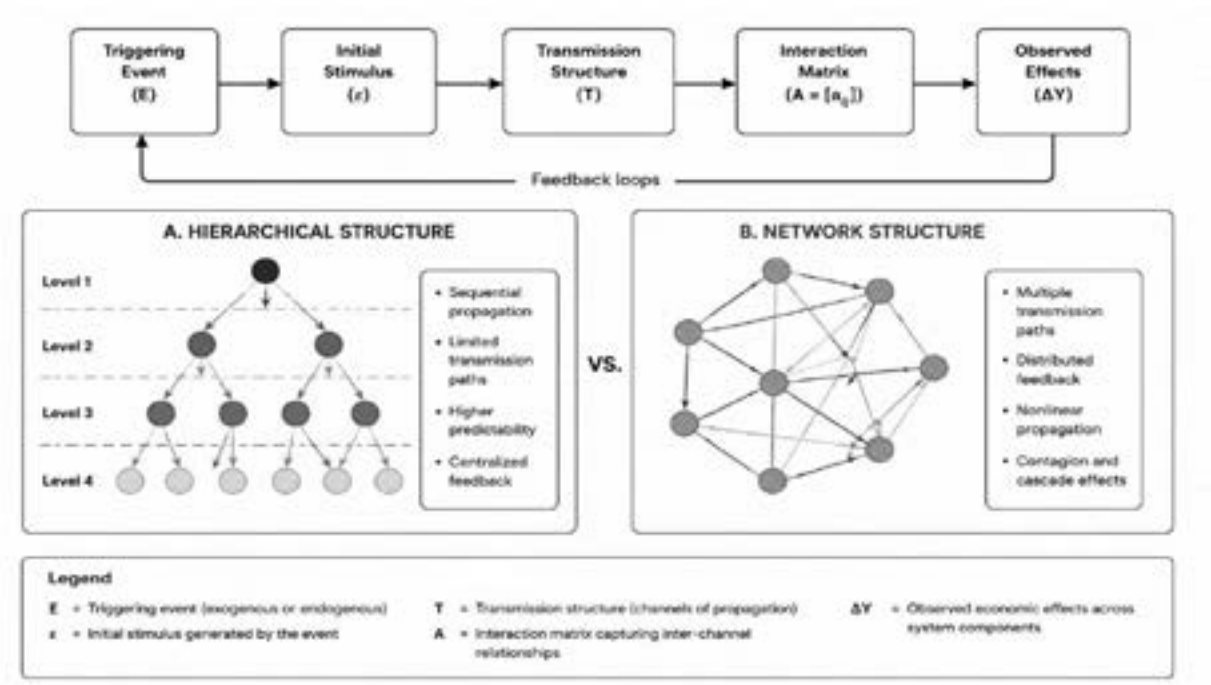
$$\Delta Y = A\varepsilon$$

where ε represents the initial impulse generated by the triggering event E.

In this framework, the propagation of the economic shock depends on the properties of the matrix A which captures the density of interdependencies and the intensity of the relationships between the transmission channels. Thus, the same event can generate different effects depending on the structural configuration of the economic system.

We summarise the relationships among the main elements of the proposed model and their roles in the propagation of economic shocks in Figure 1 below.

Figure 1.
Conceptual Framework of Economic Shock Propagation in Hierarchical and Network Structures



Source: developed by the author.

Figure 1 illustrates that the observed effects of an economic shock do not result directly from the triggering event itself, but rather from the interaction between the initial impulse generated by that event, the transmission channels it activates, and the relationships among them. From this perspective, the propagation of shocks appears to be a systemic process, influenced by the configuration of interdependencies and the feedback mechanisms developed within the economic system.

THE PROPAGATION OF SHOCKS IN HIERARCHICAL STRUCTURES

In hierarchical structures, the system's components are arranged across multiple levels, and relationships are predominantly organised vertically, which allows economic shocks to propagate accordingly. This type of organisation means that the impulse (ε) generated by a triggering event must pass through a relatively limited number of nodes or decision levels. Furthermore, the transmission of shocks is subject to mechanisms of validation, filtering, or transformation specific to each level of the hierarchy, thereby giving the propagation process a sequential character (Simon, 1962).

In this context, compared with decentralised structures, the shock's propagation trajectories are more clearly defined, and the number of possible transmission pathways is relatively limited. All of this gives the process greater predictability, since the relationships among components are generally stable and well known.

From the perspective of the model presented in Section 4.1, the hierarchical organisation of the system influences both the transmission structure T and the interactions among transmission channels represented by the matrix A. Because flows tend to follow predetermined paths and are mediated through a relatively small number of decision-making levels, interactions between channels are more limited than in network-type structures. Thus, shock propagation occurs through a smaller number of possible pathways, and the effects tend to be easier to anticipate and monitor.

Given our assumption that the economy functions as a complex system, the propagation of shocks tends to follow a nonlinear path. However, this nonlinearity is limited by the relatively ordered nature of the relationships among components, which reduces the number of simultaneous interactions and the possibility of emergent effects. At the same time, feedback mechanisms tend to be more clearly defined and institutionally embedded, being integrated into the system's decision-making structure, which helps monitor the propagation and correct deviations as they arise. In principle, the system therefore possesses a greater capacity to control and direct its response to disturbances.

Under these conditions, although triggering events may occur randomly, the dynamics of propagation tend to be more predictable, and policy or regulatory

interventions can act relatively directly on the relevant transmission channels, thereby limiting potential adverse effects. Nevertheless, this configuration entails a specific vulnerability: when central nodes or decision points are affected, shocks may propagate throughout the entire system because these elements concentrate key transmission mechanisms. As a result, the impact of the shock is generally more concentrated and easier to localise, but it can be significantly amplified if these nodes are affected.

In summary, within hierarchical structures, the propagation of economic shocks tends to be sequential, more concentrated, and easier to localise. The intensity of the resulting effects is determined not only by the characteristics of the triggering event, but also by its position within the system's architecture and by the role occupied by the affected components in the transmission mechanism.

THE PROPAGATION OF SHOCKS IN NETWORK STRUCTURES

Unlike hierarchical structures, networks are characterised by a multitude of connections that serve as alternative pathways for the transmission of shocks. In this context, the impulse generated by the triggering event (ε) does not follow a single, predetermined path, but is distributed simultaneously through multiple channels, with its effects influenced by the configuration of interdependencies among the system's components, which function as nodes (Barabási, 2016).

Within this type of structure, there are no clearly defined relationships of subordination and no single centres of coordination. Consequently, the effects of a disturbance may be propagated through different paths, recombine, and interact with one another, making the dynamics of propagation more difficult to anticipate than in hierarchical structures (Watts, 2002).

From the perspective of the model presented in Section 4.1, network structures are characterised by a more complex transmission structure T and a denser interaction matrix A, reflecting numerous connections and alternative propagation pathways. Under these conditions, the effects of a disturbance can be transmitted simultaneously through multiple channels and to multiple components of the system. As a result, propagation becomes less predictable and more dependent on the configuration of the interdependencies existing within the network.

If we accept the assumption that the economy functions as a complex system, the propagation of shocks in network structures is characterised by pronounced nonlinearity. Depending on the configuration of interdependencies, the same disturbance may generate very different effects, ranging from the non-complete absorption of the initial impulse (ε) to large-scale propagation throughout the entire system. The intensity of these effects depends not only on the characteristics of the triggering event but also on how the components of the interaction system evolve over time. In this context, the system's thresholds and critical points play a particularly important role. Up to a certain level, the impulses generated by a disturbance can be absorbed without major consequences. However, once critical thresholds are exceeded, qualitative changes in system dynamics may occur, giving rise to extensive propagation processes (Bak, 1996).

Feedback mechanisms also play a central role in the dynamics of shocks. Unlike hierarchical structures, where feedback is explicitly integrated into the decision-making architecture, feedback in networks is distributed and emergent, arising from interactions among system components. The activation of one transmission channel may alter the functioning of others, generating cumulative processes that can either amplify or attenuate the initial effects of a disturbance (Forrester, 1961; Meadows, 2008).

A particularly important role in this process is played by hubs, that is, nodes that concentrate a large number of connections within the network (Barabási & Albert, 1999). Due to their position within the structure, they can amplify, attenuate, or redirect the effects of economic shocks. Depending on the location of the disturbance and the position occupied by hubs within the network, the same impulse (ε) may generate effects that remain locally contained or may trigger large-scale cascading propagation processes (Watts, 2002).

The complexity of propagation is further amplified by the interconnection of different types of economic networks. Trade, financial, institutional, and expectations networks do not operate in isolation but are interconnected, forming multilayer structures (Kivelä et al., 2014). Under these conditions, the impulses (ε) associated with an economic shock may be transferred from one level of the system to another, simultaneously activating multiple transmission mechanisms and generating effects that extend beyond the initial sphere of the disturbance.

Thus, in network structures, economic shocks cannot be associated with a single transmission channel. Rather, they emerge from the interaction of multiple networks and propagation mechanisms. The dynamics of their effects are shaped by the density of interdependencies, the distribution of connections, and the position occupied by the various components within the system. As a result, the propagation of shocks tends to be less predictable, more sensitive to feedback mechanisms, and more prone to cumulative effects and systemic contagion processes.

THE EUROPEAN UNION AS A SYSTEM OF INTERDEPENDENCIES: IMPLICATIONS FOR THE PROPAGATION OF SHOCKS

In this section, we will apply the theoretical framework developed in the preceding sections to the case of the EU to examine how its specific structure influences the propagation of economic shocks. From an organisational perspective, the EU can be understood as a hybrid system that integrates both elements of a hierarchical structure, which involve decision-making and coordination processes implemented through supranational institutions and mechanisms (Baldwin & Wyplosz, 2022), as well as characteristics typical of network structures, arising from the relationships among Member States that generate trade, financial, and institutional interdependencies.

From this perspective, the EU may be characterized as a system combining: a) a high degree of interdependence; b) incomplete institutional integration (Baldwin & Wyplosz, 2022; De Grauwe, 2020). In terms of the framework developed earlier, these characteristics influence both the transmission structure T and the interactions among the transmission channels described by the matrix A, determining specific mechanisms for the propagation of economic shocks. Thus, the effects of shocks are shaped both by the density of network relationships between member states and by the institutional mechanisms through which these are coordinated and managed at the European level.

STRUCTURAL CHARACTERISTICS OF THE EUROPEAN UNION SYSTEM

Within the EU, several forms of integration define a specific structure of interdependencies. These forms of integration, which shape the EU as an economic system, are:

- *trade integration*. From a trade perspective, the EU is a deeply integrated area, with supply chains that extend beyond the national borders of Member States, generating mutual dependencies among economies. The literature on international trade and production networks highlights that such structures tend to amplify the transmission of shocks, as local disruptions in the economic system can spread rapidly along value chains (Antràs, 2020).
- *financial integration*. There is a significant degree of financial integration within the EU, but it is characterised by major asymmetries. Financial exposures are not evenly distributed among member states; rather, they are concentrated in certain centres, revealing nodes that are more centrally positioned within the network. Research on financial networks shows that instability can be amplified in such configurations, as disturbances affecting central nodes tend to spread more rapidly throughout the system (Acemoglu et al., 2012).
- *fiscal integration*. It is limited due to the absence of fully developed fiscal mechanisms at the central European level. This situation constrains the system's capacity to respond to shocks in a coordinated manner, creating an imbalance between the level of interdependencies that generate vulnerabilities and the instruments available for managing shocks. The literature on monetary unions emphasizes that this discrepancy can amplify the effects of asymmetric shocks in the absence of risk-sharing or shock-absorption mechanisms at the central level (Thirion, 2017; De Grauwe, 2020).

Taken together, these three dimensions describe the configuration of the EU's structure of interdependencies and the manner in which this structure shapes the propagation of shocks across member states. It should be noted, however, that trade integration and financial integration primarily reflect the density of network-type relationships among Member States, while fiscal integration expresses the hierarchical dimension, namely the extent to which the EU possesses common institutions and mechanisms capable of stabilizing the economy against shocks at the supranational level.

To illustrate these characteristics empirically, Table 2 presents a set of indicators of trade, financial, and fiscal integration in the EU over the period 2002–2024. These indicators demonstrate strong trade and financial interdependencies alongside a relatively limited common fiscal capacity.

Table 2.

Structural Dimensions of Economic Integration in the EU (2002-2024)

Dimension	Indicator	2002	2008	2013	2019	2024
Trade integration	Intra-EU exports share (%)	50.2	51.1	46.5	44.8	44.5
Financial integration	Transactions with euro-area counterparties (%)	n.a.	47.6	34.4	43.5	37.1
Fiscal integration	EU budget (% EU GDP)	~1.0	~1.0	~1.0	~1.1	~1.1

Source: developed by the author, based on Eurostat and ECB data

Note: The EU budget has remained close to 1% of EU GDP throughout the period, indicating a comparatively low degree of fiscal integration relative to trade and financial integration.

The data in Table 2 indicate that trade integration remained at a high level throughout the period analysed. Intra-EU exports accounted for approximately 45–50% of member states' total exports. This finding suggests relatively dense relationships among EU economies, indicating that, from the perspective of the transmission of economic shocks, changes in one part of the economic system could be rapidly transmitted to other components through trade flows and supply chains.

Similarly, the financial integration indicator recorded high values, reflecting significant linkages among financial actors across member states. Although the share of transactions involving euro-area counterparties located in other countries fluctuated over time, values exceeding 34% indicate that the EU financial system remained substantially interconnected. In this context, conditions were created for difficulties arising in a particular segment of the system to spread through mutual exposures, thereby facilitating financial contagion (Allen & Gale, 2000).

The evolution of trade integration is clearer in Figure 2, which shows the share of intra-EU exports in total exports between 2002 and 2024.

Figure 2.

Evolution of Intra-EU Export Integration

Source: developed by the author based on Eurostat and ECB data.

In contrast to the two dimensions, the data reported in Table 2 confirm relatively limited fiscal integration, with the EU budget remaining at a low level throughout the period, close to 1% of aggregate GDP. This suggests that the development of common stabilization instruments has not kept pace with the process of economic integration, creating a structural vulnerability from the perspective of economic shocks (De Grauwe, 2020). Thus, the system's capacity to respond in a coordinated manner to shocks has remained relatively limited compared to the extent of existing interdependencies.

Consistent with the analytical framework proposed in Section 4.1, high levels of trade and financial integration have increased the density of the EU's transmission structure *T*. As the number and intensity of economic

connections expanded, the matrix of interactions A within the system became denser, facilitating the propagation of disturbances across national economies. At the same time, limited fiscal integration reduced the system's capacity to mitigate the effects propagated through these channels.

From this perspective, the EU may be characterised during the period under analysis as a system with highly developed mechanisms for transmitting economic shocks but with limited common stabilisation mechanisms. This configuration explains why, within the EU, economic shocks spread rapidly across Member States and why their effects persisted or were unevenly distributed.

IMPLICATIONS FOR PROPAGATION MECHANISMS

At the outset, it is important to distinguish propagation mechanisms from transmission channels, which represent the pathways through which a shock's effects are transmitted to the economic system (whether trade-, financial-, institutional-, or expectations-based). Propagation mechanisms should be understood as processes resulting from the interaction between these channels and the structure of the economic system. From this perspective, the propagation of shocks is an emergent process, resulting from the interaction between transmission channels and the structure of interdependencies that characterize the system in which it occurs (Mitchell, 2009; Meadows, 2008).

In the case of the EU, the combination of high trade integration, significant financial integration, and limited fiscal integration results in a specific configuration, reflected in the particular way in which the transmission structure T and the matrix of interactions A are defined and which directly shapes the mechanisms of economic shock propagation. This structure of the EU has several implications for the propagation of economic shocks, as follows:

- *rapidity of propagation*. The high level of trade integration and the existence of extensive supply chains enable economic disturbances to be transmitted rapidly among Member States. The high number of trade links means that the effects of a shock are not limited to the components initially and directly affected, but tend to spread simultaneously to multiple components of the system. In terms of the proposed model, trade integration contributes to an increase in the density of the transmission structure T, thereby increasing the likelihood of rapid propagation of the effects.
- *the multiplicity* of propagation mechanisms. There are multiple dimensions of integration (trade and financial integration) and, thus, multiple levels of interdependence, that means that economic shocks can be transmitted through multiple mechanisms simultaneously (Acemoglu et al., 2012). Such mechanisms include flows of goods and services, mutual financial exposures, portfolio adjustments, credit tightening, and changes in risk perception. Regarding the matrix of interactions A this implies alternative channels for the propagation of shocks, thereby facilitating contagion processes and systemic effects (Allen & Gale, 2000).
- *limited capacity* for mitigation. As we have shown, while the EU is highly integrated in trade and finance, the capacity for fiscal stabilisation at the European level remains relatively limited. Thus, there are powerful mechanisms for transmitting shocks within the economic system, but the tools for absorbing and mitigating them are relatively limited. Within the proposed framework, this situation can be interpreted as a limitation on the system's ability to reduce the intensity of the effects propagated through the structure. Thus, propagation depends not only on the existence of transmission channels but also on the institutional capacity to interrupt or moderate the transmission processes.

All these characteristics create conditions for both amplification effects and differentiated impacts of economic shocks within the EU. Given the multiple transmission channels, effects generated in one channel may influence the functioning of the others, and the resulting system-wide reactions may generate feedback mechanisms. At the same time, the limited capacity for mitigation means these effects are not uniformly absorbed across the system. As a result, the impact of shocks tends to be distributed unevenly among EU member states, depending on their position within the network of interdependencies and their capacity for national adjustment. Thus, the propagation mechanisms described above create conditions for the emergence of asymmetric effects, which are analysed in the following section.

ASYMMETRIES AND DIFFERENTIATION OF IMPACT

Within the EU structure discussed, the economies of the member states occupy different positions in the network of interdependencies, which causes the effects of propagated economic shocks to be distributed unevenly throughout the economic system. In the framework presented in Section 4.1, these differences in network position can be understood as variations in the components of the transmission structure T and the interaction matrix A. In this context, the impulse associated with a single event may generate different effects across the economies of

Member States, depending on the configuration of the relationships it encounters along its path, resulting in an uneven distribution of shock effects (Acemoglu et al., 2012). This asymmetry in the effects of economic shocks can be explained by the following distinct mechanisms:

- *differences in centrality*. Some of the member states' economies exert greater influence than others on the overall structure of the EU's economic system. Those that are more integrated into trade and finance thus function as hubs in the EU's economic network and serve as key points through which economic shocks propagate to the rest of the system (Barabási & Albert, 1999; Acemoglu et al., 2012). From this perspective, shocks affecting economies that occupy central positions within the network are more likely to generate system-wide effects, whereas shocks affecting more peripheral economies tend to have a more limited distribution of impacts (Acemoglu et al., 2012).

To highlight differences in centrality within the EU's economic system, Table 3 presents the share of selected Member States[1] in the EU's GDP and in intra-EU exports. These indicators provide an overview of the position occupied by national economies within the European network of interdependencies.

Table 3.

Economic Hubs within the EU in 2024

Country	Share of EU GDP (%)	Share of intra-EU exports (%)
Germany	24.02	20.81
France	16.20	7.93
Italy	12.22	7.85
Spain	8.85	6.09
Romania	1.96	1.65

Source: developed by the author based on Eurostat data.

The data reported in Table 3 reveal inequality among EU member states in the distribution of overall economic activity and intra-EU trade. Among them, Germany is one of the main hubs, accounting for 24% of the EU's GDP and approximately 21% of total intra-EU exports, followed by France and Italy, which have lower but still significant shares of these two indicators. Owing to their positions within the European economic network, these economies play a significantly greater role in the propagation of economic shocks than less developed economies such as Romania.

Within the proposed framework, these differences translate into variations in the position occupied by national economies within the EU's transmission structure *T*. Those economies with a greater number of active connections are located closer to the centre of the network and therefore possess a greater capacity to contribute to the propagation of shocks and the generation of systemic effects, whereas others occupy more peripheral positions.

- *differentiation* of exposure to shocks. While more developed and highly connected economies play a more significant role in the propagation of economic shocks, the less developed and more peripheral economies are more exposed to receiving these shocks. This is largely due to their greater dependence on economic flows originating from other EU economies—many of which occupy central positions—as well as their more limited capacity for adjustment at the national level. In these situations, peripheral economies are affected indirectly through secondary propagation mechanisms, even though they are not the original source of the disturbance (Acemoglu et al., 2012; Allen & Gale, 2000).
- *the interaction between economic structure and the institutional framework*. Given the limited degree of fiscal integration and the absence of fully developed mutual stabilisation mechanisms, the differences resulting from structural divergences cannot be fully compensated. This means that, once they occur, the effects of economic shocks persist longer in some economies than in others, and their trajectories differ (De Grauwe, 2020).

The interaction of these mechanisms amplifies the effects of economic shocks in some parts of the system and mitigates them in others, resulting in an asymmetry in the distribution of economic effects. In this context, the analysis of EU-specific economic shocks must take into account not only the transmission mechanisms but also the distribution of effects within the system.

[1] The Member States listed in Table 3 were selected based on their importance within the EU's economic system and their relevance to our study.

ILLUSTRATING THE PROPAGATION MECHANISMS OF ECONOMIC SHOCKS THROUGH RECENT EPISODES

The propagation mechanisms discussed above can be more clearly illustrated by analysing recent episodes that have affected the EU. For this purpose, we consider the cases of the 2008–2009 Global Financial Crisis and the COVID-19 pandemic shock. Beyond their impact on the EU economy, these episodes are particularly relevant because each possessed its own distinct characteristics and therefore constitutes a specific case for analysis. What is of interest here is how the same structure of interdependencies influenced the propagation of different types of shocks.

To this end, Table 4 presents the annual real GDP growth rates in selected EU Member States during the Global Financial Crisis (2009) and the COVID-19 pandemic (2020). These data provide an overview of the magnitude of the economic effects during the two episodes and highlight the differentiated nature of their effects across the European system.

Table 4.

Asymmetric Impact of Major Economic Shocks in the European Union

Country	GDP Growth 2009 (%)	GDP Growth 2020 (%)
Germany	-5.5	-4.1
France	-2.8	-7.4
Italy	-5.3	-8.9
Spain	-3.8	-10.9
Romania	-5.5	-3.6
EU27	-4.3	-5.6

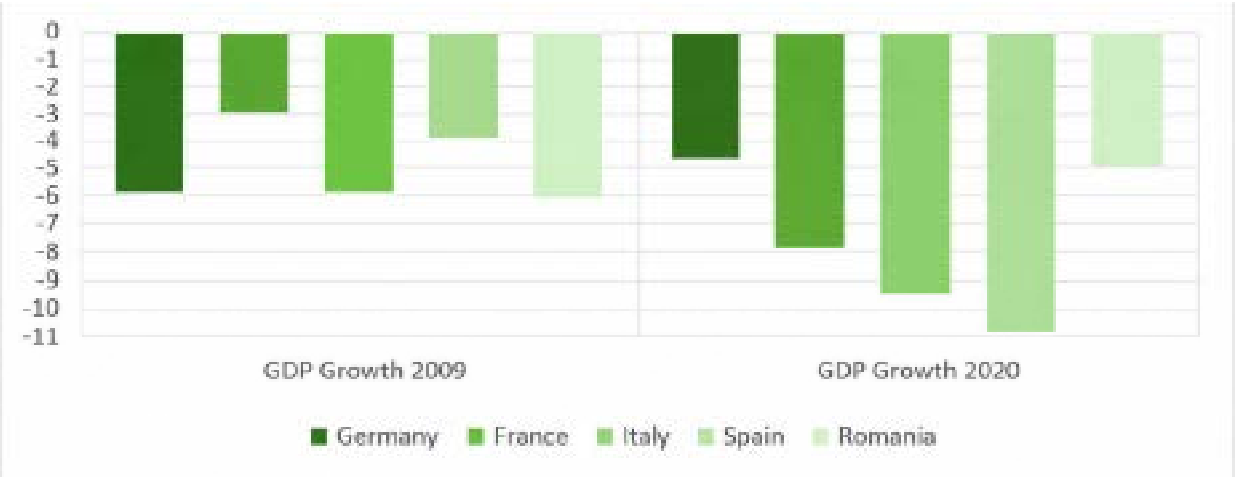
Source: developed by the author based on Eurostat data.

The figures reveal significant differences in the severity of economic contractions across countries. All economies were affected by both shocks, but the magnitude of the impact varied considerably. These differences support the argument developed throughout this paper that the effects of economic shocks are determined not only by the characteristics of the triggering event but also by the position of economies within the network of interdependencies, their exposure to transmission channels, and their capacity to absorb shocks.

Figure 3 provides a visual comparison of the economic impact of the 2008–2009 Global Financial Crisis and the COVID-19 shock across selected Member States.

Figure 3.

GDP growth during major shocks



Source: developed by the author based on Eurostat data.

Figure 3 confirms that the economic impact of the two shocks was unevenly distributed across Member States. While all economies were affected, the magnitude of the contractions varied substantially, suggesting that the effects of shocks depend not only on the triggering event but also on the structure of interdependencies and each economy's position within the European system.

THE GLOBAL FINANCIAL CRISIS (2008–2009)

The 2008–2009 Global Financial Crisis provides a relevant example of how an economic shock can propagate within a system characterised by high financial interdependencies, such as the EU. From the perspective of the framework proposed in this paper, the episode can be analysed in terms of the triggering event, the activated transmission channels, the resulting propagation mechanism, and the effects generated within the European system.

Under this framework, the *triggering event (E)* was the deterioration of the U.S. subprime mortgage market and the bankruptcy of major financial institutions, such as Lehman Brothers, in September 2008 (Brunnermeier, 2009). *The initial impulse (ε)* generated by this event consisted of deteriorating financing conditions, rising uncertainty, and reduced liquidity in international financial markets. These events occurred outside the EU, but their effects spread rapidly from the U.S., with the shock subsequently transmitted to the European economic system through activated financial channels and propagating to other components of the economy.

Within the EU, *the transmission mechanism (T)* consisted primarily of financial and trade interdependencies established among Member States. At the onset of the crisis, financial institutions in the EU were closely interconnected through interbank markets, cross-border exposures, and shared holdings of financial assets (Lane, 2013). These relationships served as the primary channels through which the shock's effects were transmitted to other components of the EU system. Consequently, difficulties arising in one part of the financial system rapidly affected other institutions and markets, highlighting the tendency of rapid propagation of shocks associated with highly interdependent structures.

It is worth noting that the shock's propagation was not limited to the financial sector. The reduction in liquidity and the tightening of credit conditions, for example, affected investment and consumption, leading to a decline in economic activity and trade. The effects that initially emerged in the financial sector were transmitted further through trade and production channels, thereby triggering multiple propagation mechanisms.

In this context, the matrix A can be interpreted as describing the relationships between the financial (F) and trade (C) channels activated during the propagation of the shock. Elements such as a_{FC} thus indicate how the deterioration in financial conditions affected the real economy, while elements such as a_{CF} describe the reverse reactions, the effects of the decline in economic activity on the financial sector. Through these interactions, the initial effects of the shock were amplified and propagated to an increasing number of components of the EU's economic system.

Another aspect highlighted by the 2008–2009 financial crisis is how the effects of the economic shock were amplified through feedback mechanisms activated at the EU system level. For example, the decline in economic activity affected firms' operations and borrowers' capacity to repay, placing additional pressure on the financial system. In turn, difficulties in the financial sector led to further credit tightening and an acceleration of the economic decline (Brunnermeier, 2009; Claessens et al., 2010). Through these processes, the effects generated in the financial component of the economic system triggered reactions that fuelled new disturbances in other components of the system, thereby amplifying the overall impact of the shock.

Beyond the above, as shown in Table 4, the effects of the crisis were not distributed evenly among Member States. Germany and Romania recorded more significant declines in GDP, with 5.5% in 2009, while economies such as Spain and France recorded smaller contractions (-3.8% and -2.8%), below the EU average (-4.3%). This uneven distribution of the shock's effects can be explained by differing exposures to the shock and unequal capacities to adjust. In other words, although the initial disruption was common to all Member States, the resulting economic impact varied from one economy to another.

THE COVID-19 PANDEMIC SHOCK

Unlike the 2008–2009 financial crisis, the COVID-19 pandemic was driven by an exogenous shock that simultaneously affected production processes, factor mobility, and economic exchange. From this perspective, the pandemic highlights how a non-financial shock can activate transmission channels and generate effects throughout the EU's economic system.

In accordance with the framework developed in this paper, the *triggering event (E)* in this case was the COVID-19 pandemic and the measures adopted to limit the virus's spread among the population. *The initial impulse (ε)* generated by this event manifested itself through the interruption of economic activities, reduced mobility of persons, disruptions to production processes, and disturbances in supply chains. These initial effects were introduced into the economic system through the activated transmission channels and subsequently spread to multiple components of the EU economy.

At the EU level, *the transmission structure (T)* consisted primarily of interdependencies in trade and production among Member States. Integrated supply chains and the intensity of trade meant that disturbances occurring

in one economy were rapidly transmitted to other economies. In this context, the interruption of activity in certain firms or sectors affected not only the economies in which they were located, but also other components of the EU system that depended on the same flows of goods, services, and production inputs (Antràs, 2020).

The propagation of the economic shock, in this case, was driven by the interaction between trade channels (C) and production channels (P). In *the interaction matrix (A)*, the relationships a_{PC} describe the effects of reduced production on trade flows, while the relationships a_{CP} express the impact of disrupted trade flows on production processes. Through these interactions, the effects generated in one segment of the supply chains were transmitted to other segments, contributing to the propagation of the disturbance throughout the EU economic system (Baldwin & Freeman, 2021).

As with the 2008–2009 Global Financial Crisis, the pandemic confirms that the effects of economic shocks can be amplified through feedback mechanisms within the economic system. The reduction in production and economic activity affected household incomes and aggregate demand in EU countries, which in turn further reduced firms' activity and economic exchanges. Thus, the initial disturbances induced by the COVID-19 pandemic in the economic system also triggered reactions in other components of the system, amplifying the impact of the shock.

The effects of the COVID-19 pandemic shock were also distributed unevenly across Member States. The data presented in Table 4 show that, in 2020, Spain recorded a GDP decline of 10.9%, Italy of 8.9%, France of 7.4%, Germany of 4.1%, and Romania of 3.6%. These results reflect varying degrees of exposure to the shock, shaped by each country's economic structure, the importance of sectors directly affected by mobility restrictions, and the adaptive capacity of national economies. Economies dependent on activities such as tourism, transportation, or mobility-related services were affected more than those with a different sectoral structure.

DISCUSSION AND POLICY IMPLICATIONS

The analysis presented in this paper highlights that the system-level effects of economic shocks are shaped not only by the characteristics of the triggering event or initial disturbance, but also by how the shocks interact with the system. The application of the proposed theoretical model to the EU has shown that the high degree of trade and financial interdependencies facilitates the rapid propagation of shock effects across national economies, while differences in countries' positions within the network and their unequal capacity to adjust contribute to the asymmetric distribution of these effects. This leads to several key findings, as follows:

- A first important finding concerns the role of economic centrality in the dynamics of shocks. As the data presented in Table 3 suggests, economic activity and intra-EU trade are unevenly distributed among Member States, with some economies occupying significantly more prominent positions within the European network of interdependencies. In such configurations, disturbances affecting central economies tend to generate broader effects across the entire system than those affecting peripheral economies. This observation confirms the importance of network structure in modelling propagation processes and suggests that the impact of a shock depends not only on its intensity but also on the position of the affected component within the system.
- A second finding of the analysis is the coexistence of multiple transmission channels in the propagation of economic shocks. The discussion presented in Sections 4.1 and 4.2, together with the two episodes examined, showed that the effects of a shock are not transmitted through a single mechanism, but rather through the simultaneous interaction of multiple channels. In the case of the Global Financial Crisis, the shock initially spread through financial channels but was subsequently transmitted to the real economy and international trade through specific channels. During the COVID-19 pandemic, the main mechanism was the interaction between production and trade channels. In both situations, the effects were amplified by interactions among different transmission channels and by feedback mechanisms within the system.
- A third finding emphasize the asymmetric nature of the effects of economic shocks. The evidence presented in Table 4 indicate that the same disturbance can generate different outcomes across Member States. Both during the Global Financial Crisis and the COVID-19 pandemic, the magnitude of economic contractions varied significantly across economies. These differences point to varying exposures to shocks, different economic structures, and differing positions within the network of interdependencies and in terms of adjustment capacities. From this perspective, the asymmetries are not merely consequences of the shocks, but rather the different ways in which they interact with the characteristics of the system's components.

The results discussed above yield a series of implications for economic policy within highly interconnected systems. These implications are:

- the effectiveness of interventions depends on the ability to identify components relevant to the economic system. In structures with unevenly distributed centralities, disturbances affecting central nodes can generate disproportionate effects for the entire system. From this perspective, preventive measures and stabilisation policies should pay particular attention to institutions,

sectors, and economies that occupy central positions within the network of interdependencies.

- the existence of multiple propagation mechanisms suggests the need for coordinated interventions. Policies targeting a single transmission channel may be limited in effectiveness, as effects can continue to propagate through other channels. Therefore, managing economic shocks requires an integrated approach that accounts for the trade, financial, and institutional dimensions of their propagation.
- the asymmetric distribution of effects necessitates relatively flexible adjustment mechanisms. Given that the same shock can produce different effects across the various components of the system, uniformly applied measures may lead to unequal outcomes. This highlights the importance of instruments that can respond differently depending on the characteristics and vulnerabilities of the various components.

In the case of the EU, these implications are reinforced by the fact that, as shown in Table 1, the high level of trade and financial integration is not matched by an equivalent degree of fiscal integration, which results in a high capacity for the propagation of shocks but lacks the instruments to absorb their effects. From this perspective, strengthening the resilience of the EU system requires not only improving the response to shocks after they occur but also incorporating the structural conditions that shape their propagation into the measures designed to address them. In this regard, three priorities are particularly important:

a strengthening monitoring and intervention capabilities in systemically important sectors;

b reducing excessive interdependencies that may amplify the effects;

c developing coordination and stabilisation mechanisms that are better aligned with the existing degree of economic integration within the EU.

It should be noted that addressing these areas does not necessarily entail centralising economic policies at the EU level, but rather achieving better alignment between the EU's institutional architecture and the structure of economic interdependencies that characterise it.

CONCLUSIONS

In this paper, we aimed to analyse the propagation of economic shocks from the perspective of the structure of the economic system in which they occur. Based on the premise that the effects of shocks depend not only on the characteristics of the triggering event but also on the architecture of relationships among the system's components, we developed an analytical framework that links the triggering event, the transmission mechanisms, and the structure of the economic system.

The analysis revealed that hierarchical structures and network-type structures generate different mechanisms for the propagation of economic shocks. In hierarchical structures, propagation tends to follow more clearly defined paths, characterised by a relatively higher degree of predictability and the possibility of intervention through existing coordination levels. In contrast, in network-type structures, the existence of multiple connections and distributed feedback mechanisms fosters more complex propagation processes that are less predictable and more sensitive to the configuration of interdependencies among components.

Applying the proposed framework to the EU has shown that the high degree of trade and financial integration contributes to the development of strong mechanisms for transmitting economic shocks, while limited fiscal integration reduces the system's capacity to absorb and mitigate their effects. The analysis also highlighted that the positions occupied by national economies within the European network of interdependencies, and their varying capacities for adjustment, contribute to the asymmetric distribution of shock effects across Member States.

The main contribution of this paper lies in developing a comparative framework for analysing the propagation of economic shocks in hierarchical and network-type structures and highlighting the role of the architecture of relationships between components in shaping their effects. From this perspective, the findings suggest that the analysis of economic shocks could benefit from greater attention to the system's structure and the mechanisms by which the effects of disturbances propagate among its components.

At the same time, the analysis remains predominantly theoretical and conceptual. Future research may expand the proposed framework by developing empirical indicators of economic interdependencies, component centrality, and propagation mechanisms, and by applying it to other types of economic systems and categories of shocks.

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THE POWER OF ATTRACTION: UNDERSTANDING HOW SOFT POWER GENERATES NATIONAL BRAND VALUE

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SUMMARY

Amid ongoing political, economic, and digital transformations, soft power and nation branding have emerged as strategic resources shaping international perceptions and national competitiveness. The article examines the relationship between soft power and nation brand value, analysing whether attraction-based influence can be translated into measurable economic outcomes at the country level. The study combines a qualitative literature review with a conceptual framework and a quantitative empirical analysis using data from the top 20 countries in the Global Soft Power Index 2025. The empirical findings reveal a statistically significant positive relationship between soft power and nation brand value. The results remain robust after controlling for economic size by including GDP as a control variable, suggesting that the observed relationship cannot be explained solely by differences in economic scale. The article proposes a conceptual framework in which soft power functions as a source of national attractiveness, the nation brand represents the perceptual output, and nation brand value constitutes the measurable economic outcome. The study highlights the strategic importance of soft power in strengthening national brands and supports integrating soft power considerations into nation-branding strategies and public policy design.

Keywords: *soft power, nation brand, nation brand value*

INTRODUCTION

In an era defined by rapid globalisation and pervasive digitalisation, the mechanisms through which nations exert their influence and build their international reputation are undergoing a fundamental transformation. The proliferation of transnational communication networks, the diversification of information channels, and the availability of information at the click of a button have collectively reshaped the dynamics of international perception. In this context, a nation's reputation is no longer determined primarily by objective material attributes, but is increasingly shaped through the lens of perception itself - a phenomenon with profound implications for contemporary geopolitical and geoeconomic dynamics.

Against this backdrop, *soft power* has emerged as a central strategic resource in the repertoire of modern governance. Introduced to the literature by Nye (1990) as the ability to shape others' preferences through attraction and persuasion rather than coercion and force, soft power operates through culture, values, and foreign policy. In addition to its strategic significance at the normative level, soft power also generates tangible economic results: increased export competitiveness, growth in foreign direct investment, the attraction of human capital, and the development of tourism. As such, soft power constitutes not only a diplomatic tool but also a structural determinant of long-term national competitiveness in an increasingly interconnected global system (Nye, 2004, 2008).

A central element of this study is the concept of national brand value, which represents the monetary and strategic expression of a country's international reputation. Where the national brand captures how a country is perceived, national brand value translates those perceptions into measurable economic terms. According to Brand Finance's methodology, the value integrates three interconnected components: brand strength, based on familiarity, influence, and prestige; financial and market performance, quantified by GDP, exports, tourism, and foreign direct investment; and a royalty relief approach, which converts reputation capital into a monetary estimate by treating the national brand as an asset that can be licensed. The conceptual relevance of linking national brand value to soft power rests on their shared foundations: both constructs operate through perception, credibility, and attraction, rather than through material coercion. As Fan (2010) argues, soft power constitutes the fundamental substance of a national brand, shaping its global perception. National brand value thus emerges as the most appropriate empirical indicator for assessing the measurable effects of soft power at the country level.

Despite the growing importance of soft power, from both academic and public policy perspectives, the direct relationship between soft power and national brand value remains underexamined in the existing literature. Although the literature contains relevant studies on soft power (Nye, 2008; Repnikova, 2022; Chitty, 2023) and country branding (Anholt, 2006; Dinnie, 2022), the relationship between the two has a predominantly diplomatic character, grounded in public diplomacy, economic factors, and normative appeal (Fan, 2010; Szondi, 2008; Potter, 2009; Alzowibi, 2023). Crucially, the relationship between soft power and national brand value — understood as the quantifiable economic expression of a country's reputational capital — has received little or no direct empirical attention. This gap is theoretically meaningful: if non-coercive influence operates primarily through reputation and credibility, its effects should be most clearly visible precisely in the measurable outcomes captured by national brand value. Addressing this gap constitutes the main scientific contribution of the present study.

The article therefore advances a central hypothesis: there is a statistically significant positive relationship between a country's soft power and its national brand value. Empirically examining this relationship allows for a rigorous assessment of the extent to which soft power,

operating as an input through culture, values, and foreign policy, generates perceptual outputs, namely reputation, positioning, and international attractiveness, which in turn produce measurable country-level outcomes, including national brand value, export performance, foreign direct investment, and tourism flows. This analytical framework reinforces the strategic importance of both constructs for governments, public institutions, and economic actors operating in an increasingly competitive international environment (Brand Finance, 2020).

The present research addresses this gap from both theoretical and empirical perspectives, contributing to the existing literature in several distinct ways. From a theoretical perspective, the author proposes a conceptual framework in which soft power functions as an input factor, the nation brand as a perceptual output, and national brand value as a quantifiable outcome — an analytical architecture that extends and formalises existing conceptual approaches. From an empirical perspective, this research examines both the correlation and the directionality of the relationship between soft power and national brand value, using the latest available data from the Global Soft Power Index 2025. The practical relevance of these findings is equally significant: in an international environment marked by intensifying competition for talent, tourists, investments, and capital flows, understanding how soft power translates into measurable results and contributes to enhancing national competitiveness provides actionable insights for governments, public institutions, decision-makers, and economic actors seeking to strengthen their international strategic positioning.

The objectives of this study are threefold. First, it examines the conceptual foundations and interrelationships between soft power, nation branding, and nation brand value through a comprehensive review of the relevant literature. Second, it proposes a conceptual framework linking soft power, nation brand, and nation brand value as complementary dimensions of national attractiveness and competitiveness. Third, it empirically investigates the relationship between Soft Power and Nation Brand Value using correlation and Ordinary Least Squares (OLS) regression analysis based on data from the Global Soft Power Index 2025, while testing the robustness of the relationship through the inclusion of Gross Domestic Product (GDP) as a control variable.

THEORETICAL FRAMEWORK

The conceptual framework of this study is grounded in a distinct yet complementary analysis of the concepts of *soft power* and *nation brand value*, with particular emphasis on the *nation brand* as an integral component of overall brand value, as well as an analysis of studies that conceptualise soft power and country brand value as both independent variables and interconnected analytical dimensions.

Despite the growing body of literature addressing soft power and nation branding independently, there remains a notable lack of in-depth research examining the direct relationship between a country's soft power and its national brand value. Given the inherently interconnected nature of these concepts, this gap provides a strong conceptual rationale for empirically investigating their interaction and for exploring the mechanisms through which soft power and national brand value may mutually reinforce one another.

The notion of *soft power* was introduced by Joseph S. Nye Jr. in *Bound to Lead: The Changing Nature of American Power* (1990) to describe a form of influence distinct from coercion or material inducements. Nye defined soft power as "the ability to achieve desired outcomes by shaping the preferences of others through attraction rather than force or payments" (Nye, 1990). Although the term itself is relatively recent, Nye emphasised that the behaviour it captures is "as old as human history."

The concept was further developed in Nye's subsequent works, including *Soft Power: The Means to Success in World Politics* (2004), *Public Diplomacy and Soft Power* (2008), and *The Future of Power* (2012). Across these contributions, soft power is consistently framed as a relational and perception-based form of power. Nye (2004) succinctly defines it as "the ability to get what you want through attraction rather than coercion or payments" (p. x), or, more concisely, as "attractive power" (p. 6).

According to Nye (2008), a country's soft power "rests primarily on 3 resources: its culture (in places where it is attractive to others), its political values (when it leaves up to them at home and abroad) and its foreign policies (when they are seen as legitimate and having moral authority)". Crucially, these resources do not automatically generate influence; their effectiveness depends on credibility and perception. In this regard, Nye (2011) argues that in the Information Age, credibility constitutes the "scarcest strategic resource" and that "the best propaganda is not propaganda".

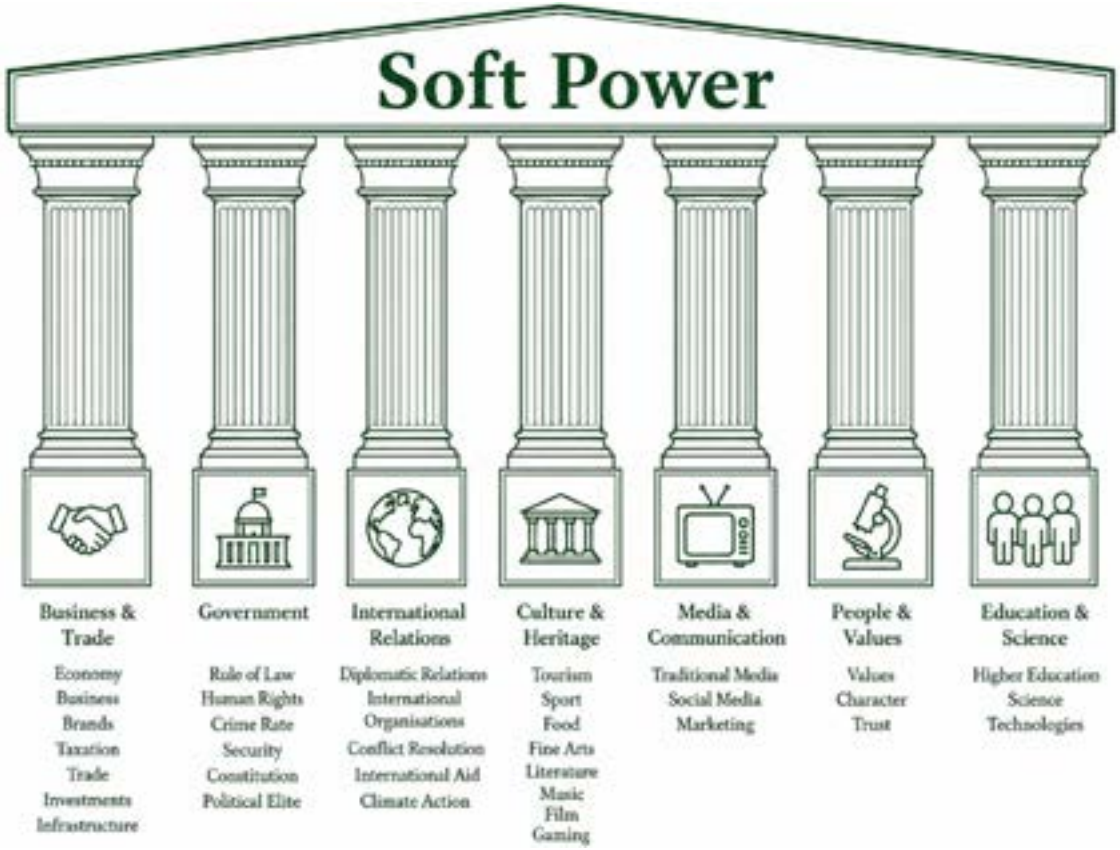
Subsequent scholarship has largely retained this conceptual core while extending its analytical depth. One example is Naren Chitty, who, in his work *The Routledge Handbook of Soft Power*, offers a contemporary perspective on soft power, emphasising the role of public diplomacy and modern communication tools in enhancing international appeal. Watanabe and McConnell (2008), on the other hand, focus on the cultural dimension of soft power, highlighting the importance of national cultural heritage in defining international attractiveness. This idea is supported by Maria Repnikova (2022), who analyses how cultural resources and global communication shape perceptions and a state's influence on the international stage. Solomon (2014) further advances the concept

by emphasising the affective dimension of soft power, arguing that attraction emerges not only from narratives or cultural influence but also from audiences' emotional investments, thus extending the concept of soft power by introducing the notion of emotional investments. At the same time, there are also critical perspectives; for example, John Mearsheimer (2018), in *The Great Delusion: Liberal Dreams and International Realities*, questions the effectiveness of soft power, arguing that realists believe that coercive power and material interests remain dominant in international relations. Thus, contemporary literature reflects both the modern and applied exploration of soft power and debates about its theoretical and practical limitations.

The growing institutionalisation of soft power is reflected in the *Global Soft Power Index*, which Brand Finance has published annually since 2020. In this applied context, soft power is defined as a nation's ability to influence international actors through attraction and persuasion rather than coercion (Brand Finance, 2020). This definition closely aligns with both academic consensus and mainstream lexicographic sources, such as Oxford or Cambridge Dictionary, which similarly emphasise cultural, political, and economic influence as alternatives to military power.

In fact, the Global Soft Power Index is among the most comprehensive empirical assessments of the soft power concept, offering a structured, multidimensional analysis, as illustrated in the figure below.

Figure 1.
The 7 pillars of Soft Power



Source: Global Soft Power Index, Brand Finance

Figure 1 illustrates the multidimensional architecture of soft power, as conceptualised by Brand Finance in the Global Soft Power Index. Soft power is presented as a multidimensional concept, supported by seven interconnected pillars: Business and Trade, Government, International Relations, Culture and Heritage, Media and Communication, Education and Science, and People and Values. Each pillar captures a distinct but complementary channel through which attraction-based influence is generated and transmitted internationally.

The framework clearly emphasises that soft power is not confined to a single domain, but rather the result of the cumulative interaction between economic performance, institutional quality, diplomatic engagement, cultural expression, communication capacity, knowledge production, and shared societal values. The sub-dimensions associated with each pillar operationalise soft power by linking abstract sources of attraction to measurable indicators, such as tourism, governance quality, media presence, innovation, and trust.

Overall, the literature converges on a shared understanding of soft power as a non-coercive, attraction-based form of influence grounded in culture, values, credibility, legitimacy, and human capital. This conceptual consensus provides a robust foundation for examining how soft power contributes to reputational and economic outcomes, a relationship further explored in the following section in relation to national brand value.

These approaches constitute the first pillar of the conceptual framework, which posits that soft power operates through intangible outputs, such as cultural expressions, promoted values, and globally visible behavioural patterns, that shape external interpretations and perceptions. Through the cultural system, normative attractiveness, and internationally observable behaviour, states project meanings and narratives that influence how they are perceived, evaluated, and positioned by foreign audiences. These inputs do not yield immediate material results but operate at the perceptual level, gradually forming the cognitive and emotional foundations upon which reputation, trust, and attractiveness are built. In this sense, soft power acts as a pre-structuring force that conditions the reception of a country's actions and messages in the international arena.

The second part of the theoretical framework focuses on *nation branding*, which examines how countries develop and manage their international reputation. Simon Anholt is widely credited with coining the term nation branding and remains one of the most influential theorists in the field, being among the first scholars to conceptualise countries as entities whose international reputation can be managed and measured strategically, in a manner analogous to a commercial brand. According to Anholt, the nation brand, built on 6 dimensions: culture, governance, people, tourism, exports, and investment (collectively known as the Nation Brand Hexagon, also introduced by Anholt), directly influences its global attractiveness, economic opportunities, and soft power potential. In this sense, the concept of nation brand is not merely a strategic tool, but an acknowledgment of the fact that, in today's interconnected world, a country's reputation constitutes one of its most valuable and consequential assets.

Among the authors who have further developed the field, Dinnie stands out as one of the most-cited researchers, with his seminal work, Nation Branding: Concepts, Issues, Practice, providing an in-depth theoretical and practical exploration of how states use marketing techniques to manage their international image and reputation. Rojas-Méndez and Khoshnevis (2022) offer a systematic review of the nation branding literature, proposing an integrated conceptual model and clarifying its distinctions from related constructs, such as place branding and public diplomacy. Furthermore, in Branding the Nation: The Global Business of National Identity, Aronczyk (2013) provides a critical perspective on nation branding in political and cultural contexts, examining the interplay among identity, communication, and promotion.

Collectively, these contributions establish nation branding as a structured perceptual framework through which a country's intangible assets, such as culture, values, governance, and people, are consolidated into a coherent international image. Where soft power generates attractiveness as an input, the nation brand represents the perceptual output: the consolidated image through which external audiences evaluate, position, and engage with a country at the international level. This intermediary role of the nation brand is central to the analytical framework of the present study, as it provides the conceptual bridge between soft power-generated attractiveness and its quantifiable economic expression — national brand value.

While the nation brand captures how a country is perceived, national brand value translates those perceptions into measurable economic terms - representing the quantifiable economic expression of a country's reputational capital. Operationalized through Brand Finance's Nation Brands methodology, national brand value integrates three interrelated components: brand strength, which reflects reputational and perception-based factors, such as international familiarity, influence, and prestige; financial performance and market strength, encompassing GDP, exports, tourism, and investment attractiveness; and a royalty relief approach, which translates the reputational capital into a monetary estimate by treating the nation's brand as a licensable asset. Together, these elements produce a monetary estimate of a nation's brand, linking perceptual soft power to measurable economic and strategic outcomes.

Within this context, national brand value emerges as a measurable outcome of perceptions and attraction. A strong reputation and positive associations increase a country's attractiveness for tourism, investment, international students, export demand, and geopolitical influence (Anholt, 2006). Thus, the second pillar of the conceptual framework postulates that perceptions formed by external audiences generate measurable economic and diplomatic outcomes; As reputational capital accumulates, it shapes investment behaviour, trade relations, tourism demand, and international cooperation, outcomes that are typically captured through indices of national brand value and complementary econometric indicators, such as FDI flows, tourist and human capital flows, import-export operations, and so on.

Although soft power and nation branding have traditionally been examined independently, recent scholarship has adopted an increasingly bidimensional perspective, analysing the two constructs in relation to one another and acknowledging their mutual reinforcement in shaping national competitiveness and global attractiveness. Fan (2010) argues that soft power is the essence of a national brand, shaping its global perception. Potter (2009) demonstrates, through case studies, that public diplomacy initiatives—classic instruments of soft power—directly enhance national

reputation and, consequently, economic attractiveness. Szondi (2008) presents an influential model of conceptual convergence in which public diplomacy and national branding share a common goal: building trust, credibility, and long-term international engagement. More recently, Alzowibi (2023) treats national branding as a strategic instrument of soft power, conceptually linking it to the ways countries use symbolism and communication to shape external perceptions and build reputational capital.

Taken together, these studies establish a solid theoretical foundation for understanding the interdependence between soft power and national brand value. However, previous research has addressed this relationship primarily from a conceptual perspective, focusing on public diplomacy and normative appeal rather than empirically measurable outcomes. This study builds on this discourse by explicitly focusing on national brand value and empirically investigating the extent to which soft power generates tangible outcomes at the country level, thereby introducing a new analytical perspective that operationalises soft power in terms of measurable strategic effects.

These theoretical perspectives collectively lay the groundwork for the central hypothesis of this study: a positive relationship exists between a country's soft power and its national brand value. More precisely, if soft power generates attractiveness and reputational capital, and national brand value reflects the quantifiable economic expression of this capital, then a statistically significant positive relationship between the two concepts should be empirically observable. The hypothesis advanced in this study is therefore not only theoretically grounded in the specialised literature on soft power and national branding, but is also methodologically supported by the direct incorporation of soft power data into Brand Finance's methodology for evaluating national brand value.

DATA AND METHODS

This study adopts a mixed-methods research approach, integrating qualitative and quantitative approaches to examine the relationship between soft power and national brand value. The qualitative component supports critical analysis and synthesis of the literature, as well as a comparative analysis of the world's 20 most competitive countries in terms of soft power. The quantitative component focuses on correlation and regression analysis to empirically assess the relationship between the soft power index and national brand value. In addition, GDP is introduced as a control variable in an extended regression model to isolate the independent effect of soft power from differences in countries' economic size.

For the empirical study, the research is based on data from Brand Finance's 2025 Global Soft Power Index. For the empirical analysis, Soft Power and Nation Brand Value data were obtained from the Global Soft Power Index 2025, published by Brand Finance, while 2025 GDP data were collected from Worldometer. The latter source was selected due to the limited availability of cross-country GDP estimates for 2025 at the time of the study. Although both the Global Soft Power Index and Nation Brand Value are published by Brand Finance, the two indicators measure different dimensions. The Global Soft Power Index is based primarily on perceptions of reputation, influence, governance, international relations, culture, education, business, and societal values, whereas Nation Brand Value represents the estimated monetary value of a country's brand. Consequently, the former captures a country's attractiveness and influence, while the latter reflects the economic value associated with its national brand.

The sample consists of the top 20 countries ranked as the most competitive in terms of soft power: the United States, China, the United Kingdom, Japan, Germany, France, Canada, Switzerland, Italy, the United Arab Emirates, Sweden, South Korea, Spain, Australia, the Netherlands, Russia, Norway, Denmark, Belgium, and Saudi Arabia. This sample was selected to focus on countries with high soft-power visibility while maintaining a sample size that allows for meaningful comparative and statistical analysis. All data refer to the year 2025, ensuring temporal consistency between indicators.

Two econometric models were estimated using the ordinary least squares (OLS) method. According to the proposed conceptual framework, Soft Power is treated as an explanatory variable reflecting the attractiveness-based influence of a country, while Brand Value represents the measurable outcome - or the monetary worth of a country's reputation, shaped by its economic performance and global standing. The first model examines the direct relationship between Soft Power and Brand Value:

$$ln(NBV_i) = \alpha + \beta_{1SPi} + \varepsilon_i$$

where:

ln – natural logarhythmic transformation of the dependent variable;

NBV_i – Nation Brand Value of country i;

α – intercept (constant term);

β_1 – coefficient measuring the effect of Soft Power on Nation Brand Value;

SP_i – Soft Power Index score of country *i*;

ε_i – stochastic error term;

i – country included in the sample.

The second model extends this framework by introducing Gross Domestic Product (GDP) as a control variable to isolate the independent contribution of Soft Power from the effect of the economic size of the countries under analysis.

$$ln(NBV_i) = \alpha + \beta_{1SPi} + \beta_{2\backslash ln(GDPi)} + \varepsilon_i$$

where:

ln – natural logarithmic transformation of the dependent variable;

NBV – Nation Brand Value of country *i*;

α – intercept (constant term);

β₁ – coefficient measuring the effect of Soft Power on Nation Brand Value;

SP_i – Soft Power Index score of country *i*;

β₂ – coefficient measuring the effect of GDP on Nation Brand Value;

GDP_i – Gross Domestic Product of country *i*;

ε_i – stochastic error term;

i – country included in the sample.

This approach allows for a more comprehensive understanding of the structural relationship between soft power and national brand value.

Including GDP as a control variable strengthens the methodological robustness of the analysis by accounting for differences in economic size across countries. This allows for a more accurate assessment of Soft Power's independent contribution to national brand value, thereby reducing the risk that the observed relationship is driven solely by a country's economic capacity.

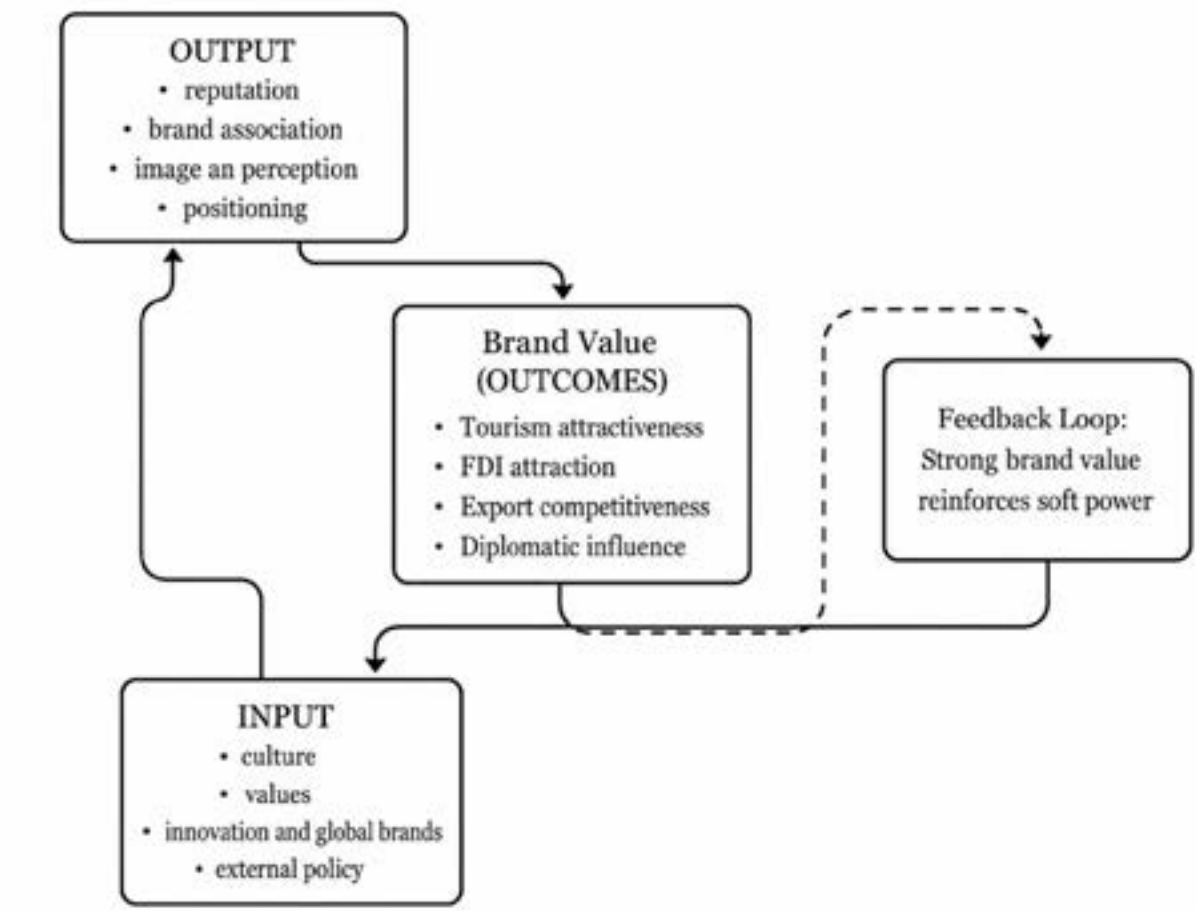
In parallel, the study incorporates a conceptual modelling approach to illustrate the causal logic underlying the empirical analysis. In this framework, soft power is conceptualised as an input composed of intangible resources, such as culture, values, innovation, and foreign policy, while national brand equity is treated as an outcome reflected in measurable economic and strategic indicators, including exports, tourism, and foreign direct investment. This mixed methodological approach allows for a more comprehensive understanding of how attraction-based power translates into tangible national brand outcomes.

MAIN RESULTS

Based on the empirical results, a conceptual model was developed, based on a causal sequence: soft power resources → influence external perceptions → shape the nation's brand image → generate brand value outcomes.

The proposed model explains the interactions observed between perception-based variables, classified by the author as system inputs (culture, values, brands, etc.), and economic performance indicators, which already represent outcomes capitalised through exports, investments, tourist flows, etc. The model is based on interdependence.

Figure 2.
The conceptual model of soft power – nation brand value framework



Source: developed by the author

The author proposes an original conceptual model that illustrates the dynamic relationship between soft power resources, global perceptions, and the resulting national brand value. The model is grounded in two theoretical assumptions drawn from the existing literature: (1) soft power functions as an intangible input shaping a country's attractiveness (Nye, 2004), and (2) nation branding represents the aggregated external perception of these intangible assets (Anholt, 2006; Dinnie, 2022). Building on these foundations, the author argues that national brand value emerges as the quantifiable outcome of this perceptual process, serving as the measurable economic expression of soft-power-generated attractiveness.

Soft power serves as the system's input, sending signals to the world through a country's cultural assets, societal values, capacity for innovation, global brands, and foreign policy behaviour. These signals do not automatically exert influence; rather, their effects emerge through transmission mechanisms such as international communication, media visibility, cultural diffusion, and public diplomacy initiatives. These mechanisms convert latent resources into externally accessible signals.

The output is expressed through global perceptions - reputation, brand associations, national image, and international positioning. This stage reflects how external audiences interpret and internalise the soft-power signals they receive. In this sense, the nation brand functions as a cognitive and emotional construct formed in the mind of the global public.

Once perceptions are consolidated, they produce measurable outcomes in the form of national brand value. These outcomes manifest economically (tourist flows, foreign direct investment, export competitiveness) and strategically (diplomatic influence). Thus, brand value represents the tangible impact of intangible power resources.

The model underpins the study's core hypothesis: a positive relationship exists between a country's soft power and its national brand value. Specifically, it is assumed that countries with higher levels of soft power, reflected in their cultural assets, societal values, innovation capacity, national brands and ambassadors, as well as their foreign policy and relations with other states, generate stronger signals that are perceived favourably by international audiences. These perceptions, in turn, shape the cognitive and emotional components of the national brand, ultimately translating into measurable outcomes such as increased tourist flows, foreign direct investment, export competitiveness, and enhanced diplomatic influence. Accordingly, the hypothesis posits

not only a direct association between soft power and national brand value, but also an indirect mechanism through which intangible resources are transformed into tangible strategic advantages. This formulation aligns closely with the conceptual framework presented in Figure 2.

To validate the hypothesis, the author proposes a correlation-based estimation model to examine the relationship between Soft Power and National Brand Value. More specifically, the analysis combines correlation and regression techniques to assess both the strength and direction of the relationship between the two variables and to determine the extent to which variations in Soft Power are associated with changes in National Brand Value.

To examine the relationship between soft power and nation brand value, an Ordinary Least Squares (OLS) regression model was estimated using data for the top 20 countries included in the Global Soft Power Index 2025.

Given the highly skewed distribution of nation brand values, the dependent variable was transformed using the natural logarithm. This transformation was necessary due to the substantial disparities in nation brand values across the sample, with the United States and China representing dominant outliers, recording brand values of USD 37,328,559 million and USD 20,530,402 million, respectively. In contrast, the remaining countries exhibit considerably lower values. For instance, the United Kingdom, ranked third in the index, records a nation brand value of approximately USD 4,446,486 million, while Denmark and Belgium, ranked 18th and 19th, report values of USD 531,169 million and USD 794,848 million, respectively. The logarithmic transformation reduces the influence of extreme observations, improves the model's statistical properties, and facilitates clearer visualisation and interpretation of the relationship between the variables. The baseline regression model is specified as follows:

$$ln(NBV_i)=\alpha+\beta_{1SPi}+\varepsilon_i$$

where:

NBV_i represents Nation Brand Value;

SP_i denotes the Soft Power Index score;

α is the intercept;

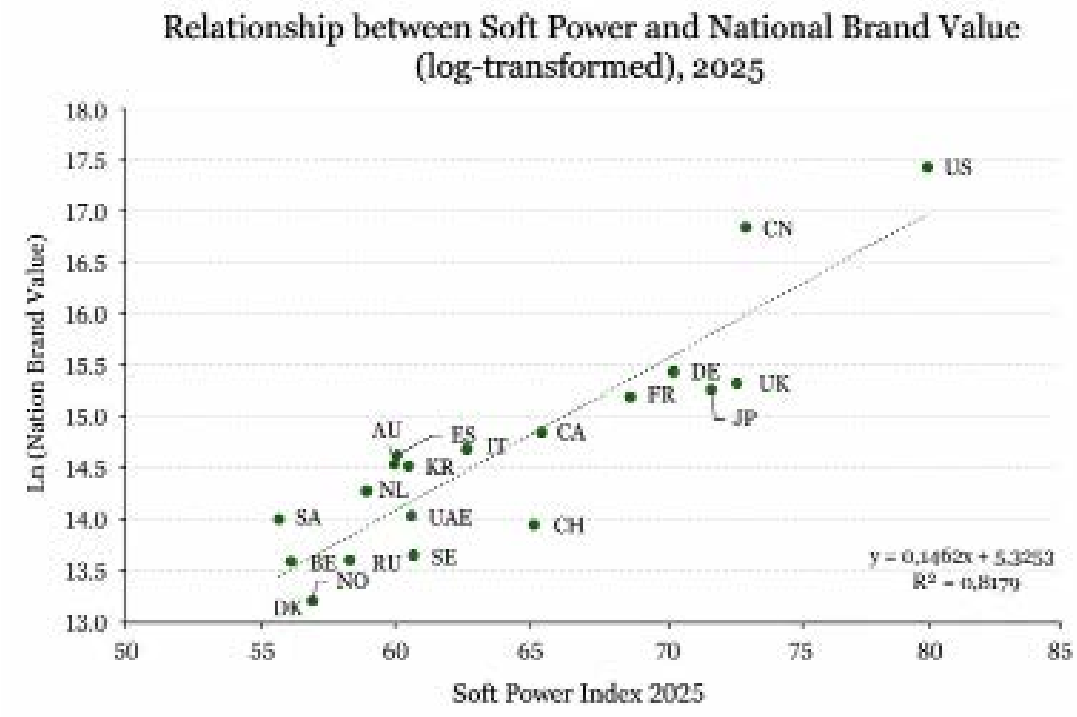
β_1 measures the effect of soft power on nation brand value;

ε_i is the error term.

Figure 1 presents the scatter plot illustrating the relationship between Soft Power and the logarithm of Nation Brand Value:

Figure 1.

Relationship between Soft Power and Nation Brand Value (log-transformed), 2025



Source: Author's calculations based on Brand Finance Global Soft Power Index 2025 and Nation Brand Value 2025.

The scatter plot reveals a strong positive relationship between the two variables. Countries with higher soft power scores generally exhibit higher nation brand values. The fitted trend line shows a clear upward trajectory, indicating that improvements in soft power are associated with higher nation-brand values. This relationship is further supported by the positive coefficient on Soft Power (β = 0.1462), indicating that a one-point increase in the Soft Power Index is associated with an approximately 14.62% increase in Nation Brand Value.

The coefficient of determination ($R^2 = 0.8179$) indicates that approximately 81.8% of the variation in the logarithm of Nation Brand Value can be explained by differences in Soft Power scores. This result demonstrates substantial explanatory power and provides empirical evidence of a strong association between a country's soft power resources and the value of its national brand. The remaining 18.2% of the variation may be attributed to other factors not included in the model, such as economic performance, investment attractiveness, institutional quality, tourism competitiveness, or geopolitical influence.

The findings provide empirical support for the theoretical arguments advanced by Nye (2004) and Anholt (2006), according to which a country's attractiveness, reputation, cultural appeal, and international influence constitute strategic intangible assets capable of generating measurable value. The strong positive association identified in this study suggests that soft power contributes not only to international visibility and influence but also to the economic valuation of national brands. Consequently, soft power may be regarded as an important determinant of a nation's brand value and a strategic resource that enhances a country's position and competitiveness within the international environment.

Although the previous results indicate a strong relationship between Soft Power and Nation Brand Value, larger countries, in economic terms, generally benefit from greater international visibility, stronger economic performance, and higher nation brand values. Consequently, part of the observed relationship may reflect differences in economic size rather than the independent contribution of soft power.

To address this concern, Gross Domestic Product (GDP) was introduced as a control variable in the extended regression model. GDP was selected because it represents one of the most widely used indicators of economic size and overall economic performance. Given the highly skewed distribution of GDP across the countries included in the sample, its natural logarithm was used in the analysis.

The extended regression model is specified as follows:

$$ln(NBV_i)=\alpha+\beta_1\ SP_i+\beta_2\ ln(GDP_i)+\varepsilon_i$$

where:

NBV_i represents Nation Brand Value;

SP_i denotes the Soft Power Index score;

α is the intercept;

β_1 measures the effect of soft power on nation brand value;

ε_i is the error term.

$ln(GDP_i)$ represents the natural logarithm of Gross Domestic Product;

β_2 captures the effect of economic size on nation brand value.

Table 1 presents the results of the multiple regression analysis:

Regression Statistics	
Multiple R	0,96801145
R Square	0,93704616
Adjusted R Square	0,92963983
Standard Error	0,29268167
Observations	20

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	21,675981	10,8379905	126,519574	6,19E-11
Residual	17	1,45626351	0,08566256		
Total	19	23,1322445			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	1,54120194	0,9159753	1,68258024	0,11073087	-0,391337	3,4737409	-0,391337	3,4737409
X Variable 1	0,05190084	0,019314	2,687214	0,01558529	0,01115187	0,09264981	0,01115187	0,09264981
X Variable 2	0,67147338	0,11838449	5,67197106	2,7562E-05	0,42170394	0,92124281	0,42170394	0,92124281

Dependent variable: ln (Nation Brand Value)

Source: *elaborated by the author*

The results indicate that both explanatory variables exert a positive and statistically significant influence on the nation brand value. The coefficient associated with Soft Power ((β = 0.0519), (p = 0.0156)) remains statistically significant after controlling for GDP, suggesting that soft power contributes independently to the development of national brands.

At the same time, GDP exhibits a strong positive effect (β = 0.6715, p < 0.001), confirming the importance of economic size in shaping a nation's brand value.

The explanatory power of the model increases substantially after the inclusion of the control variable, with rising from 0.8179 to 0.9370. This indicates that approximately 93.7% of the variation in nation brand value can be jointly explained by soft power and economic size.

Most importantly, the persistence of a statistically significant Soft Power coefficient after the introduction of the control variable - GDP, demonstrates that the relationship between soft power and national brand value cannot be explained solely by differences in economic size, such that economic scale is insufficient to explain the observed variation in national brand value. In other words, countries do not derive their national brand value solely from their economic capacity but also from their ability to generate trust, admiration, and positive perceptions among tourists, investors, transnational companies, talent, and human capital.

These findings support the argument that soft power should be considered a strategic intangible asset capable of creating measurable value beyond purely economic factors. Accordingly, investments in culture, education, public diplomacy, international cooperation, research and innovation and country brand reputation can enhance a country's brand value even when differences in economic size are taken into account.

CONCLUSIONS

The empirical analysis identifies a strong and statistically significant positive association between Soft Power and National Brand Value for the countries analysed - the top 20 economies according to the SOFT POWER INDEX. The basic model indicates that approximately 81.8% of the variation in the logarithm of National Brand Value is associated with differences in Soft Power scores (= 0.8179). Countries with higher levels of soft power tend, in general, to present more valuable national brands, suggesting a close relationship between attraction-based influence and the economic valuation of national brands, as reflected in country brand value.

To account for differences in economic size, GDP was introduced as a control variable in an extended regression model - the fact that countries with larger and more developed economies would also tend to have higher country brand values, being an obvious one. The results, however, only confirmed and reinforced the results obtained in the first correlation - both GDP and Soft Power remain statistically significant. Most importantly, the Soft Power coefficient remains positive and significant ((β = 0.0519), (p = 0.0156)) after controlling for GDP, while the explanatory power of the model increases substantially (from = 0.8179 to = 0.9370). These findings suggest that the observed relationship between Soft Power and National Brand Value cannot be explained exclusively by differences in economic size and that Soft Power is itself an independent variable whose evolution can be associated with higher national brand values.

The findings provide empirical support for the theoretical arguments advanced by Nye (2004), Anholt (2006), Fan (2010) and subsequent literature on nation branding, according to which a country's attractiveness, reputation, cultural appeal and international influence constitute valuable intangible assets – a hypothesis launched and validated in the Brand Finance Report. The results suggest that countries characterised by stronger reputation-based resources and attractiveness also tend to register higher levels of nation brand value.

From a conceptual perspective, the study supports the proposed framework in which Soft Power represents a source of nation attractiveness, Nation Brand reflects the perceptual dimension of this attractiveness, and Nation Brand Value captures its measurable economic dimension. Although the present analysis does not establish causality, it provides quantitative evidence of a strong relationship between these constructs and helps to bridge the gap between theoretical discussions of Soft Power and empirical research on nation branding.

Some limitations should be acknowledged. The analysis is based on a relatively small sample of twenty countries – the top 20 in the Global Soft Power Index 2025. Therefore, the results should be interpreted with caution and cannot be generalised to all countries. Future research could use larger, more heterogeneous samples, incorporate additional control variables, and employ longitudinal datasets to further examine the relationship between Soft Power, country branding, and broader indicators of national competitiveness and economic performance.

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