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CONTENT

Erica GORGOS	CONCEPTUAL APPROACHES TO SUSTAINABILITY MANAGEMENT IN RENEWABLE ENERGY PROJECTS	**6-13**
Erick Nicolae FURDUESCU	IMPULSE BUYING IN E-COMMERCE: DIGITAL DRIVERS, CONSUMER RESPONSES AND ECONOMIC IMPLICATIONS	**14-22**
Victoria IORDACHI, Rodica PERCIUN, Olga TIMOFEI	ADDRESSING GREENWASHING IN THE AGRI-FOOD SECTOR: INTERNATIONAL PRACTICES, VERIFICATION MECHANISMS AND POLICY RESPONSE	**23-44**
Olusola Enitan OLOWOFELA, Ariyibi Mayowa EBENEZER	BANK STABILIZATION TOOLS, RISK AND PERFORMANCE OF DEPOSIT MONEY BANKS (DMBS) IN NIGERIA	**45-61**
Delia TESELIOS	ANALYSIS AND FORECASTING OF INTERNATIONAL TOURIST FLOWS IN ROMANIA USING THE HOLT- WINTERS METHOD	**62-70**
Alina Georgeta AILINCA, Gabriela Cornelia PICIU	GOOD GOVERNANCE IN A CONCEPTUAL ANALYSIS - ESG AS A TOOL TO ACHIEVE SDGs	**71-79**
Adrian Cosmin BAICU, Constanta POPESCU	THE ROLE OF PRIMARY HEALTHCARE IN ENHANCING MEDICAL SERVICES MANAGEMENT PERFORMANCE WITHIN THE MINISTRY OF INTERNAL AFFAIRS (MAI) UNITS	**80-86**
Iuliu TURCAN, Olga BACA, Alina STRATILA	DIGITAL TRANSFORMATION READINESS OF MOLDOVA'S FOOD INDUSTRY: DEVELOPMENT TRENDS AND EMERGING AI ADOPTION	**87-99**
Mihail CIOBANU	THE COGNITIVE TRAP: HOW SCARCITY MINDSET REPRODUCES AND DEEPENS INCOME INEQUALITY	**100-107**
Mihail CIOBANU, Silvia SAVCENCO	A THEORETICAL EXPLORATION OF THE MULTIDIMENSIONAL REPRESENTATION OF INCOME	**108-115**
Ion CARA	INTEGRATION OF ENVIRONMENT, SOCIAL AND GOVERNANCE RISKS INTO INTERNAL CONTROL SYSTEM OF BANKS	**116-130**
Elena Florentina S. MIRCEA (POPESCU)	THE PRIVATE PATRIMONY OF THE ROMANIAN ACADEMY – SOME LEGAL ASPECTS REGARDING THE COMPLIANCE WITH TESTAMENTARY BEQUESTS	**131-135**

Sebastian George ENE, Mihaela SAVU	ANALYSIS OF THE DEPENDENT VARIABLE INSURANCE PREMIUM IN RELATION TO THE INDEPENDENT VARIABLES IN THE ROMANIAN INSURANCE MARKET	**136-143**
Otilia MANTA	THE CONTAGION EFFECT BETWEEN CRYPTOCURRENCY AND EQUITY MARKETS: EVIDENCE FROM CRISIS PERIODS	**144-161**
Catalin ANDRUS, Lucian IVAN	THE IMPACT OF THE MIDDLE EAST CRISIS ON THE GLOBAL ECONOMY. THE IMPACT ON THE ROMANIAN ECONOMY	**162-168**
Catalina-Elena V. ANDRONACHE (VARTIC), Emilia IORDACHE, Corneliu-George IACOB	CONSIDERATIONS ON THE IMPACT OF THE ENERGY CRISIS ON REGIONAL COMPETITIVENESS	**169-178**
Anemary Alexandra JDERU, Erick Nicolae FURDUESCU	DIGITAL PLATFORMS AND THE ECONOMIC PERFORMANCE OF TOURISM SMES: BETWEEN MARKETING VISIBILITY AND PLATFORM DEPENDENCE	**179-191**
Tatiana IATISIN	SUSTAINABILITY AND INNOVATION AS VECTORS OF ECONOMIC PERFORMANCE IN THE WINE SECTOR IN THE REPUBLIC OF MOLDOVA	**192-204**
Catalina-Elena V. ANDRONACHE (VARTIC), Emilia IORDACHE, Corneliu-George IACOB	THE IMPACT OF MULTIPLE CRISIS ON ECONOMIES IN THE BORDER REGIONS OF THE EUROPEAN UNION	**205-213**
Svetlana ZLATOVA	APPLICABILITY OF THEORIES OF COMPETITIVE ADVANTAGE FOR ENTERPRISES FROM GAGAUZ REGION	**214-229**
Cristina GĂNESCU	PERFORMANCE EVALUATION OF LOGISTICS MANAGEMENT	**230-236**

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CONCEPTUAL APPROACHES TO SUSTAINABILITY MANAGEMENT IN RENEWABLE ENERGY PROJECTS

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Abstract: *This paper analyses the evolution of renewable energy project management, moving from a traditional model focused on technical compliance and productivity toward a modern conceptual approach based on systemic sustainability. In the context of the global climate crisis, the energy transition has become a vital necessity for future generations; however, this study emphasize that the mere substitution of fossil fuels with clean technologies does not implicitly guarantee absolute sustainability. The experience of recent decades reveals that green infrastructure can generate significant negative externalities, including pressure on land use, the intensive consumption of critical raw materials, and potential social conflicts with local communities. The central objective of this research ist o explore the methodological frameworks that allow an energy project to transform from a simple supplier of megawatts into a driver of long-term sustainable development. The analysis focuses on moving beyond the "narrow sustainability", which is centred exclusively on decarbonization, and adopting an integrated perspective that harmonizes economic efficiency with biodiversity protection and social equity. Advanced management tools, such as Life Cyrcle Sustainability Assetments and Multi-Criteria Decision Analysis are evaluated as essential for monitoring multidimensional impacts, from the resources collection phase to decommissioning and recycling. The research highlights that the success of green investments is contingent upon the integration of circular economy principles and ESG criteria directly into the core corporate strategy. By transitioning from linear models to circular flows and securing a "social licence to operate" through transparency and participatory governance, organizations can ensure resilience in an unstable market. The study concludes that sustainability management in the renewables sector now represents the strategic capacity to navigate the tension between technological limits and ethical responsabilities toward future generations, generating shared value and suatainable corporate perfoemance.*

Keywords: *sustainability, renewable energy, sustainability management, renewable energy projects.*
JEL Clasification*: Q01, Q4, Q42.*

1. Introduction

In the current landscape of the global crisis, the transition toward renewable energy sources has ceased to be a mere policy option, envolving into an existential imperative. The accelerated implementation of wind, solar, hydroelectric, and byomass projects represent the central pillar of the strategy to decarbonize the global economy. However, the simple replacement of fossil fuels with clean technologies does not implicitly guarantee absolute sustainability. The experience of recent decades has demonstrated that renewable energy projects can, in turn, generate negative externalities – ranging from pressure on land use and the intensive consumption of critical raw materials to potential conflicts with local community interests.

In this context, sustainability management in renewable energy projects can no longer be viewed as a purely administrative or compliance function; instead, it must be understood as a complex and multidimensional conceptual approach. Modern management must harmoniously integrate technical efficiency and economic viability with biodiversity protection and social equity. This paper aims to analyze the primary conceptual frameworks that allow an energy project to transform from a simple supplier of megawatts into a driver of long-term sustainable development. The central problem of this analysis lies in moving beyond "narrow sustainability" – focused exclusively on CO_2 reduction – and adopting "systemic sustainability". This broader perspective requires the use of advanced tools, such as Life Cycle Sustainability Assessment (LCSA) and Multi-Criteria Decision Analysis (MCDA),

to monitor a project's impact from the design and raw material extraction phases to the eventual decommissioning and recycling of components.

By exploring these approaches, this work seeks to provide a structured vision of how participatory governance and circular economy strategies become critical success factors. The ultimate objective is to demonstrate that the true sustainability of an energy investment is determined by management's ability to navigate the tension between technological constraints and ethical responsabilities toward future generations.

2. Understanding the definition of sustainability

Sustainable development has emerged as a critical framework to mitigate the ecological damage resulting from resource overexploitation, environmental degradation, climate change, and rapid demographic shifts (Damico et al., 2022). With United Nations (2020)[1] projections estimating a 26% increase in the global population – reaching 9.7 bilion by 2050 – the long-term quality of life for future generations is increasingly at risk. Consequently, there is an urgent need to adopt a developmental model that "meets the needs of the present without compromising the ability of future generations to meet their own needs" (Damico et al., 2022), a principle applicable across virtually all academic and professional disciplines.

The term "sustainability" serves as the practical and theoretical application of this developmental philosophy. While the U.S. Environmental Protection Agency (US EPA, 2025)[2] notes that sustainability can be defined through various lenses, its core pillars remain constant: the strategic orchestration of economic growth, environmental stewardship, and social equity (Zwickle et al., 2014).

In contemporary discourse, sustainability has evolved into a ubiquitous paradigm (Msengi et al., 2019). However, it remains a complex and inherently multidisciplinary subject that integrates the environmental social and economic dimensions formally recognized in UN Resolution A/60/1 (2005). Due to its multifaceted nature, it continues to be the most extensively referenced concept in current scientific literature (Damico et al., 2022).

In conclusion, sustainability is no longer a peripheral concern but a foundational imperative for the survival of modern civilization. Given the looming demographic and climatic pressures, the success of this model hinges on our capacity to harmonize the three core pillars: economic growth, social equity, and environmental protection. Ultimately, bridging the gap between theoretical discourse and practical application is the only way to ensure a resilient global future that honors the needs of both current and future generations.

3. Sustainability Management

Sustainability has envolved from a peripheral concept into a central strategic priority for contemporary organizations, driven by constant stakeholder pressure to adopt responsible management practices (Saputra et al., 2021). This management model seeks to satisfy current business needs without compromising essential resources for the future, providing companies with the necessary legitimacy in the eyes of both society and investors. Beyond mere compliance, sustainable management is influenced by factors such as government regulations,

[1] UNITED NATIONS, 2020. Shifting Demographics. *United Nations*. Online. December 2020. Available from: https://www.un.org/en/un75/shifting-demographics

[2] US EPA, 2025. Sustainability | US EPA. *US EPA*. Online. 2025. Available from: https://www.epa.gov/sustainability

cost efficiency, and the need to respond to challenges raised by economic crises, which compel organizations to become more agile and economical (Widayanti et al., 2024).

In the renewable energy sector, these principles translate into startegies that go beyond the simple production of "green" power. Authentic sustainable management in this field involves adopting circular economy practices, ensuring the recycling of infrastructure components (such as photovoltaic panels or wind turbine blades) at the end of their life cycle. Futhermore, the success of clean energy projects depends on harmonious integration into local ecosystems, where protecting biodiversity and maintaining solid community relations become performance indicators as vital as energy yield.

Expansion into new markets or technologies, inclunding green ones, is guided by resources theory, which postulates that specific assets and internal expertise form the foundation of competitive advantage(Montgomery & Hariharan, 1991; Widayanti et al., 2024). When a company possesses specialized resources, the strategic choice tends toward related diversification – a process that becomes particularly vital for family business. For these entities, sustainable management and diversification are essential tools for ensuring business survival and the successful transfer of the legacy to future generations (Bae et al., 2011; Ducassy & Prevot, 2010; Widayanti et al., 2024), allowing for effective navigation through an uncertain economic climate (Chakrabarti et al., 2007; Widayanti et al., 2024).
Ultimately, integrating sustainability into the core corporate strategy acts as a catalyst for innovation and long-term performance (Alameeri et al., 2018). Diversifying activities allows organizations to achieve superior returns from green initiatives, directly impacting overall profitability (Widayanti et al., 2024). Moreover, new generations of managers who focus on sales growth through sustainable solutions succeed not only in increasing current revenues but also in consolidating the company's market value for the future (Kwon et al., 2021).

4. Sustainability management in renewable energy projects

Organizations in the energy sectorthat assimilate environmental management systems directly into their integrated mangement structure demostrates superior corporate performance comparated to operators that treat these procedures as auxiliary. In the context of renewables, green practices are not merely compliance measures but essential mechanisms through which companies adopt groundbreaking technologies tu optimize clean energy production. Through this integration, firms successfully mitigate critical issues generated by their activities – such as biodiversity impact in wind or solar farm areas – thereby bolstering long-term sustainability and business viability in a rapidly shifting market (Abbas, 2020; Ikram et al., 2019; Lăzăroiu et al., 2020; Liu et al., 2019).

To navigate a competitive energy landscape, companies require heterogenerous sustainability proposal adapted to the specific technical and social needs of each region. Traditional business strategies can no longer solely support deep decarbonization goals; an approach that balances economic, environmental, and social requirements is imperative. In this regard, top management engagement and operational governance focused on stakeholder commitment are vital. Implementing green marketing and operational improvement strategies, not only enhances corporate reputation but also significantly reduces costs by optimizing material consumption during the construction phase of energy infrastructure(Ara et al., 2019; Caiado et al., 2019; Lăzăroiu et al., 2020; Ruokonen, 2020; Yildiz Çankaya & Sezen, 2019).

Socially responsible corporate behaviour has direct impact on the economic performance of renewable energy developers. The premise of success resides in the ability of

these organizations to develop low-carbon innovation behaviours, converting environmental limitation into profitability opportunities. Proactive organizations, which integrate the concerns of local communities and inventors into their decision-making processes, manage to navigate the complex dialectic of sustainability more effectively. Thus, low-carbon innovation becomes the bridge between market expansion goals and the urgent need to minimize greenhouse gas emissions across the entire value chain (Brulhart et al., 2019; Lăzăroiu et al., 2020; Nikolaou et al., 2019; Xie & Zhu, 2020).

In modern renewable energy project management, sustainability is treated as a continous flow, from the feasibility phase th decommissioning. A major current challenges is the transition from a linear to a circular model, where project components – such as wind turbine blades or photovoltaic cells – are designed to be reused or recycled at the end of their life cycle. Effective project management prioritizes the selection of suppliers who demonstrate a reduced carbon footprint throughout the logistics chain and opts for high-durability materials. This approach reduces the frequency of maintenance interventions and diminishes technological waste, transforming the ecological vision into a direct economic advantage by lowering operational expenditures.

Sustainability is a decisive factor for the advancement of energy organizations, defining how they connect with and are influenced by their environment. To stabilize their financial position, industry companies place a strong emphasis on resource conservation and the technological efficiency of their assets. Continuous evaluation of the determinants of sustainable performance directly shapes capital investors' decisions. Constructive actions, such as implementing advanced methods for monitoring equipment efficiency, can mitigate the correlation between increasing energy market penetration and the environmental footprint of auxiliary industrial processes (Lăzăroiu et al., 2020; Pislaru et al., 2019; Tsalis et al., 2020; Wani et al., 2021).

The contemporary notion of sustainability addresses the protection of society and the environment for future generations. In the renewable sector, this translates into the deployment of low-carbon breakthroughs by companies of all sizes, triggered by robust corporate ethics. Investments in social and environmental sustainability are not just responses to regulatory requirements but strategic decisions that configure new operational patterns. By assuming social and environmental duties, renewable energy firms enhance their business conditions and create "green" products that satisfy long-term market capitalization goals (Lăzăroiu et al., 2020).

Green energy project management increasingly integrates rigorous ESG criteria to ensure long-term asset resilience. This involves not only protecting biodiversity but also actively managing social risks, such as obtaining a "social license" to operate through constant dialogue with local communities. A sustainable project utilizes digital real-time monitoring technologies to optimize energy yield and transparently report performance indicators. This transparency reduces the risk perceived by creditors, lowers the cost of capital, and protects the company against "greenwashing" allegations by providing factual evidence of positive impact.

To adjust to unstable energy market conditions, companies must integrate economic and social components into their competitive sphere. Organizational transparency and the use of knowledge assets positively influence the degree to which a company reaches its decarbonization potential. Organization that generates and reports complex sustainability data tend to operate more efficiency and are preffered by stakeholders. In a context where rapid

expansion has sometimes led to high resources consumption, the demand for transparent practices has become a gold standard in the green energy industry (Hassan et al., 2020; Lăzăroiu et al., 2020; Ozbekler & Ozturkoglu, 2020; Wu et al., 2019).

Corporate environmental undertakings offer a sustainable competitive advantages by fortifying internal value mechanisms and external infrastructure. Reconfiguring corporate strategy through the lens of environmental protection allows organizations to influence the networks and broader environmental in which they operate. Due to regulatory constraints, conapnies have adopted rigorous carbon governance routines, evidenced by heterogenerous reporting and monitoring approaches. Inter-and intra- organizational preparatory measures in emissions management are now essential to convert eco-innovation into tanagible corporate performance and to reduce global greenhouse gas impact (Amoako, 2019; Lăzăroiu et al., 2020; Madsen, 2020).

5. Conclusions

The transition toward renewable energy sources has ceased to be a mere policy option, envolving into an existential imperative in the face of the global climate crisis. However, as this analysis has demonstrated. The simple replacement of fossil fuels with clean tecnologies does nor implicity gurarantee absolute sustainability. Sustainability management in renewable energy projects must move beyond a purely administrative or compliance function, evolving into a multidimensional conceptual approach that harmoniously integrated technical efficiency and economic vbiability with social equity. The shift from “narrow sustainability” focused exclusively on carbon reduction, toward “systemic sustainability” represents the central pillar of long-term success. This broader perspective requires the use of advanced tools to monitor a project’s impact across its entire life cycle – from the extraction of critical raw materials to eventual decommissioning and recycling.

In tins context, the adoption of circular economy strategies becomes a critical success factor, transforming ecological vision into a direct economic advantage by reducing technological waste and optimizing operational expenditures. The success of green energy investment depends fundamentally on management’s abilities to navigate the tension between technological constraints and ethical responsabilities toward local communities and future generations. Securing a “social license to operate” through participatory governance and radical tarnsparency not only mitigates risks perceived by creditors and investors but also consolidates corporate reputation in a rapidly shifting market.

Ultimately, integrating sustainability into the core of corporate strategy acts as a catalyst for innovation and long-tern financial perfoemance, allowing organizations to convert environmental limitations into opportunities for profitability. By assuming social and envirnmental duties, renewable energy firms do more than just respond to regulatory requirements; they configure new operational patterns that ensure asset resilience and resource conservations. In conclusion, the true sustainability of an energy investment is determined by the ability to harmonize economic growth with biodiversity protection, ensuring a resilient global future that honors the needs of the present without compromising the legacy left to those who follow.

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IMPULSE BUYING IN E-COMMERCE: DIGITAL DRIVERS, CONSUMER RESPONSES AND ECONOMIC IMPLICATIONS

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Abstract: *Online shopping has made the act of buying faster, easier and more present in everyday life. In this context, impulse buying becomes an important topic because many purchases are influenced by what consumers see while browsing, not only by what they planned to buy in advance. This paper examines how electronic commerce can encourage unplanned purchases through platform design, product recommendations, social media signals, limited offers, visual content and simplified payment systems. The study is based on recent scientific literature and official sources, using a qualitative approach. The analysis suggests that impulse buying should not be understood only as a personal weakness or as a simple emotional reaction. It is also connected to the way online platforms organize attention, create urgency and reduce the effort needed to complete a transaction. For companies, these mechanisms can increase sales and customer engagement. For consumers, they may also create pressure to buy quickly, compare less and regret some purchases afterwards. The paper highlights the need to understand impulse buying as both a marketing opportunity and a consumer protection issue.*

Keywords: *digital consumer behavior, impulse buying, electronic commerce, online marketing, consumer decision-making.*
JEL Classification: *M31, D91, L81.*

1. Introduction

In many online shopping situations, browsing does not remain a passive activity, as consumers can end up buying products they had not planned to purchase. This situation is common in e-commerce, because the consumer is constantly exposed to recommendations, discounts, reviews, short videos and simple payment options. The purchase decision becomes faster, and sometimes the distance between interest and payment is reduced to only a few clicks (Anoop and Rahman, 2025; Nyrhinen et al., 2024).

In this context, impulse buying should not be seen only as a moment of weak self-control. The online environment is built in a way that can encourage quick decisions. Product suggestions, targeted advertising, mobile applications, live streaming sessions and limited-time offers all create pressure, curiosity or urgency around products. Therefore, the platform itself becomes part of the buying decision, not just the place where the transaction happens (Escobar-Farfán et al., 2025; Li et al., 2025).

For companies, this behavior can be useful because it may increase sales, improve conversion rates and keep consumers more engaged with the platform. For consumers, however, the same mechanisms can lead to purchases made too quickly, without enough comparison or reflection. This is why online impulse buying has to be discussed from both a marketing and an economic perspective, especially as digital commerce becomes a normal part of everyday consumption (Kathuria and Bakshi, 2025; Bhardwaj et al., 2026).

This paper analyses the main drivers of impulse buying in e-commerce, using recent scientific literature on online consumer behavior, mobile commerce, social media and live streaming commerce. The objective is to identify how technological, social, psychological and marketing factors influence consumer decisions and how these mechanisms may affect firms and consumers (Singh et al., 2023; Li and Deng, 2026).

2. Literature Review and Conceptual Framework

2.1. Digital Consumer Behavior

Digital consumer behavior refers to the way consumers search for information, evaluate alternatives and make purchasing decisions in online environments. Digital commerce changes the buying situation because the consumer is not only searching for products, but is also constantly guided by what the platform displays. Compared with a physical store, the online space brings together product information, advertising, reviews, recommendations and social media influence in the same decision environment. Therefore, the consumer's choice can be shaped before a clear purchase intention is formed (Nyrhinen et al., 2024; Singh et al., 2023).

A key characteristic of digital consumer behavior is that the buying process is no longer linear. Consumers may move from social media to an online store, from a review to a product page, or from a live streaming session directly to checkout. This creates a more fragmented but also more persuasive consumer journey, where purchasing decisions can be influenced at several points. In this context, digital platforms do not only provide access to products, but also organize the way products are displayed, recommended and promoted (Li et al., 2025; Escobar-Farfán et al., 2025).

Another important aspect is personalization. Online platforms collect and use data about consumer preferences, browsing history and previous purchases in order to display more relevant products and advertisements. While personalization can improve the consumer experience, it can also increase the probability of unplanned purchases, especially when consumers are exposed to products that match their interests at the right moment (Nyrhinen et al., 2024; Bhardwaj et al., 2026).

2.2. Impulse Buying in E-commerce

Impulse buying can be understood as a spontaneous and unplanned purchase, usually made with limited reflection. In e-commerce, impulse buying is closely linked to the way the purchase process is organized. A product can be seen, evaluated and bought in a very short time, sometimes without the consumer leaving the same application or page. This makes the decision less separated into clear stages and gives digital platforms a stronger role in transforming attention into purchase (Anoop and Rahman, 2025; Li and Deng, 2026).

Online impulse buying does not usually come from one isolated cause. It appears when consumer related factors, such as emotions, hedonic motivation, self-control or the desire for immediate satisfaction, meet platform related factors, such as discounts, product recommendations, limited-time offers, visual design, social media influence and easy payment options. For this reason, recent studies treat online impulse buying as the result of an interaction between the consumer and the digital shopping environment (Kathuria and Bakshi, 2025; Escobar-Farfán et al., 2025).

Newer forms of digital commerce have strengthened this tendency. In live streaming commerce, the consumer sees the product being presented in real time and can react immediately to the host, the comments of other viewers and the purchase link. In mobile commerce, the buying opportunity is even more accessible, because the consumer can shop almost anywhere and at any moment. Both formats make impulse buying more likely by bringing stimulation and transaction very close to each other (Li et al., 2025; Escobar-Farfán et al., 2025).

From this perspective, impulse buying in e-commerce should be analysed as part of a wider digital consumer behavior process. It is not only the result of individual emotions, but also the result of how platforms combine technology, marketing and social influence. This makes the phenomenon important for companies, because it can support sales growth, but also important for consumers, because it can lead to less rational spending decisions (Anoop and Rahman, 2025; Bhardwaj et al., 2026).

3. Research Methodology

This paper is based on a qualitative and literature-based research approach. The analysis does not use primary data, such as surveys or interviews, but relies on recent scientific articles, books and official sources related to online impulse buying, digital consumer behavior, mobile commerce, social media and live streaming commerce.

The scientific articles used in this paper were selected from recognized academic platforms and publishers, including ScienceDirect, Wiley Online Library, Emerald Insight, Taylor & Francis Online and MDPI. The selected studies were published mainly between 2023 and 2026 and cover different aspects of impulse buying in digital environments, such as targeted advertising, social media influence, mobile commerce, limited-time deals, live streaming and technological factors that affect consumer decisions.

The academic literature was complemented by books on digital marketing and by official sources from international and European institutions. The Organisation for Economic Co-operation and Development, the European Commission and Eurostat were used to place the topic in a broader economic and digital context, especially regarding the development of online shopping, digital markets and consumer conditions.

The main limitation of the methodology is that the paper does not test the phenomenon through primary empirical research. Therefore, the results should be understood as a synthesis and interpretation of existing studies, not as direct statistical evidence collected by the author. However, by combining recent academic literature with official sources, the paper offers a structured perspective on the main factors that explain impulse buying in e-commerce.

4. Drivers of Impulse Buying in E-commerce

4.1. Technological factors

Technology influences impulse buying mainly by making the buying process shorter and less demanding for the consumer. In a physical store, the consumer usually has more time to observe, compare and decide. In e-commerce, the path is more direct: a product appears on the screen, the platform suggests similar products, and the payment can be completed almost immediately. This does not mean that every online purchase is impulsive, but it shows why the digital environment can favour faster and less planned decisions (Anoop and Rahman, 2025; Nyrhinen et al., 2024).

Personalization is one of the clearest examples of this influence. Online platforms do not display products randomly. They use browsing history, previous purchases and consumer preferences to place certain products in front of certain users. This can improve the relevance of what the consumer sees, but it also makes the shopping process less neutral. The consumer is not only searching for products, but is also being guided toward products that the platform considers attractive for him or her (Nyrhinen et al., 2024; Bhardwaj et al., 2026).

Mobile commerce adds another important element. Because the smartphone is always available, shopping is no longer limited to a specific place or moment. A consumer can see an

advertisement on social media, open the product page and complete the purchase during a short break or while travelling. When payment details are already saved in the application, the act of buying becomes even easier, which reduces the time available for reflection (Escobar-Farfán et al., 2025).

4.2. Social and psychological factors

The social side of online shopping is stronger than it may seem at first sight. A product page is rarely just a product page anymore. It usually contains reviews, ratings, comments, reactions, recommendations or links with social media content. These elements can change the way a product is perceived, because the consumer does not judge only the product, but also the visible reactions around it. When many users approve, recommend or discuss a product, the purchase may feel less risky and more justified (Singh et al., 2023; Li and Deng, 2026).

Impulse buying also has an emotional component. Sometimes the consumer is not looking for a product with a precise function, but reacts to what the product suggests at that moment: novelty, pleasure, status, comfort or reward. In e-commerce, this reaction can be intensified by images, short videos, collections, product bundles or entertaining presentations. The attraction created around the product may become more important than a careful evaluation of price, need or long-term usefulness (Kathuria and Bakshi, 2025; Li and Deng, 2026).

Self-control should also be discussed in relation to the environment in which consumers make decisions. Young consumers, for example, do not encounter buying opportunities only when they deliberately enter an online store. They may meet them while scrolling on social media, watching videos, reading comments or receiving targeted advertisements. In such situations, the temptation to buy appears repeatedly and in ordinary moments of online activity. This makes impulse buying less a single isolated act and more a consequence of constant exposure to persuasive digital cues (Nyrhinen et al., 2024).

4.3. Marketing stimuli

Marketing stimuli are among the most visible tools used to encourage impulse buying. Discounts, limited-time offers, flash sales and promotional messages work because they make the consumer feel that delaying the purchase may mean losing an opportunity. This pressure can reduce comparison between alternatives and can make the consumer decide faster than usual. The effect becomes stronger when the promotion is combined with simple payment options and fast delivery (Kathuria and Bakshi, 2025; Bhardwaj et al., 2026).

Live streaming commerce uses a different but very effective logic. The product is not only displayed, but presented in real time, often by a host who explains, demonstrates and reacts to viewers. The comments of other users, the direct purchase link and the idea that the offer is available during the live session can create a stronger feeling of immediacy. In this situation, the consumer is not simply reading product information, but participating in a commercial event (Li et al., 2025).

Visual design also has an influence on impulse buying. The way a product page is built can make the purchase seem simple and natural. Clear images, visible buttons, product suggestions and an easy layout reduce hesitation and guide the consumer toward the next step. Therefore, design should not be seen only as an aesthetic element. In e-commerce, design also

organizes attention and can influence how quickly a consumer moves from interest to purchase (Escobar-Farfán et al., 2025; Bhardwaj et al., 2026).

Taken together, these elements show that impulse buying in e-commerce is not produced by a single isolated factor. It is more often the result of several mechanisms acting at the same time: the platform makes products visible, marketing messages create urgency, social signals increase trust, and payment systems make the transaction easier. What is important is that these mechanisms do not work separately. A consumer may first notice a product through a recommendation, then become more interested after seeing reviews or social media reactions, and finally decide to buy because the offer seems limited or the payment process is very simple. This combination explains why impulse buying in e-commerce should be understood as a process shaped by both consumer reactions and platform strategies. The consumer still makes the final decision, but the digital environment influences the speed, context and emotional intensity of that decision. For this reason, the main drivers can be summarized by connecting each digital trigger with the consumer reaction, the economic effect for firms and the possible risk for consumers (Table no. 1).

Table no. 1 – Mechanisms through which e-commerce platforms stimulate impulse buying

Driver category	Digital trigger	Consumer reaction	Economic effect for firms	Possible consumer risk
Technological factors	Personalized recommendations, targeted advertising and saved payment systems	Faster movement from attention to purchase	Higher conversion rates and lower purchase friction	Less time for reflection before buying
Mobile commerce	Smartphones, mobile applications and permanent access to online stores	Buying becomes possible in ordinary daily moments	More frequent purchasing opportunities	More spontaneous and less planned spending
Social influence	Reviews, ratings, comments, influencer content and social media signals	Products appear more trustworthy, popular or desirable	Stronger engagement and stronger social proof effects	Decisions may rely more on popularity than real need
Psychological factors	Emotional appeal, novelty, pleasure and desire for reward	The consumer evaluates the product more emotionally	Higher probability of unplanned purchases	Post-purchase regret or weak price evaluation
Marketing stimuli	Discounts, limited-time offers, flash sales and live shopping offers	Urgency and fear of missing an opportunity	Short-term sales growth and traffic stimulation	Overconsumption and pressure to buy quickly

Driver category	Digital trigger	Consumer reaction	Economic effect for firms	Possible consumer risk
Platform design	Visual appeal, clear product display and visible purchase buttons	The next step in the buying process becomes easier	Reduced hesitation and faster checkout	Purchases made without enough comparison

Source: Own elaboration based on Anoop and Rahman (2025), Nyrhinen et al. (2024), Li et al. (2025), Escobar-Farfán et al. (2025), Kathuria and Bakshi (2025), Singh et al. (2023), Bhardwaj et al. (2026) and Li and Deng (2026).

5. Results and discussion

The reviewed literature points to one central idea: impulse buying in e-commerce does not usually start with a clear decision to buy. It often begins with exposure. A product appears in front of the consumer through a recommendation, an advertisement, a social media post or a live presentation. After that, other elements may intervene: reviews make the product seem safer, a discount makes the offer seem urgent, and a saved payment method removes the last practical obstacle. The purchase appears spontaneous, but the context around it is carefully organized (Anoop and Rahman, 2025; Nyrhinen et al., 2024; Bhardwaj et al., 2026).

This is why the digital platform cannot be treated as a simple intermediary between seller and buyer. In e-commerce, the platform decides what becomes visible, what is repeated, what is recommended and how quickly the consumer can complete the purchase. The buying decision is therefore influenced not only by the product itself, but also by the route created around it. This idea is consistent with the evolution of digital marketing, where technology is used not only to promote products, but also to shape the entire consumer journey (Kotler et al., 2017; Kotler et al., 2021; Escobar-Farfán et al., 2025).

The expansion of online shopping makes this discussion more concrete. Eurostat indicates that 78% of European Union internet users bought online in 2025, compared with 62% in 2015. This change shows that e-commerce is no longer a marginal channel, but a normal part of consumption. As consumers buy online more often, they also meet more recommendations, visual content, reviews, discounts and quick payment options. Therefore, the mechanisms that can encourage impulse buying are not rare situations anymore, but regular elements of the online shopping experience (Eurostat, 2026).

Social signals also appear as an important result of the analysis. In online shopping, consumers often use the reactions of others to reduce uncertainty. Reviews, ratings, comments and influencer content can make a product seem safer or more attractive before the consumer has analysed it in detail. This does not mean that the decision is completely irrational. Rather, the consumer uses visible approval as a shortcut, especially when there are too many alternatives and little time to compare them carefully (Singh et al., 2023; Li and Deng, 2026).

For firms, these mechanisms have a clear commercial meaning. A platform that obtains attention, reduces hesitation and makes payment simple can turn browsing into purchases more easily. Digital competition is therefore not only about price or product quality, but also about how well a company manages visibility, speed and the user experience. This interpretation fits the broader economic context described by the Organisation for Economic Co-operation and Development, where digital technologies play an increasing role in market development and business models (OECD, 2024).

The same mechanisms, however, raise concerns from the consumer perspective. When purchasing becomes too easy and too fast, comparison may become weaker. A consumer may buy because the offer feels urgent, because the product appears repeatedly, or because payment requires almost no effort. The European Commission reported that 94% of consumers expressed worries about online targeted advertising, especially regarding personal data, profiling and cookies. This concern is important because targeted advertising is one of the same tools that can make impulse buying more effective (European Commission, 2023; Kathuria and Bakshi, 2025).

The main result of the paper is therefore not that e-commerce simply increases impulse buying. The more important result is that digital platforms create a buying environment where attention, emotion, social approval, urgency and payment convenience are brought very close together. This proximity changes the nature of the purchase decision. The consumer still chooses, but the choice is made in an environment designed to make action quick and attractive. For this reason, impulse buying should be seen both as a source of economic value for firms and as a challenge for responsible digital marketing (Anoop and Rahman, 2025; Bhardwaj et al., 2026; OECD, 2024).

Table no. 2 – Synthesized results regarding impulse buying in e-commerce

Main result	Explanation	Economic and marketing meaning	Consumer-related concern
Impulse buying is created by combined mechanisms	Recommendations, reviews, urgency and simple payment often act together	Firms can transform browsing into purchases more efficiently	Consumers may decide before fully evaluating the purchase
Platforms influence the buying route	Product visibility, repetition, recommendations and checkout design shape the decision path	Platform design becomes part of digital marketing strategy	The decision may be guided more by the interface than by real need
Social approval reduces hesitation	Reviews, ratings, comments and influencer content make products appear safer or more desirable	Social proof can increase trust and conversion rates	Popularity may replace careful comparison
Mobile and live shopping increase immediacy	Consumers can buy during ordinary moments or live commercial interactions	Firms gain more touchpoints and faster sales opportunities	Shopping pressure becomes more constant
Firm value and consumer risk coexist	Impulse buying supports sales, engagement and conversion	It creates short-term commercial value	It may also lead to overconsumption, regret or weak price evaluation

Source: Own elaboration based on the analysis of selected scientific literature and official sources.

6. Conclusions

Impulse buying in e-commerce cannot be reduced to the simple idea that consumers buy too fast or without thinking. The analysis developed in this paper shows that the phenomenon is more complex. In many cases, the consumer does not enter the platform with a strong intention to buy, but the buying intention is gradually formed through exposure to products, recommendations, reviews, discounts, visual content and easy payment options. Therefore, impulse buying appears less as a random accident and more as a result of the way the digital shopping environment is organized.

The main conclusion of the paper is that impulse buying in e-commerce is created at the intersection between consumer reaction and platform strategy. The consumer still makes the final decision, but that decision is influenced by what the platform makes visible, how urgent the offer seems, how much trust is created by other users and how easy the payment process becomes. This is why impulse buying should not be treated only as a psychological weakness. It should also be seen as a consequence of digital market design.

The value of this article is that it brings together the consumer side and the platform side of impulse buying. Instead of explaining the phenomenon only through emotions or self-control, the paper shows how consumer reactions are shaped by concrete digital mechanisms, such as recommendation systems, social proof, urgency-based promotions and simplified payment. This perspective is useful because it connects consumer behavior with firm strategy and with the broader functioning of digital markets.

From a business perspective, impulse buying can bring clear advantages. It can increase sales, improve conversion rates and help firms transform simple browsing into actual purchases. However, these advantages should not be interpreted only in the short term. If firms rely too much on pressure, urgency or excessive personalization, consumers may start to feel manipulated rather than assisted. In the long run, trust can become more valuable than a quick transaction.

From the consumer perspective, the problem is not that every impulse purchase is negative. Some spontaneous purchases may bring satisfaction or help consumers discover useful products. The risk appears when the decision becomes too fast, too frequent or too strongly shaped by external stimuli. In such situations, consumers may compare less, spend more emotionally and regret some purchases afterwards. This makes online impulse buying relevant not only for marketing, but also for consumer protection.

The paper also has some limitations. The research is based on secondary sources, so it does not include original survey data, interviews or statistical testing. Future research could examine how different age groups react to impulse buying mechanisms, especially in mobile commerce and live streaming commerce. Another useful direction would be to compare consumers from different countries or to analyse whether transparency tools, such as clearer advertising labels or payment warnings, can reduce excessive impulse buying without eliminating the benefits of digital commerce.

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ADDRESSING GREENWASHING IN THE AGRI-FOOD SECTOR: INTERNATIONAL PRACTICES, VERIFICATION MECHANISMS AND POLICY RESPONSES

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Abstract: *The phenomenon of greenwashing represents an increasingly important challenge for the agri-food sector, amid growing consumer interest in sustainable and environmentally responsible products. This article analyzes the main typologies of misleading environmental claims and the mechanisms through which they can affect market transparency, fair competition and consumer trust. The study includes an analysis of statistical indicators on the credibility of ecological claims, as well as an assessment of the tools used to verify certifications, the sources of information available to consumers and the transparency of the product life cycle. At the same time, relevant international experiences on the prevention and combating of greenwashing practices are examined, with a focus on recent legislative regulations, institutional control mechanisms and legal interventions applied in the agri-food sector. The results highlight the need to strengthen the regulatory framework, independent verification mechanisms and the level of information transparency in sustainability communication. Finally, the article formulates recommendations aimed at adapting international good practices, increasing the responsibility of economic operators, and developing effective tools to prevent greenwashing practices and support the transition to sustainable and credible food systems.*

Keywords: *greenwashing; agri-food sector; environmental claims; sustainability certifications; transparency; public policies.*
JEL Classification: *Q56, Q18, L15.*

1. Introduction

In recent years, sustainability has become a central element of the marketing and communication strategies of companies in the agri-food sector. The increase in public interest in environmental protection and responsible consumption has led to a rapid proliferation of ecological labels and claims applied to food and agricultural products. However, this development has been accompanied by a significant increase in the risk of greenwashing, a phenomenon consisting in the use of ambiguous, incomplete or scientifically unfounded ecological messages, intended to mislead consumers.

International data confirms the scale of this phenomenon and the real difficulties consumers face in interpreting green claims. The European study The Great Green Maze (BEUC, 2023) shows that 56% of respondents believe that there are too many green labels and logos, which makes it difficult to identify the credible ones. At the same time, almost a third of consumers say that they do not feel able to distinguish between real and misleading green claims, and only 3% are convinced that they can always identify greenwashing practices. These results highlight the high level of confusion among the public and the need for clear verification and communication mechanisms.

The complexity of the phenomenon is also amplified by the large volume of information used in sustainability communication. Over 230 sustainability labels are used in the European Union, and research shows that 53% of environmental claims are vague, misleading or unfounded, while 40% of them are not supported by verifiable evidence (European Commission, 2020). Furthermore, about half of green labels do not provide clear verification mechanisms, which limits the ability of consumers to correctly assess the real environmental impact of products (European Court of Auditors, 2023).

In the agri-food sector, the implications of this phenomenon are particularly relevant, as products are frequently associated with terms such as “natural”, “eco”, “bio” or “carbon neutral”, which can create misleading perceptions if not supported by transparent and standardised criteria. According to EU market monitoring, over 40% of food products labeled as "natural" contain at least one synthetic ingredient or have undergone high levels of industrial processing that contradicts the consumer's understanding of the term (BEUC, 2020).

A recent analysis of "carbon-neutral" food claims found that 80% of these products rely solely on carbon offsets (planting trees elsewhere) rather than actually reducing emissions within their own supply chain (BEUC, 2020).

Studies show that although almost half of consumers (48%) prefer products that carry an eco-label, and two out of five are willing to pay more for certified products, the level of understanding of the concepts used remains limited (BEUC, 2020). For example, a significant proportion of consumers misinterpret the term “carbon neutral”, assuming that it implies the total absence of emissions, while in reality most products labelled as such compensate for emissions, without completely eliminating them.

These trends highlight a clear contradiction between consumers' intention to make responsible choices and their actual ability to correctly evaluate the information available. Although around 70% of consumers say they trust public authorities and independent bodies to verify environmental claims, only 25% frequently seek additional information about the environmental impact of products, which underlines the essential role of regulations and international standards (BEUC, 2020).

In this context, the analysis of international experience becomes essential for identifying effective tools to combat greenwashing, especially in the agri-food sector, where information transparency and the credibility of certifications directly influence consumer trust and producers’ competitiveness. Studies and practices implemented in different jurisdictions demonstrate that approaches based on clear standards, independent verification and legal accountability can significantly reduce the use of misleading claims and contribute to the consolidation of sustainable markets.

Based on these realities, this article aims to analyze relevant lessons from international experience in combating greenwashing in the agri-food sector and to highlight tools that can support the development of transparent and credible sustainability communication systems. The focus is on identifying good practices, verification mechanisms and institutional frameworks that contribute to protecting consumers and promoting fair competition in the agri-food sector.

2. Literature review

The literature on greenwashing in the agri-food sector has grown significantly in recent years. A recent bibliometric study by Nugraha et al. (2024) analyzed over 711 articles from the Scopus database, highlighting that academic interest in this phenomenon has increased

dramatically over the past decade (Nugraha et al., 2024). However, although greenwashing is a well-established phenomenon in the food industry and an emerging concern among consumers, studies specifically dedicated to this sector remain relatively few – the same research identifying only 16 articles that met the inclusion criteria for the systematic review (Nugraha et al., 2024).

The literature defines greenwashing as the misleading or superficial communication of environmental actions that do not bring real ecological benefits (Montero-Navarro, 2021; Sciortino et al., 2025). In the agri-food sector, this phenomenon has evolved from outright false claims to more subtle practices based on ambiguity, selective data and scientifically unverifiable marketing.

A 2024 systematic review analyses 16 key papers from 711 Scopus articles, highlighting factors such as advertising, transparency, labelling and consumer trust. Major subthemes include retailers, supply chains and stakeholder engagement (Montero-Navarro, 2021).

The behavioral dimension of the greenwashing phenomenon in the agri-food sector is also highlighted by a series of empirical studies that analyze how consumers perceive and interpret ecological claims associated with food products. A relevant example in this regard is the study conducted by Grinberga-Zalite et al. (2025), which investigates consumers' perceptions of sustainability claims and potentially misleading messages associated with local agri-food products. The research results highlight the fact that consumers' perception of the credibility of ecological claims is significantly influenced by their level of education, level of information and socio-economic characteristics. The study shows that people with a higher level of education demonstrate a greater capacity for critical evaluation of the information presented on labels and in promotional materials, being less susceptible to the influence of vague or insufficiently substantiated claims. At the same time, income and the level of awareness of environmental issues determine a greater predisposition to choose local products perceived as more sustainable (Grinberga-Zalite et al., 2025).

The literature review highlights the existence of three major types of greenwashing practices in the agri-food sector.

First, general claims about environmental impact are common, which are not supported by concrete evidence. This category includes the use of terms such as “green”, “natural”, “sustainable”, “environmentally friendly” or “climate neutral”, without providing clear explanations or verifiable data to justify these claims (Tzoula, 2026). According to Directive (EU) 2024/825, such claims are considered “generic” when they are not associated with an officially recognised sustainability label or are not accompanied by specific explanatory details.

Second, the literature indicates the existence of certification and assurance schemes that can mislead consumers. Examples documented in the United Kingdom show that certain agricultural certification schemes can suggest a high level of environmental protection, although the actual certification requirements do not confirm these standards. A relevant case is the Red Tractor scheme, which includes approximately 45,000 British farms and which was assessed by the Advertising Standards Authority as potentially misleading, because it created the impression of the existence of ecological standards that were not supported by the results of the inspections carried out (River action, 2024).

Thirdly, misleading claims regarding the origin of products and production methods are identified. In the United States, several disputes have concerned marketing campaigns that

promote the image of small, traditional or pastoral farms, while in reality hiding industrial-scale production processes. A relevant example is the Tillamook case, in the state of Oregon, where it was claimed that promotional materials presented an idealized image of dairy farms, while production was carried out in industrial units of the CAFO (concentrated animal feeding operations) type, associated with significant environmental impacts (Pardo, 2019).

In recent literature, concerns about identifying and preventing greenwashing practices in the agri-food sector have led to the development of increasingly sophisticated tools and methodological frameworks. Recent studies highlight that detecting misleading claims is no longer limited to analyzing the textual content of labels, but involves the use of digital technologies, analytical methods and interdisciplinary approaches.

For example, research by Nicolau and Petcu (2026) proposes an integrated model based on the use of blockchain, Internet of Things (IoT) and artificial intelligence technologies, designed to verify the veracity of ecological claims in the agri-food sector. The authors develop a mathematical index for verifying sustainability claims ("Green Claim Veracity Index"), which allows assessing the coherence between the information communicated to consumers and the actual data on product traceability (Nicolau and Petcu, 2026). This approach highlights the potential of digital technologies in increasing the transparency of agri-food chains and in reducing the risk of misleading communication.

At a conceptual and normative level, the study by Sgroi et al. (2025) analyses the European policy framework and the Italian context, demonstrating that clear regulations on the labelling and communication of environmental claims can significantly contribute to reducing greenwashing practices (Sciortino et al., 2025). The authors underline the importance of harmonising the legislative framework with effective monitoring and sanctioning mechanisms, as well as the need to involve public institutions in the verification of sustainability claims.

A relevant contribution to the systematization of methods for identifying greenwashing is provided by Nugraha et al. (2024), who carry out a systematic analysis of over 700 articles indexed in international databases. The results of the study highlight the decisive role of information transparency, label clarity and independent verification in preventing misleading communication (Nugraha et al, 2024). The authors also propose a series of practical measures, such as standardizing information on environmental impact and strengthening certification systems.

From the perspective of the evolution of the field, the bibliometric analysis carried out by Montero-Navarro et al. (2021) shows that research on greenwashing has developed significantly in recent decades, highlighting three main areas of interest: corporate social responsibility, marketing strategies and sustainability auditing (Montero-Navarro A., et al. 2021). The study emphasizes the need to integrate verification and auditing mechanisms into sustainability communication processes, to prevent distortion of the information presented to consumers.

In recent years, the literature increasingly highlights the use of innovative technological tools to detect greenwashing in packaging and visual communication. Fuentes et al. (2021) propose the use of eye-tracking and biometric technologies to analyze consumer reactions to visual elements of packaging, demonstrating that certain symbols, colors or expressions can influence the perception of the greenness of products. Similarly, Gonzalez Viejo et al. (2022) explore the use of smart technologies and sensors to authenticate packaging and verify

sustainability claims, providing a methodological basis for the objective evaluation of green communication.

Overall, the literature highlights that effectively identifying greenwashing practices requires an integrated approach, combining technological tools, independent verification mechanisms and clear communication standards. These developments demonstrate that detecting greenwashing is not only a regulatory challenge, but also an emerging area of methodological innovation, with direct implications for the credibility of the agri-food market and consumer trust.

3. Practical frameworks and consumer-oriented tools for detecting greenwashing in the agri-food sector

3.1. Key warning signs and visual indicators of greenwashing

European consumers' perceptions of green claims reflect a high level of interest in environmental protection, but also an increase in uncertainty about the credibility of green labels. Recent studies highlight that, although consumers show significant concerns about climate change and adopt sustainability-oriented behaviors, they have difficulties in identifying authentic claims and show a low level of trust in existing verification mechanisms. The main results on consumer perceptions are summarized in Table 1.

Table 1. European consumers' perception of environmental claims

Indicator	Survey result	Interpretation
Consumers feeling anxious about climate change	54%	▪ Reflects high sensitivity to environmental issues and openness to sustainable products
Consumers striving for an environmentally friendly lifestyle	79%	▪ Indicates a clear trend towards responsible consumption
Consumers buying products with eco-labels	48%	▪ Confirms the major role of labels in the purchasing decision
Consumers who believe there are too many green labels	56%	▪ Highlights the risk of confusion generated by the proliferation of labels
Consumers who believe polluting companies should not use green claims	75%	▪ Reflects high expectations for corporate responsibility
Consumers with little or no information about the criteria for ecological claims	66%	▪ Indicates the existence of a major information deficit
Consumers who believe that green claims are verified by authorities	35%	▪ Suggests a low level of trust in control mechanisms

Source: adaptated by authors based on (BEUC, 2020).

At the same time, the high diversity of certification schemes contributes to the fragmentation of the labelling system and to increased confusion among consumers. Studies show that around half of the existing green labels do not offer clear mechanisms for independent verification or certification, which reduces the credibility of product sustainability messages (BEUC, 2020). Furthermore, over 230 sustainability labels are used in the European Union, which creates a complex and difficult-to-interpret information

environment for consumers, favoring the emergence of misperceptions and misleading communication practices (European Commission, 2020; OECD, 2011). Overall, these data highlight that the lack of standardization and uniform verification mechanisms contributes to maintaining a high level of uncertainty among consumers and facilitates the proliferation of greenwashing practices.

Overall, the data presented highlights a combination of increased consumer interest in sustainability and high levels of confusion generated by the proliferation of eco-labels.

Thus, greenwashing often occurs when sustainability is communicated at a declarative level rather than demonstrated by verifiable data. In practice, sustainability becomes apparent when the information provided to consumers is incomplete, difficult to verify or selectively presented, which limits their ability to distinguish between real environmental performance and marketing strategies. This problem is amplified by the lack of standardized reporting mechanisms, the insufficiency of independent auditing and the proliferation of sustainability labels.

From the perspective of the agri-food chain, apparent sustainability can be identified at several stages of economic activity, including production practices, climate impact assessment, formal compliance with regulations and communication to consumers.

The main manifestations of apparent sustainability and the mechanisms associated with greenwashing practices are summarized in Table 2.

Table 2. Typologies of apparent sustainability and mechanisms associated with greenwashing practices

Domain	Typology of apparent sustainability	Mechanisms that facilitate greenwashing practices	Implications for the credibility of environmental performance
Production practices	Situations where actual production practices are partially hidden or selectively communicated	➢ Promoting the "green" nature of products while ignoring the impact on soil and water resources; ➢ Use of resource-intensive inputs without transparency regarding quantities used, provenance or environmental footprint; ➢ Lack of documented evidence demonstrating measurable reductions in environmental impact.	➢ Creates an incomplete representation of environmental performance and can mislead stakeholders about the true level of sustainability; ➢ Limits traceability and reduces the possibility of verifying real improvements in environmental performance; ➢ Leads to poorly substantiated sustainability claims and reduces the level of trust in environmental reporting.
Climate impact	Situations where climate performance is declared without a full and integrated assessment	➢ Mentioning emissions without calculating, monitoring and reporting them according to standardised methodologies; ➢ Excluding relevant stages such as production, processing, storage and distribution from environmental data reporting; ➢ Avoiding long-term accountability and lack of climate impact reduction strategies.	➢ Causes underestimation of real environmental pressures and affects the climate responsibility of organizations; ➢ Produces fragmented life cycle information and prevents complete assessment of environmental impacts; ➢ Favours short-term communication strategies at the expense of real structural transformations.

Regulation and control	Situations where compliance is formal and does not reflect real performance	➢ Minimal compliance with legal requirements without implementation of measures aimed at environmental performance; ➢ Lack of independent audit and insufficient traceability mechanisms; ➢ Absence of independent verification mechanisms or third-party certification.	➢ Creates apparent compliance without significant environmental results; ➢ Reduces the credibility of environmental claims and facilitates the perpetuation of deceptive practices; ➢ Weakens institutional control and allows for the maintenance of claims that are difficult to verify.
Consumer	Situations where consumers are exposed to incomplete or ambiguous information on sustainability	➢ Use of "green" labels without clear explanations of the methodology or criteria used; ➢ Use of emotionally charged messages without presentation of verifiable data; ➢ Difficulty distinguishing between marketing communication and scientifically supported claims.	➢ Increases consumer confusion and reduces their ability to identify credible claims; ➢ Encourages decision-making based on perceptions rather than objective information; ➢ Reduces consumer trust and increases their vulnerability to misleading information.

Source: elaborated by authors.

Table 2 highlights that greenwashing can occur simultaneously at the level of production, climate reporting, institutional compliance and consumer communication. Therefore, the ability of consumers to recognize ambiguous, insufficiently substantiated or unverifiable environmental claims becomes an important element in limiting the effects of these practices and supporting informed consumer behavior.

3.2. Methodological framework for verifying and validating sustainability claims

In the context of the increasing complexity of sustainability messages used in commercial communication, it becomes essential ***to develop systematic evaluation frameworks that allow the identification of credible claims and their differentiation from greenwashing practices.*** The specialized literature emphasizes that the effective evaluation of ecological claims must be based on a set of key questions (see Figure 1) that target the transparency of the actors involved, the nature of the information presented, the methods used to support the claims and the real extent of the environmental benefits (Delmas and Burbano, 2011; Lyon and Montgomery, 2015; OECD, 2011).

WHO?

1. Is the company transparent about its supply chain?
2. Is there an independently verified sustainability report?

WHAT?

3. Is the information specific or vague? Is it relevant to the product?
4. is there clear and accessible evidence supporting the claim (studies, audits, certifications)?

HOW?

5. Is it clearly explained why the product is considered environmentally friendly?
6. Does it describe the product's impact from production to disposal?
7. Is there information about possible hidden negative effects?

HOW MUCH? **8.** How significant is the actual environmental benefit?

Figure 1. Practical framework for identifying potential greenwashing through sustainability claim evaluation

Source: Adapted by the authors based on Delmas & Burbano (2011); Lyon and Montgomery (2015); OECD (2011); European Commission (2020, 2023).

Overall, the use of an assessment framework based on the dimensions of "who, what, how and how much" contributes to the development of a critical and systematic approach to the analysis of environmental claims, facilitating the identification of potentially misleading practices and strengthening the capacity of consumers and other relevant actors to make informed decisions. This approach represents an important step in reducing vulnerability to greenwashing and in promoting transparent and responsible communication on environmental performance.

After evaluating the content and communication of ecological claims, ***verifying the credibility of the issuing company is a fundamental step in analyzing their authenticity.***

In this sense, credible companies are characterized by the availability of clear and accessible information on sustainability policies, supply chains, emissions levels and production processes used.

The publication of independently verified sustainability reports, as well as the use of internationally recognized certifications - for example, EU Ecolabel, FSC, Fairtrade or Carbon Trust - contribute to strengthening trust in the veracity of the claims communicated. At the same time, the analysis of the company's reputation is an important element in identifying the risks associated with greenwashing practices.

The existence of previous sanctions for misleading advertising, involvement in environmental impact controversies or the formulation of ambitious commitments without clear implementation plans can be warning signs of a lack of consistency in sustainability policies.

At the same time, the degree of specialization of the company in the field in which it makes environmental claims should also be assessed in relation to its main activity, since discrepancies between the business model and marketing messages may indicate the use of isolated initiatives with a predominantly reputational purpose.

Overall, the assessment of transparency, independent verification, organizational reputation and coherence of business activities provides an integrated framework for analyzing company credibility and identifying potential greenwashing practices.

These elements contribute to the development of a systematic approach to verifying sustainability claims and support informed decision-making by consumers and other actors involved in the value chain.

In addition to analyzing the company's credibility, ***identifying visual signals and techniques frequently used in greenwashing*** is an essential step in assessing the authenticity of green claims.

Thus, greenwashing techniques are often based on omitting essential information, selectively communicating favorable aspects, and lacking verifiable data or independent certifications (European Commission, 2024). In many cases, companies use minor features as

evidence of overall sustainability, creating a false impression of the actual environmental impact.

In parallel, certain visual elements can mislead consumers, such as the use of colors associated with nature, bucolic images, or proprietary symbols that mimic official certifications. Rustic, opaque packaging or labels with vague terms such as “eco”, “organic” or “natural” without clear and verifiable justifications contribute to reinforcing the perception of sustainability, even in the absence of real evidence (International Organization for Standardization, 2018).

To illustrate how visual cues and vague language can contribute to misperceptions regarding sustainability, the literature provides numerous relevant examples of internationally documented greenwashing practices.

A relevant example from the agri-food sector is associated with the company Danone, which has been involved in several controversies related to claims considered misleading regarding the characteristics of its products. The company has been involved in litigation over sustainability claims, including the use of terms such as “carbon neutral” or statements about the recyclability of packaging. Some legal actions have argued that such wording can be ambiguously interpreted by consumers and create the impression of a lower environmental impact than is actually the case, highlighting the importance of using clear, verifiable claims supported by transparent methodologies (Watson, 2024).

A common form of greenwashing in the agri-food sector is greenlighting, which consists of selectively highlighting positive aspects, while significant negative impacts are omitted or minimized in communication to consumers.

In the agri-food sector, this practice is often manifested by the use of suggestive images, such as traditional farms, green pastures or free-range animals, which create the perception of sustainable production. However, in the absence of complete information on the supply chain, greenhouse gas emissions or packaging materials, such visual representations can mislead consumers. Highlighting isolated initiatives or minor features, without a clear strategy to reduce environmental impact, can reinforce an artificially positive image, contributing to erroneous perceptions of the sustainability of agri-food products.

In addition to selective communication of information, greenwashing is frequently manifested by ***the use of general and ambitious claims that are not supported by clear evidence or measurable indicators***.

Table 3. Typical forms of vague or exaggerated environmental claims in the agri-food sector

Statement Category	Typical Examples of Expression	Main limitation	Verification sources and assessment methods
Absolute claims regarding impact	"Zero emissions", "Zero environmental impact", "100% planet friendly"	Unrealistic claims, as any product generates environmental impact	Verifying the company's sustainability reports, analyzing emission calculation methodologies (e.g. GHG Protocol), consulting independent certifications
Future commitments without a clear plan	“We will become climate neutral by 2030”	Lack of concrete steps and progress indicators	Consulting published climate strategies,

			checking for interim targets, analyzing annually reported progress
Biodegradability claims	"100% biodegradable", "Eco-friendly packaging"	Biodegradation depends on specific conditions (e.g. industrial compost)	Check applicable standards (e.g. EN 13432), analyze degradation conditions indicated on packaging, consult official certifications
Claims of exceptional performance	"Reduces pollution by 80%", "Purifies natural air"	Lack of independent testing or clear methodologies	Verifying tests conducted by independent bodies, analyzing available technical data
Use of generic terms	"Natural", "Eco", "Sustainable"	Vaguely defined terms used without measurable criteria	Check for recognized certifications, analyze definitions used, consult official labels or public databases

Source: developed by the authors based on legislative database of European Commission, OECD, ISO.

For the assessment of ecological claims to be rigorous, it is not enough to identify vague formulations or suggestive visual elements, but it is also necessary to locate concrete sources of information that allow their verification.

In the agri-food sector, the credibility of environmental claims can be analyzed by reporting to several categories of sources, each offering a distinct level of detail and validation.

A first level of verification is represented by the ***product packaging***, which is often the most accessible initial source of information for consumers. The packaging can provide important clues regarding the presence of recognized official labels, such as the EU Ecolabel, FSC or Fairtrade, but also information regarding the composition of the materials used, the applicable standards or the existence of QR codes and links to additional details (Perciun, R., et al., 2025). In this sense, the packaging should not be seen only as a marketing tool, but also as a preliminary information support for the evaluation of sustainability claims. However, the verification should not stop at the information on the label.

A second important level is provided by the ***official websites of manufacturers*** and the sustainability reports published by them. These sources allow for a more in-depth analysis of environmental commitments, by consulting the sections dedicated to sustainability, environmental responsibility or ESG reporting. Here too, the methodologies used to justify the claims can be identified, including references to Life Cycle Assessment (LCA) analyses, as well as measurable indicators relating to emission reduction, resource efficiency or waste management. Therefore, the company website can provide a higher level of transparency, provided that the information presented is clear, up-to-date and verifiable.

Furthermore, in order to avoid exclusive dependence on the information provided by the company itself, it becomes necessary to consult ***external and independent sources***. In this context, the databases of certification bodies play an essential role in validating the authenticity of the certifications invoked. They allow for confirmation of the real existence of

the certification, identification of the exact scope and verification of its validity period. Such verification is particularly important in situations where symbols, logos or statements appear on the packaging that may suggest the existence of certification, without this being clearly demonstrated.

Finally, for a more in-depth assessment, especially in the case of complex or controversial claims, it is useful to refer to ***scientific publications and the relevant regulatory framework***. Scientific studies can provide information on the actual environmental impact, calculation methodologies and comparisons between different types of products or materials, while regulations allow for the assessment of the compliance of claims with applicable standards and legal requirements. The combined analysis of scientific evidence and regulatory sources helps to distinguish between objectively supported claims and those that are mainly based on general formulations or communication strategies.

Continuing the analysis of sources of verification of ecological claims, ***it becomes necessary to assess the degree of transparency throughout the product's life cycle***, as sustainability cannot be assessed exclusively based on a single stage in the production chain.

In this sense, ***Life Cycle Assessment (LCA)*** is an essential tool for identifying stages with significant impact and for assessing the credibility of environmental claims (Perciun, R., et al., 2025).

The first relevant stage is ***the production of raw materials***, where information on the origin of ingredients and their traceability becomes essential. The assessment of this stage involves analysing the country of origin, the type of farm and the way in which natural resources are managed. In particular, the impact of agriculture on the environment can be influenced by water consumption, the use of pesticides and fertilisers, as well as soil degradation. At the same time, working conditions on farms and compliance with social standards are relevant indicators of sustainability, and emissions generated during the extraction, cultivation or primary processing stage must be systematically analysed.

Further down the production chain, ***industrial processes*** represent a critical stage, characterised by significant energy and resource consumption. At this stage, the sustainability assessment must include an analysis of the energy source used, in particular the differentiation between renewable sources and fossil fuels. It is also important to examine the amount and type of waste generated, the total water consumption and the effectiveness of measures to reduce it. The use of chemicals in processing, refining or preservation can introduce additional risks to the environment and health, which is why transparency regarding these practices is essential.

Another relevant element in assessing the environmental impact is ***the transport of products***, which contributes significantly to greenhouse gas emissions. At this stage, the distance traveled to the consumer must be analyzed, including the origin of the raw materials and the distribution of the final product. The mode of transport used directly influences the level of emissions, with air transport being considered the most polluting, while maritime and rail transport are generally more energy efficient. The evaluation of emissions associated with the logistics phase can be carried out by consulting CO_2 emission estimates or calculations integrated into the life cycle analysis.

In the product use phase, sustainability is influenced by the additional ***resources required***, such as water or energy consumption, but also by the actual duration of use of the product. A product that requires significant resources during use or that has a short lifespan may generate a higher cumulative impact than one that appears less sustainable at the

production level. In this sense, the analysis of the actual lifespan and the point at which the product becomes waste contributes to a more realistic assessment of the environmental impact.

The last stage of the life cycle is represented by ***the management of the product at the end of use***, where the actual capacity for recycling, reuse or composting becomes decisive. It is important to analyze the actual rate of collection and sorting of materials, as well as the existence of the necessary infrastructure for recycling. Similarly, claims regarding biodegradability or compostability must be evaluated in relation to the actual conditions in which these processes take place, since many materials considered biodegradable require specific industrial conditions. The alternative scenario, namely how the product is managed when not recycled, must also be analyzed.

When consumers or evaluators suspect a case of greenwashing, the initial reaction should not be passive, but oriented towards verification and documentation. Consumer involvement in reporting such situations plays an important role in strengthening market protection mechanisms. At European level, numerous complaints about misleading environmental claims are reported annually, highlighting the growing awareness of greenwashing practices. According to the results of a Eurobarometer survey conducted by the European Commission, around 42% of European consumers said they had encountered environmental claims or labels that they considered misleading or difficult to verify in recent years (Perciun et al., 2025). This percentage underlines the need to strengthen verification tools and reporting mechanisms.

4. International regulatory and enforcement approaches to greenwashing in the agri-food sector

Building on the identification, verification and reporting mechanisms discussed in the previous sections, it becomes necessary to examine how international regulatory frameworks and enforcement mechanisms address greenwashing practices in the agri-food sector. Given the diversity and increasing sophistication of greenwashing strategies identified in recent years, legislative intervention at the European level has become essential to protect consumers and ensure transparency in the market.

In this context, the European Union has introduced a set of specific regulatory instruments addressing environmental claims, particularly through Directive (EU) 2024/825 on empowering consumers for the green transition and the proposed Green Claims Directive. These instruments aim to limit the use of misleading environmental statements and strengthen the credibility and comparability of sustainability-related information provided to consumers (European Commission, 2024a; European Commission, 2023a).

The Directive introduces several important provisions regarding the way in which economic operators can use environmental claims (European Commission, 2024b).

1. First, the Directive restricts the use of general environmental claims unless they are supported by verifiable evidence demonstrating recognised excellent environmental performance relevant to the specific claim. Generic expressions such as "green", "non-toxic", "eco-friendly" or "sustainable" are permitted only when accompanied by clear, specific and substantiated explanations provided within the same communication medium.

2. Second, strict requirements are introduced regarding the use of sustainability labels (European Commission, 2023b). Under the new regulatory framework, sustainability labels are considered valid only when issued by public authorities or independent certification

bodies operating under recognised certification schemes. The introduction of private sustainability labels that are not based on transparent and verifiable certification systems is restricted, with the objective of preventing the proliferation of misleading or unverifiable eco-labels.

3. Third, the Directive establishes clear rules for environmental claims related to future commitments. Statements referring to future environmental performance must be supported by a detailed implementation plan including measurable, time-bound and publicly accessible objectives. Moreover, progress towards achieving these objectives must be regularly verified by independent third-party auditors to ensure accountability and transparency (European Commission, 2023a).

Beyond regulatory requirements, enforcement mechanisms play a crucial role in ensuring compliance with environmental claim regulations. Under the European framework, national consumer protection authorities are responsible for investigating misleading claims and applying corrective measures. These measures may include financial penalties, mandatory correction of misleading information, withdrawal of non-compliant products from the market, or public disclosure of violations. The strengthening of enforcement mechanisms reflects the growing recognition that regulatory provisions must be accompanied by effective monitoring and sanctioning systems to achieve tangible results.

Overall, the evolution of the European regulatory framework reflects an increasing institutional commitment to limit greenwashing practices and strengthen consumer trust in sustainability-related information. Recent legislative developments emphasize the importance of clarity, verifiability and accountability in environmental communication, particularly in relation to sustainability labels and future environmental commitments (see Table 4).

Table 4. Recent legislative developments addressing greenwashing and environmental claims in the European Union

Legislative instrument	Year	Key provisions relevant to greenwashing	Relevance for the agri-food sector
Directive (EU) 2024/825 – Empowering Consumers for the Green Transition	2024	Prohibits misleading environmental claims; restricts generic terms such as "eco" or "green" without substantiation; strengthens consumer protection against deceptive sustainability communication	Ensures that environmental claims related to food origin, sustainability and packaging are clear, verifiable and evidence-based
Green Claims Directive (Proposal COM/2023/166)	2023	Requires companies to substantiate environmental claims using recognized scientific methodologies (e.g., Life Cycle Assessment); mandates third-party verification of claims	Particularly relevant for claims related to organic production, carbon footprint and sustainable packaging in agri-food chains
EU Ecolabel Regulation (Regulation (EC) No 66/2010, ongoing revisions)	2010 (updated periodically)	Establishes criteria for awarding official eco-labels based on environmental performance across the lifecycle	Highly relevant for organic food products and prevention of misleading "bio" or "organic" statements

Unfair Commercial Practices Directive (Directive 2005/29/EC, amended by Directive (EU) 2024/825)	2005 / 2024	Strengthens rules against misleading advertising and introduces explicit provisions targeting greenwashing practices	Applies to marketing communication in food retail and branding of sustainability-related attributes

Source: Compiled by the author based on legislative database of European Commission.

As illustrated in Table 4, the European regulatory landscape addressing greenwashing has evolved significantly in recent years, moving from general consumer protection provisions to more specific requirements targeting environmental claims. This transition reflects the increasing recognition that sustainability-related information must be scientifically substantiated and independently verified. In the agri-food sector, where consumer trust is strongly influenced by perceptions of product origin, production methods and environmental impact, the implementation of these regulatory measures plays a crucial role in ensuring market transparency and preventing misleading communication practices.

In addition to the legislative developments discussed above, recent analytical reports highlight the geographical spread of greenwashing risks globally. Data presented in the fourth annual Greenwashing Report by RepRisk (2025) indicate that several countries characterized by a high level of exposure to biodiversity-related risks are also associated with a high incidence of greenwashing practices (see figure 2). This pattern is particularly relevant for the agri-food sector, where environmental claims are closely linked to the use of natural resources and the impact on biodiversity.

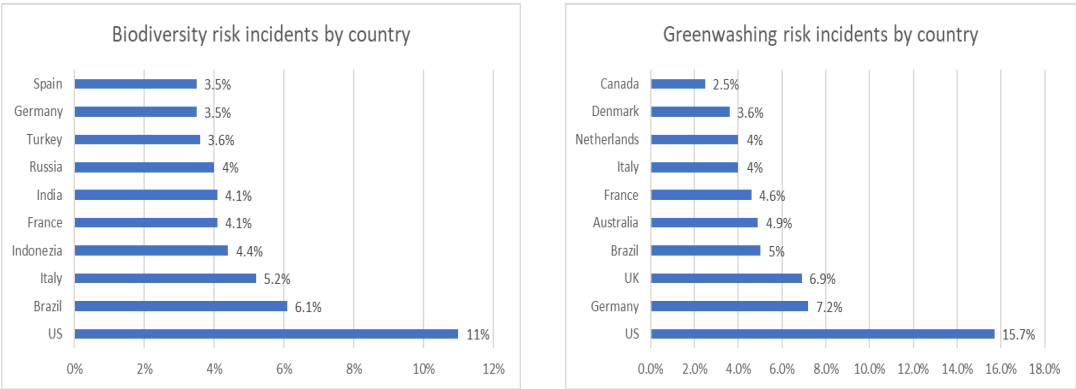

Figure 2. Top ten countries for biodiversity and greenwashing risk incidents, 2025
Source: Made by authors in base of RepRisk, 2025.

As shown in Figure 2, the United States has the highest share of incidents associated with greenwashing risk, followed by Germany and the United Kingdom, while other developed economies such as Australia, France and Italy frequently appear in the rankings for exposure to such practices. The overlap between countries with high biodiversity risk and those associated with greenwashing incidents suggests that sectors dependent on natural resources, including agriculture and food production, are particularly vulnerable to the use of potentially misleading environmental claims.

In addition to the geographical distribution of greenwashing risks, recent literature also highlights a significant sectoral concentration of these practices. The analysis carried out by RepRisk (2025) indicates that certain economic sectors are consistently associated with a high number of companies involved in greenwashing incidents, reflecting the specific vulnerability of industries with a direct impact on the environment and natural resources.

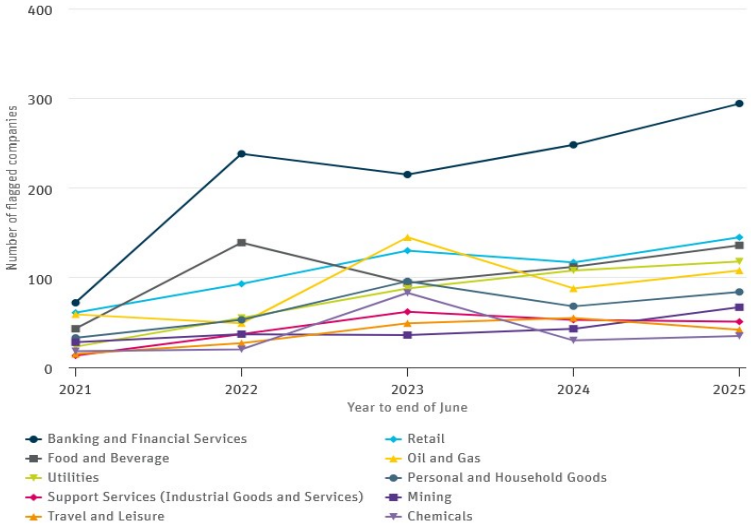

Figure 3. Sectors with the highest number of companies linked to greenwashing risk

Source: RepRisk, 2025

As can be observed in Figure 3, the Food and Beverage sector remains consistently among the sectors with a high number of companies associated with greenwashing risks in the period 2021–2025. This constant presence reflects the specific vulnerability of the agri-food sector, characterized by direct dependence on natural resources, biodiversity and agricultural practices with an impact on the environment.

At the same time, the increase in consumer interest in products perceived as sustainable, ecological or from responsible sources determines the intensification of the use of environmental claims in commercial communication. In this context, the risk of using exaggerated or insufficiently substantiated claims is becoming higher, affecting the level of consumer trust and the transparency of the agri-food market.

The persistence of the agri-food sector among the sectors exposed to greenwashing risks highlights the need to strengthen more effective practices to prevent and combat these phenomena, including through clear mechanisms for regulation, verification and enforcement of sanctions. In this sense, the analysis of international experiences regarding addressing the greenwashing phenomenon becomes essential for identifying effective intervention models and adapting them to the particularities of the agri-food sector.

Within the European Union, one of the priority directions in combating the phenomenon of greenwashing is aimed at carbon neutrality claims, especially those based on carbon offsetting mechanisms. In recent years, national consumer protection authorities have intensified checks on the way such claims are used in commercial communication,

highlighting the risks associated with the use of terms that are difficult for consumers to verify.

A relevant example is the case of *Arla Foods*, one of the largest dairy producers in Europe, active mainly in **Denmark** and **Sweden**. Regulators have asked the company to stop using the phrase "net-zero climate footprint" in advertising materials, arguing that the claim may mislead consumers. According to the authorities' assessments, the climate impact associated with milk production cannot be completely neutralized solely through compensatory measures, such as planting trees or purchasing carbon credits. Furthermore, it was highlighted that compensation mechanisms are often difficult for consumers to understand and verify, which reduces information transparency (Larsson, 2025).

Another relevant case is that of the supermarket chain *Albert Heijn*, the largest food retailer in the **Netherlands**. The company was sanctioned for using the term "carbon neutral" on the labels of some products, including fruit and vegetables, without providing a rigorous justification based on a full supply chain analysis (Houthoff, 2023). The Dutch authorities concluded that simply offsetting emissions cannot substitute for effectively reducing environmental impact, and the use of such claims without a clear scientific substantiation can create erroneous perceptions about the sustainability of the products.

France is considered one of the pioneer countries in developing a legislative framework dedicated to combating the phenomenon of greenwashing, by adopting the "Climat et Résilience" Law (Loi Climat et Résilience). This law introduces clear restrictions on the use of generic terms in commercial communication, with the main objective of reducing the use of vague and difficult-to-verify claims by consumers (French Parliament, 2021).

Within this legislative framework, the French authorities have limited the use of general expressions such as "biodegradable", "environmentally friendly" or other similar formulations, when they are not accompanied by concrete and verifiable information. Such terms have been considered potentially misleading, as they can create the perception of superior environmental performance without providing clear evidence of the product's real impact on the environment.

The implementation of these measures has had a direct impact on companies in the agri-food sector, especially those using packaging labeled as ecological or sustainable. Under the new requirements, economic operators were required to replace general claims with specific and measurable information, such as data on the composition of the materials used for packaging, the level of emissions associated with production or the actual degree of recyclability.

In many cases, this information is provided to consumers via QR codes, which allow quick access to additional details on the environmental impact of the product. From the perspective of the agri-food sector, the experience of France highlights the importance of moving from symbolic communication to communication based on verifiable data.

The restriction of generic terms has led companies to adopt a more transparent and rigorous approach to presenting environmental performance, helping to reduce the risk of misleading consumers.

In the **UK**, the fight against greenwashing is supported by the Competition and Markets Authority (CMA), which has developed the "Green Claims Code", a set of detailed rules for the assessment of environmental claims used in commercial communication. This framework provides clear guidance for companies in the retail and agri-food sectors, establishing that any

claim regarding environmental impact must be clear, specific and supported by verifiable evidence.

A relevant example in the agri-food sector is the case of plant-based drinks sold under the Alpro brand, belonging to the *Danone group*. Advertisements suggesting that almond milk is "good for the planet" were analysed by the authorities, and the use of this general claim was considered problematic from an information transparency perspective. Although plant-based products are often perceived as having a lower carbon footprint compared to conventional dairy products, the authorities highlighted the fact that almond production involves high water consumption, especially in regions characterized by a risk of drought. In this context, the general claim about environmental benefits was considered insufficiently substantiated and potentially misleading for consumers.

This case highlights that, in assessing environmental claims, the UK authorities pay close attention to the entire production cycle, not just selective indicators such as carbon emissions. In the agri-food sector, where environmental impacts are determined by multiple factors - including water consumption, land use and biodiversity - simplified sustainability claims can lead to misinterpretations of the actual performance of products.

In **Germany**, the fight against greenwashing in the agri-food sector has focused particularly on the credibility of sustainability certifications used in global supply chains. A relevant example is the case of the supermarket chain *EDEKA*, one of the largest food retailers in Europe, involved in a dispute over the use of sustainability claims for palm oil. In the context analysed, products sold under its own brand "Gut & Günstig" contained palm oil promoted as "sustainable" using the Round Table on Sustainable Palm Oil (RSPO) certification label (Kalmer, 2026). This label is frequently used to signal compliance with certain standards regarding environmental protection and respect for social rights within supply chains.

The legal action was initiated by the non-governmental organization foodwatch, with the support of the European Center for Constitutional and Human Rights (ECCHR), which challenged the way in which the RSPO certification was used in commercial communication. The plaintiffs argued that the mere use of the RSPO label does not provide consumers with sufficient information about the standards applied and can create the perception of complete sustainability, while in some cases the supply chains have been associated with human rights violations and negative environmental impacts, including in regions such as Guatemala.

In February 2026, the Hamburg Regional Court ruled that the use of the RSPO label without further explanation of the specific certification criteria may constitute a misleading practice, in violation of the provisions of German law on unfair competition (Gesetz gegen den unlauteren Wettbewerb – UWG). Following this decision, EDEKA was required to avoid using the RSPO label in the absence of clear and accessible information explaining the specific standards associated with the certification (Kalmer, 2026).

The analysis of international experiences highlights that the phenomenon of greenwashing in the agri-food sector is addressed through a combination of legislative measures, institutional control mechanisms and concrete legal interventions. Thus, the examples analyzed demonstrate that authorities in different jurisdictions emphasize limiting the use of generic terms, rigorously verifying claims regarding climate neutrality and strengthening the credibility of certification systems used in communicating sustainability.

At the same time, these cases highlight that the mere existence of labels or certifications is not enough to guarantee information transparency, as it is necessary to provide clear,

verifiable and accessible data to consumers. In the agri-food sector, where supply chains are complex and the impact on the environment is multidimensional, the use of general or insufficiently substantiated claims can generate erroneous perceptions and affect consumer confidence in sustainable products.

Therefore, the experience of the analyzed states suggests that the effectiveness of combating greenwashing depends on the integration of complementary tools, such as clear regulations, effective verification mechanisms, consistently applied sanctions and increased transparency in environmental communication.

These approaches provide valuable benchmarks for the development of coherent policies adapted to the specificities of the agri-food sector, contributing to strengthening the credibility of sustainability claims and supporting the transition to food systems with low environmental impact.

5. Conclusions and recommendations

The analysis carried out in this study highlights the fact that the phenomenon of greenwashing has become increasingly widespread and complex in the agri-food sector, amid the growing interest of consumers in products perceived as sustainable and environmentally responsible. The review of the specialized literature demonstrated that misleading environmental claims frequently appear in the context of the use of generic terms, insufficiently explained certifications and the lack of transparency regarding the real impact of products on the environment.

The results of the analyses show that the agri-food sector is highly vulnerable to greenwashing practices, due to its direct dependence on natural resources, biodiversity and agricultural processes with significant impact on the environment. At the same time, the pressure to respond to market demands regarding sustainability determines economic operators to use environmental claims more frequently, which increases the risk of exaggerated or insufficiently scientifically substantiated messages.

The international experiences analysed in the study highlight the fact that preventing and effectively combating greenwashing requires a combination of legislative measures, verification mechanisms and institutional interventions. Examples from the European Union, France, the United Kingdom and Germany demonstrate that regulating the use of generic terms, verifying climate neutrality claims and strengthening the credibility of certification systems contribute significantly to increasing transparency in sustainability communication.

At the same time, the analysis of data on the geographical and sectoral distribution of greenwashing risks confirms that the food and beverage sector remains consistently among the areas with a high level of exposure to such practices. This reality underlines the need to develop effective monitoring and control tools capable of ensuring the credibility of information on the sustainabiity of agri-food products.

Based on the lessons learned from international experience and the analysis of the existing regulatory framework, a series of recommendations are outlined aimed at strengthening the mechanisms for preventing and combating greenwashing practices in the agri-food sector:

Strengthening the legislative framework on environmental claims. It is necessary to develop and implement clear regulations on the use of environmental terms in commercial communication, including the explicit definition of generic terms such as “eco”, “sustainable”

or "environmentally friendly". These regulations should establish the obligation to provide verifiable and easily accessible evidence to consumers.

Creating effective mechanisms for verifying sustainability certifications. The competent authorities should develop tools for assessing the credibility of certifications used in the agri-food sector, including by monitoring the standards applied and verifying the way in which they are communicated to consumers.

Promoting transparency through the use of digital tools. Implementing QR codes and digital platforms that allow quick access to detailed information on the origin of products, environmental impact and sustainability assessment methodology can contribute to increasing consumer awareness.

Strengthening the role of control institutions and consistent application of sanctions. Applying clear and proportionate sanctions for the use of misleading environmental claims is an essential factor in discouraging greenwashing practices and maintaining a fair competitive environment.

Increasing consumer education and awareness. Developing educational programs and information campaigns on the interpretation of environmental labels and identifying misleading claims can contribute to forming more informed and responsible consumers. 6. Adapting international good practices to the national context

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BANK STABILIZATION TOOLS, RISK AND PERFORMANCE OF DEPOSIT MONEY BANKS (DMBS) IN NIGERIA

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Abstract: *The study examined the impact of liquidity, bank capital, loan-to-deposit ratio on risk and performance of banks in Nigeria. Data for this study was sourced from the financial statement of thirteen (13) quoted banks in Nigeria from 2012 to 2023 and employed descriptive statistic, fixed effect and system GMM method of estimation. The empirical result shows Higher capital and loan-to-deposit ratio promote DMBs performance while higher liquidity worsens the DMBs performance. Higher capital and liquidity expose the DMBs to greater risk while higher loan-to-deposit ratio reduces the risk of DMBs. Additionally, higher capital promotes the big DMBs performance while higher liquidity and loan-to-deposit ratio worsen the performance of the big DMBs. However, the small DMBs capital, liquidity and loan-to-deposit ratio promote the performance of the small DMBs. Higher capital and liquidity expose both big and small DMBs to greater risk while loan-to-deposit ratio minimizes the risk exposure of DMBs in Nigeria. The study therefore, recommends that the big DMBs should engage more in traditional banking activities as it has contributed immensely to the performance and reduce the risk of the small DMBs in Nigeria financial system. The CBN should also continue the periodic review of its policies on the DMBs into to increase the volume of credit extended to the small and medium enterprises, increasing the level of employment, protection of the customers, shareholders and other stakeholders' interest in Nigerian financial system.*

Keywords: *Bank Capital, Liquidity, Loan-to-Deposit Ratio, DMBs, Risk.*
JEL Classification*: G21, C26, G28, E51, E58.*

1. Introduction

The global banking has experienced significant reform via regulation and restructuring which has imposed various changes in the regulatory instruments, stiff competition and stability in the economy. The variation in the stabilization instruments, namely; bank capital, liquidity ratio, the loan-to-deposit ratio among others have promoted stability in the financial system and reduced the occurrence of bank failure in the economy. While the stabilisation tools have been perceived to attract benefit to the Deposit Money Banks (DMBs) performance and the financial system, it also poses financial instability on the economy through unhealthy competition, lack of risk management mechanism which adversely influence the prosperity of the banking system and increase the volatility in the banking environment. DMBs, however, play an indispensable role in an economy which makes it imperative to ascertain whether the variation in the stabilization tools has promoted the DMBs performance and reduce the risk or not.

In this study, an attempt is made to examine the complementarity roles of bank capital, liquidity ratio and loan-to-deposit ratio on bank performance in Nigeria. It is established in prior works of (Abbas et al, 2019; Majumder and Li, 2018; Obim et al, 2020; Hapsari, 2018; Fajinmi, et al., 2023; Ugorji, et al., 2025) that bank performance is not independent of bank capital, liquidity ratio and loan-to-deposit ratio which has dominated discourse at the level of Basel Committee for Banking Supervision (BCBS) and Central Bank of Nigeria (CBN) which were tailored towards enhancement of bank performance and prevention of bank crisis in the financial system. Persistency in the performance of banks is a function of bank capitalisation which serves as a shock absorber to Deposit Money Banks (DMBs) in event of internal and external crises and boost the confidence of the public in the banking sector; liquidity which is the ability of banks to meet up with their customers' requirements by maintaining adequate

reserve (Khalid et al, 2019; Oudat, et al., 2024) and used by the monetary authority as a tool to either expand or tighten the economic activities; loan-to-deposit ratio serves as an avenue through which the banks execute their core intermediation function by making the surplus sectors fund available to the deficit sectors for a reward called the interest income (Saleh and Abu Afifa, 2020) which equally promote economic output, increase employment opportunities and citizens welfare etc. The positive performance of banks is however essential for promoting the wealth of the shareholders, increasing the value of the bank and strengthening the investors' confidence in the banking sector.

Theoretically, higher liquidity ratio reduces the bank profit while lower liquidity ratio increases the bank profit (Smaoui, et al., 2020; Alqsass, et al., 2022) which could also be linked to the theory of risk, the higher the risk, the higher the expected return and vice versa. This means for banks to make a higher profit; more credit must be given to the deficit unit which exposes the bank to more risk. Similar to Khalid, et al's assertion, also postulated that an increase in capital is expected to increase bank profitability. Contrarily, holding on to excess capital without creating credit is expected not to attract any profit but equally reduces the bank risk exposure. Liquidity is however not independent of loan-to-deposit ratio, the higher the proportion of deposit given out as a loan, the lower the liquidity ratio and vice versa. An adequate level of capital therefore helps to cushion the adverse effect in the situation of low liquidity which could lead to bank run if not well managed. The endogeneity between these three tools (bank capital, liquidity and loan-to-deposit ratio) makes it imperative to investigate the complementarity role of these three variables on bank performance in Nigeria. It is also surprising to ascertain that studies on the complementarity role of these phenomena are scarce. Management of these variables with the profitability of banks is therefore viewed to be very essential to maximize the shareholders' wealth (Trans et al, 2016).

Only a few studies Afrogha, et al., 2023; Adediran, et al., 2025; Olufemi and Sunmisola, 2022; Opuene and Amadiwo, 2025) have towed this line of discourse. Prior studies have examined the individual effect of these variables on the performance of banks which is not sufficient enough because of the endogeneity of the three regressors (bank capital, liquidity ratio and loan-to-deposit ratio). It is however important to also note that adequate bank capital reduces the bank exposure to risk and bank runs in the period of a financial crisis. Adequate liquidity also assists banks in meeting up with their customers' requirements; inability to meet up with their customers need could lead to discontinuous patronage by some of the customers which could be detrimental to the bank customers retention rate while a high level of loan as a percentage of deposit channeled to the public is expected to increase the economic output, employment and increase the interest income of the bank. More so, the level of divestment by the investors experienced in the global equity market and Nigerian Stock Exchange (NSE) (Fadun, O. S., & Silwimba, 2023) recently is likely going to affect the bank capital due to the reduction in the banking stock, the magnitude of impact on Nigerian banks is what is unknown.

More so, growth of performance of bank differs which is attributable to the level of bank capital (Koroleva, et al., (2021; Abdelaziz, et al., 2022), level of participation in core intermediation activities (Roger, 1998), the amount of asset acquired by the bank (Al-Matari, 2023) operating expenses management, foreign ownership and market share (Athanasoglou et al, 2005; Tibebe and Gujral 2022) the level of engagement in non-traditional activities, stock

market development, liquidity (Obim et al, 2020) and any other factors inducing the performance of the bank.

One of the factors that determine economic output, level of employment and bank performance in Nigeria is the loan-to-deposit ratio which prior studies have excluded from their investigation. Apart from (Hapsari, 2018); who investigated the role of loan-to-deposit ratio, no country-specific study has investigated the role of loan-to-deposit ratio on bank performance in Nigeria. This study seeks to unleash the role of loan-to-deposit ratio on bank performance and the economy at large due to its significant contribution which forced the CBN to increase the loan-to-deposit ratio of DMBs from 60% to 65% in the third quarter of 2019 which is planned to be increased to 70% in 2020 (Adesina, 2019). This sudden increase was targeted towards increasing lending to the real sector which contribute massively to the level of employment and growth in the economy.

This study proxied performance using the risk-adjusted return on asset (RAROA) and risk-adjusted return on equity (RAROE) because they take into consideration the risk attached to the bank return in their computation which makes them different from the measure of performance used by the previous studies reviewed (see Baek et al, 2018 for extensive explanation). This investigation is considered important as a result of the recent review of regulatory tools used by the CBN in regulating the banking industry. The findings of this study will be useful to the policymakers, DMBs, the bank customers, the investors and other stakeholders in making decisions. The rest of this paper is structured as follows; Section 2 is the literature review, Section 3 deals with the methodology. Section 4 deals with the results and discussions and the last section deals with the conclusion.

2. Literature review

The level of performance of DMBs is very paramount in maximizing the stakeholder's wealth. Previous literatures reviewed proxied performance with return on asset (Hapsari, 2018; Majumder and Li, 2018; Gupta and Sikarwar, 2020, Munangi and Sibindi, 2020; Serwadda, 2018, Al-Rdaydeh et al, 2017; Kwashie et al., 2022; Al Zaidanin and Al Zaidanin, 2021), return on equity (Alqsass et al., 2022, Oudat et al., 2024, Olalekan et al., 2018) and net interest margin (Baek et al, 2018; Al Zaidanin and Al Zaidanin, 2021; Munangi and Sibindi, 2020) proxied performance using the risk-adjusted return on asset (RAROA) and risk-adjusted return on equity (RAROE) which is believed to take into consideration the volatility attached to the bank return. Previous studies proxied that risk exposure of bank by the Z-Score (Majumder and Li, 2018; Rahman et al., 2018; Hunjra et al., 2022; Saleh and Abu (2020), Abel et al., 2023). The Z-Score helps to determine the relationship between the bank risk exposure and the independent variables (capital, liquidity and loan-to-deposit).

Capital regulation was viewed to be the most imperative of all the tools used by the monetary authority in achieving stability in the economy (Zheng and Cronje. 2019, Smaoui et al 2020). Davydiv et al., (2021) opines that the liquidity risk exposure of banks with high capital is minimal because of the buffer capital the bank possesses. Bank capital is proxied by previous literature as total equity to the total asset which has been used by previous studies (Dutra et al., 2023, Dias 2021, Salime and Suripto, 2023, Abbas et al, 2019). The higher the ratio, the more protected the depositor's fund. A positive effect of this ratio is expected on performance while a negative impact is expected on bank risk.

Liquidity is the ability of an institution to meet up with their customer's requirement. The inability of DMBs to meet up with their customer request could be a signal of liquidity

problem. Liquidity was conceptualized as a dual concept by (Fecht et al., 2024) which implies that DMBs could either fulfil their obligation or not. Liquidity problem could however be risky to the DMBs and financial system at large because it could make the DMBs to be insolvent. To combat this liquidity problem, banks are therefore implored to be proactive by maintaining an adequate level of liquidity (Huynh, 2024) which would help to prevent the threat to the regulators, DMBs and economy at large (Khan et al, 2017). Prior literature reviewed measure liquidity by total equity to the total asset (Abbas et al, 2019; Majumder and Li, 2018; Hu, 2025; Fecht et al., 2024) proxied liquidity ratio by loan to total asset ratio. This measurement is therefore preferred by this study because the higher the amount of credit advanced to the customers, the larger the interest income and risk expected. A negative relationship is expected between liquidity ratio and performance while a positive relationship is expected between liquidity ratio and risk. However, the study of (Hunjra, et al., 2022; Dutra, et al., (2023) reported a positive impact of liquidity on profitability which implies that the higher the credit advanced to bank customers, the higher the expected profit.

The customer deposit serves as a liability in the bank statement of financial position which is transformed into loan and advances. The loan and advances represent an asset to the DMBs; this is simply referred to as liability transformation. Banks are compelled by the monetary authority to give out a reasonable percentage of their deposit as a loan to enhance the productive capacity of the SMEs and increase employment in the economy which is the loan-to-deposit ratio. Loan-to-deposit ratio is expected to increase the performance of banks which means a positive effect on profitability is expected. Hapsari, (2018) and Oudat, et al., (2024) asserted a positive impact of loan-to-deposit ratio on the profitability of banks. The loan-to-deposit ratio helps to determine the level of credit extended to the small and medium enterprises (SMEs) in the economy from the deposit with the DMBs. A higher loan-to-deposit ratio indicates that the DMBs are carrying out their core intermediation function in the economy.

Odigie and Adim (2024) investigated into the relationship between risk management and performance of deposit money banks in Nigeria. The qualitative approach was employed were twenty four banks was employed and one hundred twenty senior level managers was sourced based on the information collected for the resource base theory and performance was captured from the construct of profitability, service quality and market share. The findings suggests that risk management effect of profitability. Oluwaseun et al (2025) examines into the influence of risk management on the financial sustainability deposit money banks in Nigeria. The study was able to check the influencing impact of liquidity risk, credit risk, and market risk on return on asset, with control variables of firm size and leverage. The findings shows that credit and capital adequacy risk has positive significant effect on financial sustainability. Ogbuji and Adekunle (2024) examines into the impact of growth on the economic dexterity on Nigerian economy. The subject matter was to determine how the intermedative role of bank improves the economy, with proxies of loan-to-deposit ratio, credit to private sector, liqudity ratio, cash reserve ratio, inflation rate, interest rate, monetary policy rate and economic growth. The theory was anchored on financial intermediation theory, while the findings shows that loan-to-deposit has positive significant effect on economic growth. Diarua (2025) examines into the relationship between liqudity management and financial performance of quoted deposit money banks. The subject matter was to determine how current ratio, loan-to-deposit ratio and cash reserve ratio affect, return of asset of five deposit money banks from 2019 to 2023. The inquiry was anchored on the trade off theory. The panel

regression analysis showed that surrent ratio and cash reserve has positive significant effect on return on asset. The measures of performance using the return on asset aligns with the works of Oluwaseun et al (2025) and the insignificant effect of loan-to-deposit ration bank performance, but otherwise when the measures are used in determining the intermedaitive performance of banks in the economy (Ogbuyi and Adekunle 2024). Opuene and Amadiwo (2025) examines into the effect of financial risk management on the financial performance of deposit money bank in Nigeria. The subject matter determines how credit risk management, operational risk management and risk committee size, influence earnings per share and return on asset of selected deposit money banks. The study employing panel ARDL technique for a micro data and not inter-country data may bot be statistically correct. The findings shows from the long-run effect depicts that credit risk management and operational risk management has significant effect on return on asset. Fajinmi et al (2023) investigated into effect of portfolio management and performance of deposit money banks in Nigeria. The subject matter was to determine the portfolio componentof bank which include cash and cash equivalent, financial assets, bank foreign asset, deposit mix, private sector concentration and absolute profit before tax. The theory was anchored on the markowits portfolio theory. The findings reveals from employing the ARDL technique depicts that all constructs of portfolio management has significant effect on profit after tax, return on investment, asset quality, capital adequancy of selected deposit money banks. Afrogha et al (2023) in their inquiry examines into the effect of monetary policy on the performance of listed deposit money banks. The subject matter was to investigate how indicators of monetary policy like monetary policy rate, reserve requirments, broad money supply and exchange rate affect the performance of measure of return on assets, returnon equity, liquidity coverage, current ratio, credit growth notes, non-performing loans, capital adequacy ratio and total deposit. The findings depicts that money supply, monetary policy rate, has significant effect on total deposits. Adediran et al (2025) in their study investigated into the influence of risk management strategies and financial performance of quoted deposit money banks in Nigeria. The subject matter was to capture earnings volatility, interest coverage ratio, debt-to-equity ratioon return on assets, anchoring the inquiry on agency theory, pecking order theory and trade off theory. The findings shows that earnings volatility and debt-to-equity has positive and negative significant effect on return on assets. Olufemin and Sunmisola (2022) examines into the impact of financial risk and financial performance of deposit money in Nigeria. The subject matter was to capture how liqudity and credit risk as a measure of financial risk influences return on equity. The findings reveals that liqudity risk and credit risk have substantial effect on return on equity. Wisdom et al (2018) in their inquiry investigated into the relationship between financial risk management ad financial performance. The subject matter was to determine how market risk management and liqudity risk management influences return on average. The multiple regression shows that market risk management and liqudity risk management has significant relationship with return on average. Ehiedu (2022) examines into the relational impact of monetary jeopardy and Nigeria's deposit bank. The subject matter is to capture monetary jeopardy with credit risk, liquidity risks, operational risks, market risks and return on equity. The findings shows that credit risk and market risk has positive and negative significant effect on return on equity. Ugorji et al (2025) investigated into the effect of credit risk management and stability of deposit money banks in Nigeria. The subject matter is to determine how interest rate, loan and advances and non-performing loan affect bank stability of deposit money banks. The study was anchored on the

credit market theory and anticipated income theory. The findings from the pooled regression results shows that loand and advances, interest rate and non-performing loan has negative significant effect on banks stability.

3. Methodology

The study employs descriptive and inferential statistics in estimating the relationship between capital, liquidity, loan-to-deposit, DMBs performance and risk in Nigeria. The descriptive statistics describe the traits of each variable employed while the causal relationship between the dependent and independent variables was ascertained using the inferential statistics. The study mainly used secondary data sourced from the annual reports and accounts of the selected thirteen (13) DMBs quoted on the Nigerian Stock Exchange as at 31st December 2023 which covers the period of 2012-2023.

3.1 Model, Estimation Technique and Variables Specification

This study uses the risk-adjusted return on asset (RAROA) and risk-adjusted return on equity (RAROE) as a proxy for DMBs performance while risk exposure was proxied using the Z-Score. RAROA is measured by return on asset divided by the standard deviation of the return of asset while RAROE is measured by return on equity divided by the standard deviation of the return on equity. RAROA and RAROE further helped to ascertain whether DMBs capital, liquidity and loan-to-deposit expose bank returns to higher volatility. The risk-adjusted return was used in the previous studies of (Baek, Lee, Lee & Mohanty, 2018).

$$RAROA_{it} = \frac{ROA_{it}}{SDROA_{it}} \qquad \text{Equation (1)}$$

$$RAROE_{it} = \frac{ROE_{it}}{SDROE_{it}} \qquad \text{Equation (2)}$$

Z-Score measures the exposure of DMBs to insolvency (Ha and Quyen, 2018; Majumder and Li, 2018). The higher the Z-Score, the lower the risk exposure of a bank which means that a bank with higher Z-Score has a lower risk of being insolvent while banks with lower Z-Score has a higher tendency of insolvency. The Z-Score is calculated using the formula below:

$$Z - Score_{it} = \frac{ROA_{it} + CAR_{it}}{SDROA_{it}} \qquad \text{Equation (3)}$$

Where:
ROA is the return on asset of bank i at period t
CAR is the capital adequacy ratio of bank i at period t measured by equity to asset ratio?
$SDROA$ is the standard deviation of return on asset of bank i at period t.

This study employed the panel estimation technique to estimate the impact of the independent variables on the dependent variable. It is to be noted that it is imperative to carry out unit root test to ascertain the order of integration of these variables. This study estimated the dynamic panel system generalised method of moment (GMM) (Arellano and Bover, 1995; Blundell and Bond 1998) which was based on the prior model developed by (Arellano and Bond 1991) where differencing of all the regressors was introduced and called difference GMM. The model of Arellano and Bond was based on the following assumptions; that the observation is greater than the time (N>T), linearity in the relationship, inclusion of the lagged value of the dependent variable, regressors are not strictly exogenous, fixed individual effects and problem of autocorrelation & heteroskedasticity within a variable (Roodman, 2009). Imposing the strict exogeneity assumption leading to violations and discrepancy in our

fixed-effect model which leads to the generation of a single equation dynamic GMM estimators by using a common factor representation (Blundell and Bond, 1998). The dynamic panel output model is expressed as:

$$y_{i,t} = \rho + \omega y_{i,t-1} + \theta_1 Cap_{i,t} + \theta_2 K_{i,t} + \theta_3 L_{i,t} + \theta_4 Exc_{i,t} + \mu_{i,t} \quad (4)$$
$$i = 1 \ldots\ldots n, t = 1 \ldots\ldots T$$

ρ is the constatnt parameter, ω and θ are the output elasticities

The violation of the assumption of strict orthogonality led to the introduction of varying parameters by taking the semi-derivatives of the variables to account for variances in units and measurements.

$$\varepsilon_{i,t} = \mu_{i,t} + v_{i,t} \quad (5)$$

The disturbance term $\varepsilon_{i,t}$ comprise of two orthogonal components; the fixed effects that is time-invariant which is $\mu_{i,t}$ and the idiosyncratic shocks which is represented by $v_{i,t}$ which is assumed to be independent and normally distributed with zero (0) mean and constant variance.

Adjustment of the bank performance is expected to be affected by factors such as the capital, liquidity, loan-to-deposit ratio, asset growth and size. Bank performance adjustment to changes in these factors is dependent on two basic conditions, first is the passage of time which give rise to the introduction of the lagged values of the factors as independent variables, and second is on the difference between the equilibrium of bank performance and the previous year actual performance which led to the introduction of the dynamic GMM in which lag of the dependent variable is also included as an independent variable in the model.

Application of OLS in our estimation could lead to "dynamic panel bias" which usually occur due to correlation between the lagged value of the dependent variable and the fixed effects in the error term which leads to the violation OLS assumption which is necessary for attaining an unbiased estimate, leading to endogeneity problem. Introduction of lagged variable as an instrument in the strict orthogonal assumption helps in solving this problem which is incorporated in the system GMM (Blundell and Bond, 1998; Roodman, 2009).

This study, therefore, estimated the impact of capital, liquidity, the loan-to-deposit ratio on bank performance and risk in Nigeria using the System GMM based on the satisfaction of some assumptions; that the observation is greater than the time (N>T), ability to solve endogeneity, heteroscedasticity and serial correlation problem and produce an estimate which reduces the correlation between the instrument and the disturbance term to zero. The dynamic GMM model is expressed as:

$$y_{i,t} = \alpha \mid \beta_3 Y_{i,t-1} \mid \beta_1 X_{i,t} \mid \beta_2 Z_{i,t} \mid \varepsilon \quad (6)$$

The model for this study is based on the previous work of (Abbas, Iqbal and Aziz, 2019; Alqsass, et al., 2022)which is expressed in order to suit the objective of this study as:

$$RAROA_{i,t} = \alpha + \beta_7 RAROA_{i,t-1} + \beta_1 CAP_{i,t} + \beta_2 LIQ_{i,t} + \beta_3 LDR_{i,t} + \beta_4 ASG_{i,t} + \beta_5 SIZE_{i,t} + \varepsilon_{i,t} \quad (7)$$

$$RAROE_{i,t} = \alpha + \beta_7 RAROE_{i,t-1} + \beta_1 CAP_{i,t} + \beta_2 LIQ_{i,t} + \beta_3 LDR_{i,t} + \beta_4 ASG_{i,t} + \beta_5 SIZE_{i,t} + \varepsilon_{i,t} \quad (8)$$

The independent variables used in this study include capital, liquidity ratio and loan-to-deposit ratio while the control variables are asset growth and size. Koroleva, et al., (2021).

opines that the asset growth of the bank determines the level of risk assumed by a bank. A bank with a rapid growth rate in the asset has a high tolerance for risk while the banks with low growth rate have a low-risk tolerance. Bank size is viewed to induce bank performance (Abbas et al, 2019)

Table 1 below shows the description and justification for each variable in the model.

Table 1. Variables description and measurement

	Acronyms	Description	Measurement/Justification
Dependent	RAROA	Risk Adjusted Return on Asset	RAROA is measured by return on asset divided by the standard deviation of the return of asset (Baek, et al, 2018)
	RAROE	Risk Adjusted Return on Equity	while RAROE is measured by return on equity divided by the standard deviation of the return on equity ((Baek et al, 2018)
	Z-Score	Z-Score	Z-Score measures the exposure of DMBs to insolvency. It is measured by return on asset plus capital adequacy ratio divided by standard deviation of return on asset (Ha and Quyen, 2018; Munangi, and Sibindi (2020).
Independent	CAP	Capital	Capital is measured using total equity divided by total asset (Abbas et al, 2019;
	LIQ	Liquidity Ratio	Liquidity is measured by loan to total asset as used in the prior studies of (Obim et al, 2020; Ha and Quyen, 2018)
	LDR	Loan-to-Deposit Ratio	Loan-to-deposit is measure using customers loan divided by customers deposit (Hapsari, 2018; Saleh and Abu Afifa 2020).
	ASG	Asset Growth	Asset growth is measured using current year asset minus previous year asset divided by the previous year asset (Isshaq et al, 2019).
	SIZE	Bank Size	Bank size is measured using the natural logarithm of bank asset as used by past researchers (Abbas et al, 2019; Ugorji, et al., 2025).

4. Empirical results and discussions

The section presents the descriptive statistics, correlation matrix and regression estimation techniques. The descriptive statistics of the financial data are shown in table 1 covering 2012 to 2023.

Table 2: Descriptive Statistics

Variable	Mean	Std.Dev.	Maximum	Minimum	Observations
RAROE	0.192044	1.000001	0.756401	-9.46093	156
RAROA	0.178173	0.20967	0.652422	-1.04539	156
Z – Score	6.502241	13.14976	41.80355	-85.9302	156
LIQ	0.427625	0.096847	0.571904	0.057238	156
CAP	0.153376	0.292371	0.973031	-1.5475	156
LDR	0.66432	0.173744	1.063525	0.035504	156
SIZE	12.14124	0.395403	12.91508	11.19453	156
ASG	0.062002	0.257028	0.590438	-0.927191	156

Source: Authors Computation

Table 2 shows the descriptive statistics of the data used in this study. The Risk-Adjusted Return on Equity (RAROE) has an average value of 19.2% with a standard deviation of 100% which implies that the average risk-adjusted return on equity of DMBs is lower than the standard deviation, this means there is a decrease in the return of the bank. The Risk-Adjusted Return on Asset (RAROA) has an average value of 17.8 with a standard

deviation of 21% which implies that the average risk-adjusted return on asset of DMBs is lower than the standard deviation. Z-Score has an average value of 6.502241. The maximum and minimum values of Z-Score are 41.80355 and -85.9302.

Liquidity has an average of 42.76% with a standard deviation of 9.7% which implies that the banks have a greater ability to meet up with their customers' requirements. Capital adequacy ratio has an average value of 15.34% which is higher than the minimum requirement set by the Central Bank of Nigeria which was 15% for banks with international subsidiaries and 10% for banks without international subsidiaries. This implies that the depositor's funds are protected and the Nigerian banking system is stable.

Loan to deposit ratio has an average value of 66.43% which means that average bank in Nigeria gives out N64.43 out of every N100 deposit of the bank which is higher than the minimum of 65% set by the CBN in the third quarter of 2019. The maximum and minimum of the loan to deposit ratio are 1.06 and 0.035504. Asset growth has an average rate of 6.2% which means that average bank asset in Nigeria grows at the rate of 6.2% annually. Bank size has an average value of 12.14124 which implies that the average assets of banks in Nigeria are N1,384,331,177,311. The minimum and maximum values of bank asset are 11.19453 and 12.91508 which means that the minimum and maximum value of assets of banks in Nigeria are N156,505,642,576 and N8,223,941,265,916 respectively.

Table 2 shows the relationship that exists among the variables which are used to determine the variables to be included in the model to resent multicollinearity and biased results.

Table 3. Correlation Matrix

Variables	RAROE	RAROA	Z – Score	LIQ	CAP	LDR	SIZE	ASG
RAROE	1.0000							
RAROA	0.3079	1.0000						
Z – Score	0.0410	0.4067	1.0000					
LIQ	0.0850	-0.1775	0.3276	1.0000				
CAP	0.0619	0.5544	0.7907	-0.1340	1.0000			
LDR	0.1172	-0.0993	0.3661	0.9031	-0.0422	1.0000		
SIZE	0.2866	0.1487	0.3426	0.3443	0.0453	0.3399	1.0000	
ASG	0.0770	0.1018	0.1879	0.3140	-0.1097	0.3120	0.3086	1.0000

Source: Authors Computation

Table 3 shows that there is no likelihood of occurrence of multicollinearity among the variables used in this study as shown by the correlation coefficients.

The effect of capital, liquidity and loan-to-deposit on performance is estimated using the system GMM estimation technique as shown in table 3. The performance measurement used in the model is the risk-adjusted return on asset and risk-adjusted return on equity.

Table 4. Impact of Capital, Liquidity and Loan-to-deposit on DMBs Performance Dependent Variables: RAROA and RAROE

	One-Step Result		Two-Step Result	
Variable	*RAROA*	*RAROE*	*RAROA*	*RAROE*
RAROA(−1)	-0. 157295 (0.1606735)		0.5481888 * (0.1250879)	
RAROE(−1)		-0.0652636 * (0.0263512)		0.0577879 (0.0497958)
CAP	2.012238 * (0.2555644)	0.01058 (0.0772131)	1.409697 * (0.140459)	0.01058 (0.0772131)
LIQ	-2.898321 ** (1.37163)	-1.326572 * (0.4490248)	-1.6964 * (0.6490649)	-0.8397739* (0.2834281)
LDR	0.6027793 (0.8018286)	0.5374542 ** (0.2612218)	0.100044 (0.3207841)	0.3324423 *** (0.192697)
SIZE	0.3455775 (0.5223389)	0.5416466 * (0.1717786)	0.0255463 (0.4054007)	0.3356357 ** (0.1765255)
ASG	1.440469 * (0.4992888)	0.1028859 (0.1510043)	1.250034 * (0.1658983)	0.0557114 (0.1055146)
$\alpha_{i,t}$	-2.996395 (6.102326)	-6.085176 (2.014201)	0.3759947 (4.719796)	-3.663629 (2.09973)
Observation	91	91	91	91
Number of Countries	13	13	13	13
Number of instruments	53	55	80	80
F /Wald chi2 Prob	0.000	0.000	0.000	0.000
AR (1)	0.740	0.359	0.086	0.118
AR (2)	0.015	0.449	0.704	0.178
Sargan test Chi (2)	0.000	0.796	0.123	0.070

Source: Authors Computation

*Level of significance was reported as *, ** and *** representing 1, 5 and 10 percent respectively. The parenthesis represents the standard errors*

Table 4 reveals the empirical finding of the impact of capital, liquidity and loan-to-deposit on DMBs performance. The empirical result shows that the lag dependent variables were negative to DMBs performance based on the one-step result but positively related to performance-based on two-step result. Capital is positive and significantly related to the performance of DMBs under the model but positive and insignificantly related to the model which implies that an increase in capital leads to a higher performance of DMBs. This result is in line with the empirical findings of (Oluwaseun et al., 2025; Fajinmi et al 2023; but contrary to the findings of (Ogbuji and Adekunle, 2024; Opuene and Amadiwo, 2025, Afrogha et al 2023). The result is also in line with the apriori expectation and theory. Liquidity has a negative and statistically significant influence on the performance of DMBs across the model, this implies that an increase in liquidity leads to a decline in DMBs performance. This result is in line with the previous studies of (Olufemi and Sunmisola 2022; Wisdom et al 2018opines that liquidity negatively influences bank performance but contrary to the findings of (Ehiedu 2022; Ugorji et al 2025). where they asserted that liquidity positively influences performance in their various studies. Loan-to-deposit has a positive and statistically significant on the performance of DMBs (RAROA) but positive but insignificant impact on DMBs performance (RAROE), this implies that increase in loan-to-deposit leads to an increase in DMBs performance. This finding is in line with the result of (Ugorji et al 2025; Diarua 2025) and the apriori expectation.

The findings also revealed that bank size has a positive and insignificant impact on RAROA but a positive and significant impact on RAROE which implies that increase in bank size leads to higher performance. the apriori expectation. Lastly, asset growth has a positive and significant impact on performance (RAROA) but positive and insignificant impact on performance (RAROE). This means that increasing growth in the bank asset promotes the performance of DMBs in Nigeria.

Table 5. Impact of Capital, Liquidity and Loan-to-deposit on DMBs Risk
Dependent Variable: Z-Score

	One-Step Result	One-Step Result
Variable	$Z-Score$	$Z-Score$
$Z-Score(-1)$	0.0318946* (0.0417287)	0.1842759 * (0.0515193)
CAP	22.33474 * (0.8528187)	20.14425 * (3.416323)
LIQ	21.3168 * (4.070062)	24.50808 ** (12.26871)
LDR	-1.509484 (2.373096)	-3.39221 (6.142332)
$SIZE$	7.80403 * (1.618222)	4.705 (3.051964)
ASG	4.520721 * (1.613625)	5.465766 (3.557305)
α_{it}	-107.1712 (19.09286)	-69.41867 (37.62992)
Observation	91	91
Number of Countries	13	13
Number of instruments	55	91
F /Wald chi2 Prob	0.0000	0.0000
AR (1)	0.304	0.002
AR (2)	0.069	0.319
Sargan test Chi (2)	0.000	0.054

Source: Authors Computation

*Level of significance was reported as *, ** and *** representing 1, 5 and 10 percent respectively. The parenthesis represents the standard errors*

Table 5 shows the empirical finding of the impact of capital, liquidity and loan-to-deposit on DMBs performance. The empirical result shows that one-period lag of Z-Scores have a positive and statistically significant influence on DMBs risk which implies that the risk is persistence. Capital has a positive and statistically significant influence on the risk of DMBs which implies that increase in bank capital leads to higher volatility which is in line with the empirical findings of (Andrés and Ingmar, 2017; Nguyen et al, 2019) but contrary to the findings of (Majumder and Li, 2018; Ugorji et al 2025).

Liquidity has a positive and statistically significant impact on the risk of DMBs which implies that an increase in liquidity leads to higher volatility. This result is in line with the findings of) but contrary to the result of (Ha and Quyen, 2018; Fajinmi et al 2023). Loan-to-deposit has a negative and statistically insignificant impact on the risk of DMBs which implies that an increase in loan-to-deposit leads to lower volatility. Bank size and asset growth are positively related to bank risk which implies that an increase in bank size and asset growth leads to higher volatility.

The effect of the bank capital, liquidity and loan-to-deposit on big and small DMBs performance and risk exposure

The effect of the bank capital, liquidity and loan-to-deposit on DMBs performance and risk exposure was analysed by separating the DMBs into big and small DMBs to ascertain whether our variable of choice affects the big DMBs differently from small DMBs. The DMBs were separated into big and small based on the estimated mean of bank size. The

DMBs with average annual size greater than the estimated mean were referred to as the big DMBs while DMBs with an average annual size lower than the estimated mean were taken to be smaller DMBs. Table 5 shows the bank capital, liquidity and loan-to-deposit on performance and risk of big DMBs.

Table 6. Impact of Capital on Big DMBs Performance

Variable	BIG BANK		
	RAROA	RAROE	Z – Score
CAP	7.637724 * (2.793107)	0.0725502 (1.584332)	3.083286 * (0.3008936)
LIQ	-0.3442845 (1.985614)	-0.5953937 (1.126298)	0.160003 (0.2139046)
LDR	-0.4356999 (0.9826549)	-0.5060366 (0.5573906)	-0.0472058 (0.1058586)
SIZE	0.6078849 (0.4353938)	0.3709091 (0.2469681)	0.0177051 (0.0469037)
ASG	-0.4823992 (0.4144784)	-0.3979423 (0.2351043)	-0.100281 (0.0446506)
α_{it}	-7.178376 (5.706276)	-4.091327 (3.236767)	0.1046102 (0.614721)
R – squared	0.8695	0.2862	0.9684
Adjusted R – squared	0.6765	0.0478	0.9429
F – statistic	3.48	1.32	48.52
Prob(F – statistic)	0.0133	0.2836	0.0000
Durbin – Watson stat	2.163326	2.052133	2.224195

Source: Authors Computation

*Level of significance was reported as *, ** and *** representing 1, 5 and 10 percent respectively. The parenthesis represents the standard errors*

The empirical result in table5 shows that capital is positively related to performance and risk of big DMBs. Liquidity is negatively related to DMBs performance but positively related to big DMBs risk. Loan-to-deposit ratio is negatively related to big DMBs performance and risk. Bank size is positively related to DMBs performance and risk. Asset growth is negatively related to big banks performance and risk.

Table 7. Impact of Liquidity on Small DMBs Performance

Variable	SMALL BANK		
	RAROA	RAROE	Z – Score
CAP	1.232708 * (0.4825117)	0.0093063 (0.7139537)	26.30977 * (1.724996)
LIQ	1.996807 (2.863263)	1.123902 (4.236659)	24.95413 ** (10.23627)
LDR	1.236271 (1.596081)	-0.0366794 (2.361659)	-9.070874 (5.706046)
SIZE	-1.223716 (1.00273)	-0.1927686 (1.4837)	13.03528 * (3.584794)
ASG	2.301951* (0.6627247)	0.4252443 (0.9806079)	1.801599 (2.369264)
C	14.8124 (11.43978)	-2.698015 (16.92699)	-164.8248 (40.8976)
R – squared	0.0292	0.0310	0.8894
Adjusted R – squared	0.2706	0.0001	0.7787
F – statistic	6.18	0.33	82.03
Prob(F – statistic)	0.0002	0.8947	0.0000
Durbin – Watson stat	2.166684	2.058625	2.229051

Source: Authors Computation

*Level of significance was reported as *, ** and *** representing 1, 5 and 10 percent respectively. The parenthesis represents the standard errors*

The empirical result in table 7 shows that capital is positively related to performance and risk of big DMBs. Liquidity is positively related to big DMBs performance risk. Loan-to-deposit ratio is positively related to RAROA but negatively related to RAROE of big DMBs

performance and risk. Bank size is negatively related to big DMBs performance but positively related to risk. Asset growth is positively related to big banks performance and risk.

Discussion

Our research findings are centered on the influence of bank capital, liquidity and loan-to-deposit ratio on DMBs performance and risk in Nigeria. Discussion of our empirical findings is based on the two-step GMM result based on its superiority over the one-step result. The empirical result revealed that there is a positive influence of capital on DMBs performance in Nigeria which implies that higher capitalization promotes DMBs performance in Nigeria. Liquidity inversely influences DMBs performance implying that excess liquidity reduces the bank performance which could be likely because Nigerian banks keep excessive cash in their vault and give less loan to their customers. Loan-to-deposit ratio directly influences DMBs performance implying that giving a higher proportion of bank deposit as loan improve the DMBs performance in Nigeria.

Bank capital and liquidity increase the risk of the bank which means that the higher the capital and level of liquidity maintained by the banks, the higher the risk exposure of the bank. Loan-to-deposit ratio is inversely related to DMBs risk which implies that the higher the loan disbursed to the bank customers, the lower the risk exposure of the bank.

Big DMBs capital is positively related to DMBs performance while liquidity and the loan-to-deposit ratio is inversely related to big DMBs performance. Big DMBs capital and liquidity are directly related to Big DMBs risk while the loan-to-deposit ratio is inversely related to big DMBs risk. The small DMBs capital, liquidity and loan-to-deposit ratio are positively related to DMBs performance while higher capital and liquidity exposes small DMBs to risk but higher loan-to-deposit ratio reduces the small DMBs risk.

5. Conclusion

The study examined the impact of capital, liquidity and loan-to-deposit ratio on Deposit Money Banks (DMBs) performance and risk in Nigerian baking industry using panel data from 2012 to 2023 which were obtained from the financial statements of DMBs in Nigeria using two-steps GMM estimation technique. The study further separated the DMBs into big and small using the fixed effect estimation technique to ascertain the ban with better performance between the big DMBs and small DMBs in Nigeria.

The empirical result shows that the performance of DMBs is persistence. Higher capital and loan-to-deposit ratio promote DMBs performance while higher liquidity worsens the DMBs performance. This indicate that higher capitalization enables the DMBs to carry out their intermediation function efficiently while excess liquidity prevents the bank from giving out a loan which generates the interest income; this has a spill-over effect of a lower DMBs profit. Higher capital and liquidity expose DMBs to greater risk while an increase in loan-to-deposit ratio reduces the risk of DMBs. This implies that excessive liquidity prevents credit creation which forms part of the DMBs revenue while disbursement of a higher proportion of the deposit to the deficit sector as loan reduces the risk of the bank and generate higher interest income. Additionally, the findings show that higher capital promotes the big DMBs performance while higher liquidity and loan-to-deposit ratio worsen the performance of the big DMBs. However, the small DMBs capital, liquidity and loan-to-deposit ratio promote the performance of the small DMBs. This means the small DMBs engage in more traditional banking activities than the big DMBs in Nigeria. Higher capital and liquidity

expose both big and small DMBs to greater risk while loan-to-deposit ratio minimizes the risk exposure of DMBs in Nigeria.

The study, therefore, recommends that the CBN should continue with the periodic review of its policies on the DMBs which forced the DMBs to key into the new policy review which were aimed at increasing the volume of credit extended to the small and medium enterprises, increasing the level of employment, protection of the customers, shareholders and other stakeholders interest. The big DMBs should also engage more in financial intermediation as it has promoted the performance and reduce the risk of the small DMBs in Nigeria financial system.

DATA AVAILABILITY STATEMENT*. The data that support the findings of this study are sourced from the annual reports and accounts of the selected DMBs quoted on the Nigerian Stock Exchange as at 31st December 2019. The data are available from the corresponding author upon request.*

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ANALYSIS AND FORECASTING OF INTERNATIONAL TOURIST FLOWS IN ROMANIA USING THE HOLT- WINTERS METHOD

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Abstract: *Foreign tourists represent a source of external capital for the national economy, actively contributing to the formation of Gross Domestic Product and stimulating investments in tourism infrastructure. The aim of this paper is to develop a forecast for international tourist flows in Romania using the Holt Winters method, based on official data provided by the National Institute of Statistics for the period January 2015 - January 2026. The research was conducted using Microsoft Excel, with the Solver tool employed to calibrate parameters through nonlinear programming techniques. The optimization process aimed to minimize the mean squared error, resulting in a set of smoothing coefficients that confirms the dominance of the seasonal component. Due to the volatility induced by the COVID-19 pandemic, the study demonstrates the efficiency of the additive version of the algorithm in maintaining the numerical stability of the forecasting system. The final result of the research consists of the extrapolation of tourist flows for the remainder of 2026.*

Key words: *optimization, forecast, tourism, Holt Winters method.*
JEL Classification: *C61, C53, L83.*

1. Introducere

Since 1989, tourism has been considered the field in which Romania could be competitive, being conditioned by the development and improvement of the conditions offered to potential tourists. Over time, tourism began to develop, attracting tourists from both the country and abroad (Ioneci, 2010).

Tourism activity plays an essential role in economic and social development, contributing to the valorization of a country's natural and cultural resources and to the increase of the standard of living (Minciu, 2004).

For Romania, the flow of foreign tourists represents an engine of economic growth, as they are interested not only in the big cities, the coast and the Danube Delta, but also in authentic cultural experiences, from traditional crafts to local gastronomy, which encourages the preservation of traditions and heritage and contributes to the development of local communities and rural areas.

However, the success of these destinations depends on good management of visitor flows, the major challenge for operators in the field being the seasonal nature of the activity. In order to maintain a competitive advantage, they need to base their decisions on forecasts that reduce uncertainty and allow for the optimal allocation of resources before peak periods.

In this regard, the Holt-Winters method was used in the paper to transform data from January 2015 to January 2026 into useful benchmarks, providing a perspective on the evolution of foreign tourist arrivals until the end of 2026.

2. Methodology

The Holt-Winters method, also known as triple exponential smoothing, is a time series forecasting technique developed by Peter Winters and Charles C. Holt in the early 1960s. This method includes a forecast equation and three smoothing equations: an equation for the trend component, an equation for the seasonal component, and another equation for the series level.

Depending on the type of seasonality, the Holt-Winters method can have a multiplicative formulation or an additive formulation.

In the multiplicative formulation (Hanke and Reitsch, 1998) the 4 equations have the form:

Level estimation: $L_t = \alpha \frac{Y_t}{S_{t-s}} + (1-\alpha)(L_{t-1} + T_{t-1})$

Trend estimation: $T_t = \beta(L_t - L_{t-1}) + (1-\beta)T_{t-1}$

Seasonality estimation: $S_t = \gamma \frac{Y_t}{L_t} + (1 - \gamma)S_{t-s}$, unde:

L_t, T_t, S_t represent the current level estimation, the trend component estimation and the seasonal component estimation, respectively

α, β, γ are smoothing parameters for the level, trend and seasonality with values $0 \leq \alpha \leq 1$, $0 \leq \beta \leq 1$, $0 \leq \gamma \leq 1$

s = seasonality duration, Y_t = actual value at time t

The forecast made at time t for p periods in the future is:

Prognoza realizată în momentul t pentru p perioade în viitor este:

$$\widehat{Y_{t+p}} = (L_t + pT_t) \cdot S_{t-s+p}$$

In the additive formulation the 4 equations have the form:

Level estimate: $L_t = \alpha(Y_t - S_{t-s}) + (1-\alpha)(L_{t-1} + T_{t-1})$

Trend estimate: $T_t = \beta(L_t - L_{t-1}) + (1-\beta)T_{t-1}$

Seasonality estimate: $S_t = \gamma(Y_t - L_t) + (1-\gamma)S_{t-s}$

The forecast made at time t for p periods in the future is:

$$\widehat{Y_{t+p}} = L_t + pT_t + S_{t-s+p}$$

3. Economic study

Using the Holt-Winters method, this paper aims to develop a forecast for international tourist flows in Romania, for the period February 2026 - December 2026.

The calculation basis is made up of data provided by the National Institute of Statistics on the number of foreign tourist arrivals in tourist reception structures. The analyzed data set was obtained after applying a filter by "foreign tourists", monthly frequency and centralization at national level (by cumulating the values related to macroregions, development regions and counties, as follows (Table no. 1):

Table 1. Number of foreign tourists in tourist reception structures

Data	Numar Turiști (Valoare reala)
01.01.2015	103793
01.02.2015	108257
01.03.2015	143819
01.04.2015	160564
01.05.2015	218981
.....	.....
01.05.2025	239462
01.06.2025	248562
01.07.2025	261886
01.08.2025	298146
01.09.2025	273744
01.10.2025	253097
01.11.2025	190904
01.12.2025	198602
01.01.2026	144893
01.02.2026	

Source: INSSE, 2026. *Tempo Online. Turism. TUR104F* [online] Available at: <http://statistici.insse.ro/shop/index.jsp?page=tempo2&lang=ro&context=63> [Accessed 9 March 2026].

According to the literature (Hyndman and Athanasopoulos, 2018), for economic variables with seasonal variations that increase proportionally to the average level, as is the case for tourist flows, the use of the multiplicative model is recommended for forecasting.

However, applying this model to the data in Table 1 led to erroneous results and an inability of the system to generate statistically valid forecasts.

The main cause of the errors was the impact of the COVID-19 pandemic on international tourism in 2020-2021. Since the multiplicative model is based on the ratio of values in estimating the level and seasonality, the drastic decrease in the number of tourists during the lockdown periods forced the algorithm to perform divisions by values tending to zero.

This led to negative values of the level and a very large mean square error.

Given these conditions, the additive version of the Holt-Winters algorithm was chosen, which managed to integrate the atypical values from the pandemic period without compromising the long-term forecast.

Using the Microsoft Excel spreadsheet program, the structure of the additive model was established, and the corresponding calculations were performed for the columns dedicated to the estimates for level, trend, seasonality and forecast.

The corresponding values for the squared error and the mean absolute percentage error (MAPE) were calculated.

The results of these calculations are presented in Table 2.

Table 2. Values obtained by applying the additive method of the Holt-Winters algorithm

Data	Nivel (L_t)	Trend (T_t)	Sezon (S_t)	Prognoza $(\hat{y}_t)$	Eroarea patratica	Eroarea medie: MAPE (Mean Absolute Percentage Error)
01.01.2015	**103793**	0	1	0	10772986849	
01.02.2015	104239,300	44,630	402,670	103794,000	19918369,000	0,0412
01.03.2015	108197,170	435,954	3924,586	104686,600	1531344730	0,2721
01.04.2015	113433,753	916,017	8245,152	112557,710	2304603880	0,2990
01.05.2015	123988,378	1879,878	16919,899	122594,922	9290276032	0,4402

01.05.2025	186557,329	1171,667	10546,006	187167,352	2734730245	0,2184
01.06.2025	192757,696	1674,537	15071,836	198275,002	2528782148	0,2023
01.07.2025	199670,426	2198,357	19786,210	209504,069	2743866684	0,2000
01.08.2025	209517,884	2963,267	26670,400	221654,993	5850874211	0,2566
01.09.2025	215940,395	3309,191	29783,721	239151,551	1196637547	0,1264
01.10.2025	219655,956	3349,828	30149,453	249033,307	16513598,4	0,0161
01.11.2025	216780,660	2727,316	24546,842	253155,237	3875216513	0,3261
01.12.2025	214962,694	2272,788	20456,088	244054,818	2065958643	0,2289
01.01.2026	207955,625	1344,802	12104,217	237691,570	8611574589	0,6405
01.02.2026				220059,842		

Source: Created by the author

The values for the three parameters α, β, γ initially set to 0.1 led to an extremely high mean square error (4.222.839.353) for the forecast to be useful (Table 3).

Table 3. The initial state of the model

Alfa	0,100
Beta	0,100
Gama	0,100
Media erorilor patratic	4222839354

Source: Created by the author

For this reason, the model was optimized, the values of the three parameters α, β, γ being automatically adjusted using Solver, an Excel add-in tool.

It determines the optimal value (in this application, a minimum value) of an objective cell by adjusting the input variables, while ensuring a series of specified restrictions.

Among the three solution methods available in Solver (Simplex LP, GRG Nonlinear and Evolutionary), the Generalized Reduced Gradient Nonlinear algorithm was selected because the Holt-Winters model is nonlinear.

The objective of the optimization process was to identify that combination of parameters α, β, γ within the interval [0,1] that minimizes the mean square error (MSE) (Figure 1).

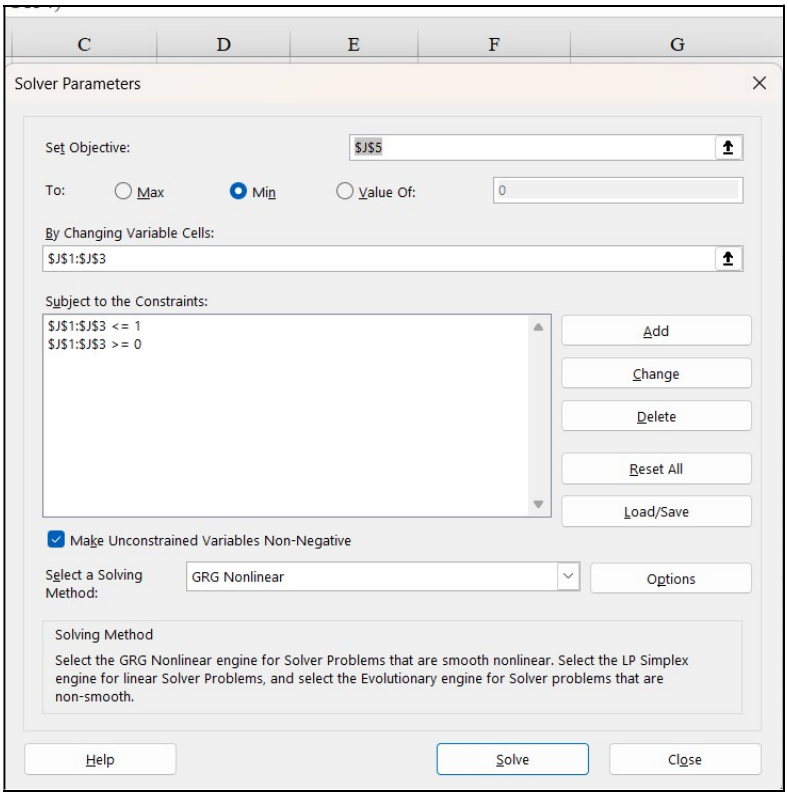

Figure 1. Solver Configuration
Source: Created by the author

As a result of the adjustments made by Solver, the values $\alpha = 0{,}817$, $\beta = 0$ and $\gamma = 1$ were obtained as shown in Table 4. With this new configuration, the mean square error decreased to the value of 1.066.192.603, representing an improvement in the model accuracy by approximately 75%.

Table 4. Results of the optimization process and final model calibration

Alfa	0,817
Beta	0,000
Gama	1,000
Media erorilor patratic	1066192604

Source: Created by the author

In the optimization process, to minimize the mean square error, the setting made by Solver on the trend parameter, $\beta = 0$, led to obtaining all values in the Trend column equal to zero (Table 5). These values signify that international tourism in Romania does not follow a linear growth, being influenced by seasonality.

According to Hyndman and Athanasopoulos (2018) the seasonality parameter γ controls the speed with which the model updates its seasonal component. The value $\gamma = 1$ indicates that the system gives maximum importance to the most recent observation (the previous year) ignoring the influence of long-term historical data.

This confirms that tourism in Romania follows a repetitive seasonal pattern, where recent data is much more relevant for forecasting than the distant ones marked by the period of instability caused by the pandemic .

Table 5. Results of the optimization

Data	Nivel (L_t)	Trend (T_t)	Sezon (S_t)	Prognoza $(\hat{y}_t)$
01.01.2015	103793	0	1	0
01.02.2015	107440,722	0,000	816,278	103794,000
01.03.2015	136506,434	0,000	7312,566	108257,000
01.04.2015	150192,542	0,000	10371,458	143819,000
01.05.2015	197938,218	0,000	21042,782	160564,000
.....	.....			
01.05.2025	214677,852	0,000	24784,148	186744,000
01.06.2025	222115,510	0,000	26446,490	239462,000
01.07.2025	233005,549	0,000	28880,451	248562,000
01.08.2025	262641,754	0,000	35504,246	261886,000
01.09.2025	242697,389	0,000	31046,611	298146,000
01.10.2025	225822,079	0,000	27274,921	273744,000
01.11.2025	174990,183	0,000	15913,817	253097,000
01.12.2025	181281,951	0,000	17320,049	190904,000
01.01.2026	137384,241	0,000	7508,759	198602,000
01.02.2026				144893,000

Source: Created by the author

The main indicator followed was the MAPE (Mean Absolute Percentage Error), which gives us a clear picture, in percentages, of the accuracy of the model.

Calculated for the entire interval 2015 – 2025, the MAPE value obtained is 35,98.

Although this value is quite high, analyzing the column of errors obtained for each month, it was observed that the largest errors were obtained during the pandemic, with periods of lockdown and restrictions contributing to the massive decrease in the number of tourists.

In the graph below (Figure 6), one can see both the very large decrease in the number of tourists during the pandemic and the way in which the forecast closely follows the real values. This fact provides confidence that the estimated values for the rest of the current year represent a useful support for planning activities in the coming months.

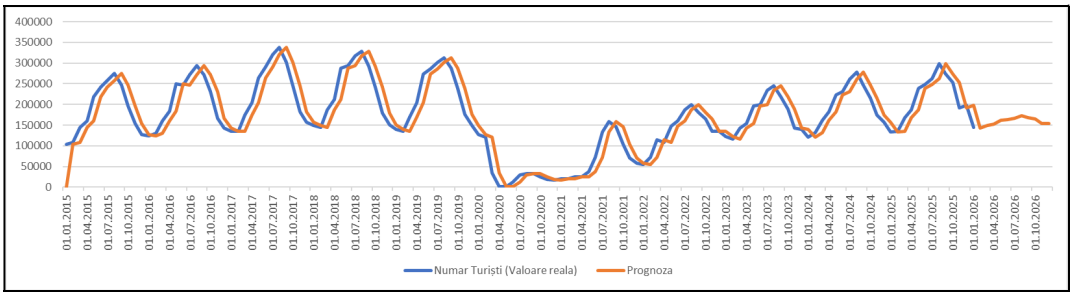

Figure 6. Comparative analysis between actual tourist flows and estimated values during the period 01.01.2015 – 01.01.2026
Source: Created by the author

Without the extremely low values during the pandemic, the MAPE would have been much lower, as demonstrated by the subsequent analysis carried out for the period 2023 – 2025, when the obtained MAPE value was 13,04.

According to Lewis (1982), a MAPE value between 10% and 20% indicates a good forecast, which demonstrates that the additive Holt–Winters method is sufficiently accurate to be used in anticipating foreign tourist flows (Figure 7).

This aspect allows tourism managers to establish their pricing strategies and reception capacities in advance, thus having a competitive advantage in the market.

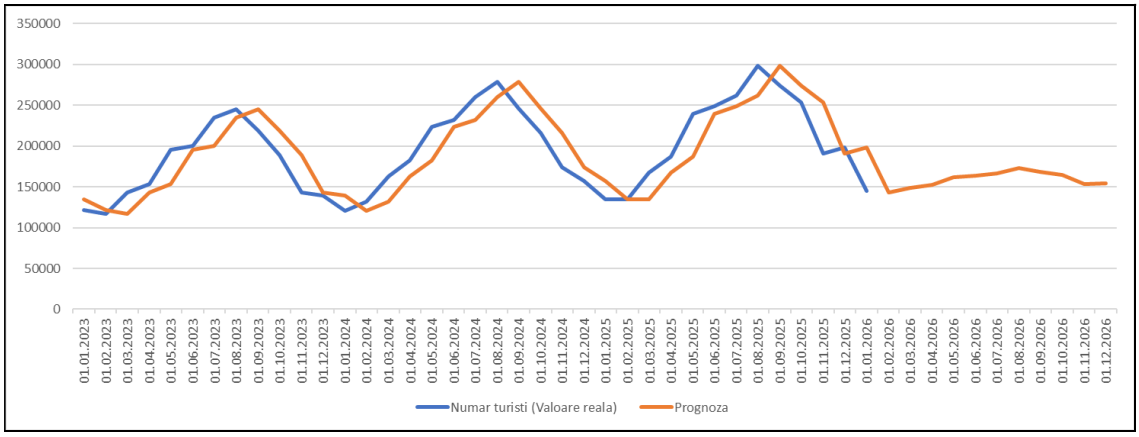

Figure 7. Comparative analysis between actual tourist flows and estimated values during the period 01.01.2023 – 01.01.2026.
Source: Created by the author

The forecast regarding the number of foreign tourists who will visit Romania between 01.02.2026 and 01.12.2026 is presented in Figure 8. The results indicate a stable evolution, with a minimum value for February of 142.981 arrivals and a maximum value of 172.888 arrivals forecast for August.

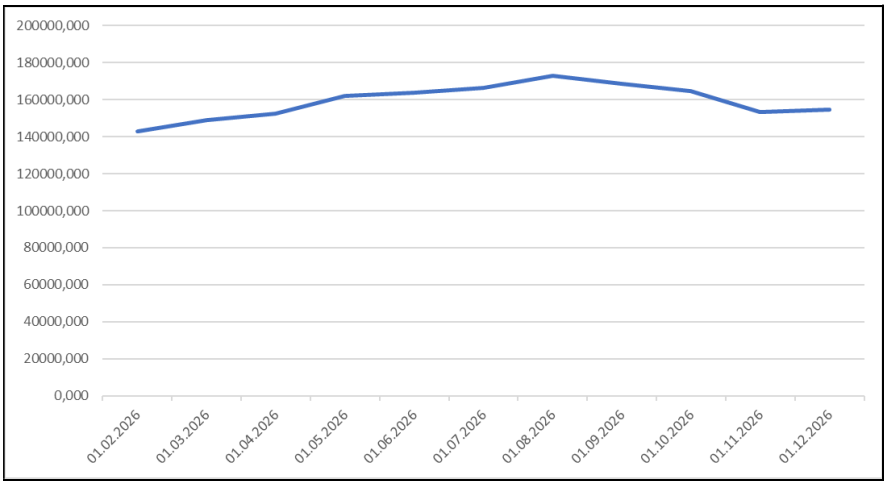

Figure 8. Forecast for the period 01.02.2026 – 01.12.2026.
Source: Created by the author

The fact that the level of forecasted values for 2026 is lower compared to previous years is due to the optimization of the parameters with Solver, which set the trend value $\beta - 0$. This means that the model did not force a continuous increase from one year to the next, but chose to rely on how last year's season looked.

For those who run tourism businesses, this way of calculating is extremely useful, as it provides a safety limit below which the number of tourists is unlikely to fall.

Thus, they can organize their staff and services based on some conservative estimates, avoiding unnecessary expenses when the market is difficult to predict.

3. Conclusions

Tourism is an important factor for a country's economy, representing a way to better capitalize on all categories of resources (Minciu, 2004).

To maintain their competitive advantage, tourism managers need an estimate of the number of visitors, which will allow them to better organize resources and services. The study presented in this paper has demonstrated that the Holt-Winters additive method is a tool capable of generating estimates of future values with high accuracy, thus providing support in planning activities according to demand fluctuations.

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GOOD GOVERNANCE IN A CONCEPTUAL ANALYSIS - ESG AS A TOOL TO ACHIEVE SDGs

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Abstract: *The ESG (Environmental, Social and Governance) framework allows, through its capacity to assess the responsibility and sustainability of organizations, to actively contribute to the implementation and monitoring of contributions to the SDGs at the company level. Governance at the company level, monitored through ESG governance, involves an internal framework capable, through its management structures, of transposing not only a good knowledge of risks and the implementation of appropriate management, but also a real policy of compliance, ethics, integrity and appropriate transparency regarding the harmonization of the company with the economic environment, the effectiveness of governance, human rights, gender, innovation, stability and the rule of law. In this context, the article aims to address the link between good governance described at the level of ESG policies and the sustainable development targets, particularly regarding SDGs 8, 9, 12, 16 and 17. The results, analyzing the rich literature on the subject, strengthen the link between ESG governance and the SDGs.*

Keywords: *sustainability, corporate governance, ESG performance.*
JEL Classifications: *M14, G34, Q01, Q56.*

1. Introduction

Globally, amid the energy and resource crisis, companies are increasingly faced with pressures to change, to review strategies to improve resource efficiency and reduce waste. In this context, ESG frameworks, in accordance with the principles of circularity, allow for transparent reporting of sustainability efforts at company level (Telukdarie & Nyathi, 2026). Thus, compliance with ESG is not only part of a legislative approach, carried out more intensively at European level, but also of a new vision of life and social approach, in which the company integrates harmoniously into the new economic environment that surrounds it.

Defined by the United Nations, the Sustainable Development Goals (SDGs) (World Commission on Environment and Development, 1987; United Nations; 2015; UNDP, 2020) represent an important benchmark for numerous public and private policies and strategies. An important element of these strategies refers to ESG (Environmental, Social and Governance). ESG allows, through its criteria, used to assess the responsibility and sustainability of companies, a direct, identifiable, concrete, often measurable reflection of the manner of fulfilling the SDGs at the company level. More precisely, it allows the internal transposition, respecting the proportions of dimensionality, capacity and effectiveness, of the SDGs at the company level.

Good governance means many things, often different for different social actors. However, the benchmarks of the concept refer to efficient and fast management structures, sensitive not only to concrete market changes, but also to trends and especially to concepts and perspectives. It also requires good compliance with legislation and public policies, adequate risk management, but especially ethics and integrity and transparency and good communication internally, within the company, but also with third parties.

Good governance makes it possible to achieve all SDGs at the organizational level, however, for ease and correspondence, this article will refer in particular to SDGs relatively equivalent to ESG policies, instruments and indicators. Therefore, SDGs such as: SDG 8 – Decent work and economic growth, SDG 9 – Industry, innovation and infrastructure, SDG 12 – Responsible consumption and production, SDG 16 – Peace, justice and strong institutions; SDG 17 – Partnerships for the goals, best reflect the idea of good public and private governance. Therefore, the purpose of the article is to analyze in detail the correspondences, connections, multi-determinations between the SDGs (especially those listed above) and ESG policies related to good governance.

2. Problem description

In recent years, there has been a growing demand for greater accountability and transparency in reporting on non-financial corporate performance. ESG frameworks aim to measure non-financial social, environmental and governance performance at the company level through standardized indicators and to assess the risks that threaten or may threaten the company in the future from a sustainability perspective. These frameworks allow investors, society and authorities to understand, evaluate, compare and discriminate between companies regarding their compliance with sustainability practices (Khamisu &Paluri, 2024; Hsu et al., 2025; Yadav et al., 2025). Despite this trend, ESG frameworks often remain channeled more towards fulfilling external requirements, as a formal list of tasks and are mainly oriented towards compliance and avoid playing a central role in the internal, deep, value-creating and responsible transformation of the company (da Cunha et al., 2025; Menichini, Salierno and Strollo, 2025), significantly differentiating large companies from small ones in terms of disclosing aspects that are less favorable for the company (Chopra et al., 2024). At the same time, when it comes to aligning ESG information with other related conceptual frameworks such as circularity, social equity, SDGs, etc., the degree of alignment reflects consistent conceptual, theoretical and empirical gaps, as well as a rigidity in mechanical reporting, the almost exclusive reliance on compliance considerably limiting the potential of the ESG framework to transform the business model into a circular one (Telukdarie & Nyathi, 2026).

3. Review of the specialized literature

The literature abounds in explaining the link between ESG and SDGs, on specific topics, such as good governance, there are numerous attempts to clarify the link with SDGs especially with SDG12, SDG16 and SDG17 (López-Cabarcos et al., 2025; Sundarasen, Rajagopalan & Zyznarska-Dworczak, 2025; Kim and Yang, 2026; Pérez Escamez et al., 2026 etc.), however, syncope still persists, and the formalism still dominates ESG frameworks. Increased transparency and the most correct identification of the role of governance are observed especially in the works of Cunea et al. (2025) and Salama et al. (2026), demonstrating that ESG, in addition to the firm's market indicators, also positively influence sustainable development outcomes, showing the strong role played by stability committees and extensive sustainability reporting in achieving these objectives.

Table 1. Recent bibliographic highlights on the link between ESG and SDG

ESG Governance	related SDG	Method	Source
Government Effectiveness; Corporate Governance	SDG 16, SDG 17	Empirical analysis (panel data, EU firms)	Pérez Escamez et al. (2026)
Ethical Governance; Accountability; Transparency	SDG 16, SDG 12	Conceptual + empirical	López-Cabarcos et al. (2025)
Governance Systems; Institutional Quality	SDG 16, SDG 17	Bibliometric + predictive analysis	Costea et al. (2025)
Corporate Governance; Risk Management	SDG 8, SDG 9, SDG 12	Systematic review	da Cunha et al. (2025)
Governance Structures; Institutional Frameworks	SDG 16	Bibliometric analysis	da Silva (2025)
Sustainability Governance; Disclosure	SDG 12, SDG 16, SDG 17	Econometric, fixed-effects model (OECD firms)	Salama et al.(2026)
Transparency; Reporting; Accountability	SDG 12, SDG 16	Bibliometric + content analysis	Sundarasen, Rajagopalan & Zyznarska-Dworczak (2025)
Regulatory Governance; Compliance	SDG 16, SDG 17	Systematic thematic review	Kim and Yang (2026)
Financial Governance; Performance Oversight	SDG 8, SDG 9	Bibliometric analysis	Cunea et al. (2025)
Governance & Inequality; Human Rights	SDG 8, SDG 16	Empirical study	Mensah et al. (2025)
Financial Governance; ESG Integration	SDG 8, SDG 12	Empirical (financial institutions)	Raimo et al. (2021)
ESG Data Governance; Transparency	SDG 12, SDG 16	Conceptual	Kotsantonis & Serafeim (2019)
Corporate Governance; Sustainability Strategy	SDG 8, SDG 9, SDG 12	Meta-analysis	Friede et al. (2015)
Strategic Governance; Multi-stakeholder engagement	SDG 17, SDG 16	Network analysis	van Zanten & van Tulder (2021)

Source: Authors' conceptions, verification and systematization, chat GPT literature search

Regarding long-term sustainability, the van Zaten & van Tulder study (2021) shows that the alignment between SDGs and corporate strategies can be an indicator of this success, and the implications include the potential to use companies' activities as leverage for a nexus approach to SDGs.

In relation to the ESG-SDGs nexus, da Silva (2025) and Costea et al (2025), through a bibliometric methodology, attempt to map corporate governance and sustainable development studies, starting from the interconnections between the two ESG and SDGs domains and ending with trends for future studies, thus addressing the critical gap related to the lack of predictive data. Their results indicated, on the one hand, that specific corporate governance terms regarding standardization are particularly linked to SDG 12, SDG13 and SDG17, and, on the other hand, they reflected a transition from business ethics and social responsibility to

topics regarding the board of directors, sustainability and corporate social responsibility, highlighting a change in the way companies understand their responsibilities and are driven to act in their internal and external environments.

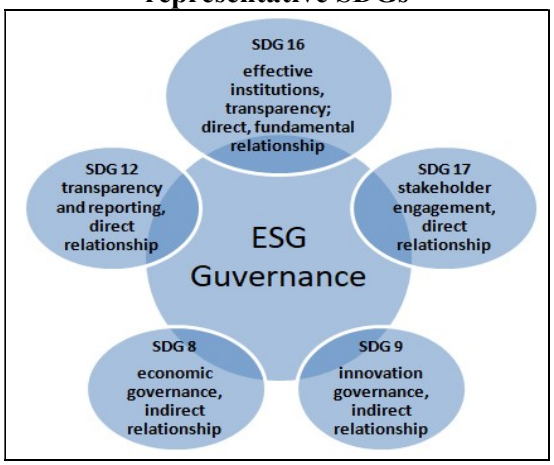
4. Methodology and data sources

The methodology aims on the one hand at an interrogative, comparative analysis of the specialized literature, and on the other hand at the theoretical systematization and conceptual clarification of the link between ESG and SDGs in the field of good governance. Although the literature abounds in the use of numerous SDGs, and the ESG-governance link is related to all SDGs, the present analysis attempts a specific focus in particular on the governance SDGs, more precisely on SDG 8, SDG 9, SDG 12, SDG 16 and SDG 17.

5. Results

With a multidirectional valence, SDG 16 (Peace, Justice and Strong Institutions) reflects the best the correspondence with ESG governance. Starting from the rule of law, the fight against corruption and effective institutions and ending with more subtle elements such as institutional transparency, good governance ESG contributes directly and indirectly to achieving this target. Also, fulfilling SDG 16 to the best extent possible provides the premise for achieving good governance ESG to the best extent possible and faster. Also, SDGs 17, which focuses on partnerships, involves not only institutional compliance through ESG reporting and standardization, but especially the way in which companies understand to work together for a common good, of the field in which they operate, of the economic branch in which they operate, but also for the common good of the economic, social, religious, cultural, political, global institutional environment in which they operate. In figure 1, the link between ESG governance and SDGs is graphically presented.

Figure 1. Diagram of the interrelationships between governance ESG and governance representative SDGs



Source: literature investigation, authors' conception

Likewise, SDG8, through its indicators on good, responsible labour practices and combating informal work, and SDG9, which aims at responsible regulation and especially

innovation and responsible investment management, start from the premise that these are reflected at the societal level, through an equivalent ESG compliance of corporate and technological governance. Last but not least, SDG 12 – Responsible consumption and production, offers ESG compliance through effective reporting, traceability, audit and effective internal control.

The conceptual scheme (see Figure 2) highlights that the ESG governance dimension constitutes the target variable that shapes the institutional and organizational framework of the company. Thus, ESG governance frameworks act through governance mechanisms (ESG reporting, risk management, compliance, stakeholder engagement and strategic decision-making), which function as mediating variables, facilitating the transposition of governance principles into concrete results. These processes involve the achievement of the Sustainable Development Goals, especially in the areas of efficient and accountable institutions, partnerships, economic growth, innovation and responsible production.

Figure 2. ESG governance schematic transmission model on Sustainable Development Goals

Source: literature investigation, authors' conception

Thus, by studying the literature, it can be stated that ESG governance has a direct and indirect positive effect on the achievement of the SDGs through governance mechanisms such as ESG reporting, compliance, risk management and stakeholder engagement.

The literature highlights the essential role of ESG governance (regarding transparency, accountability, regulatory quality and the rule of law, reporting, compliance and stakeholder engagement) as an institutional driver for achieving the Sustainable Development Goals (SDGs), and empirical evidence suggests that effective corporate governance mechanisms enhance institutional performance and promote trust, thereby directly and indirectly contributing to better governance outcomes. At the same time, studies show that transparency and accountability mechanisms, in particular ESG reporting frameworks, play a mediating role in aligning corporate behaviour with sustainable production models, decent work,

collaboration and innovation-driven economic growth (Sundarasen, Rajagopalan & Zyznarska-Dworczak, 2025; Salama et al, 2026, da Cunha et al., 2025; Friede et al., 2015).

If we take, for example, the World Bank's ESG governance classification, we observe systematization into specific sections, with well-defined indicators that can be connected to some of the sustainable development targets considered previously. Although the evidence does not allow for a perfect overlap between ESG governance and the SDGs, numerous analogies, simplifications and connections can be made. This may allow us in future analyses to apply specific analysis models that may or may not strengthen the premises outlined so far in the literature.

Table 2. The link between ESG and SDG considering World Bank ESG Governance classification

ESG Governance group	Indicators' name	Correspondent SDG(s)
Economic Environment	- GDP (annual % growth); - Individuals using the Internet (% of population)	SDG 8, SDG 9, SDG 17
Gender	- Proportion of seats held by women in national parliaments (%); - Ratio of female to male labour force participation rate (%); - School enrollment (GPI); - Unmet need for contraception (%)	SDG 16, SDG 17, SDG 8
Government Effectiveness	- Government Effectiveness: Estimate; - Regulatory Quality: Estimate	SDG 16, SDG 12
Human Rights	- Economic and Social Rights Performance Score; - Voice and Accountability: Estimate;	SDG 16, SDG 8
Innovation	- Patent applications, residents; - R&D expenditure (% of GDP); - Scientific and technical journal articles	SDG 9
Stability & Rule of Law	- Control of Corruption: Estimate; - Net migration; - Political Stability and Absence of Violence; - Rule of Law: Estimate	SDG 16, SDG 17

Source: www.esgdata.worldbank.org; authors' conception and systematization

At the same time, particular attention must be paid to the manner of reporting so that undesirable elements are not hidden under the carpet, transparency is maximum and constructive, carefully and permanently involving all institutional actors who can improve the company's real sustainability performance.

Certain aspects of incongruence between voluntary corporate frameworks and global sustainable development targets generate a series of problems of methodological compatibility, standardization and reporting, which generate reporting asymmetries and lack of methodological comparability. In ESG governance, problems related to "greenwashing" arise, as well as internal conflicts between various actors (shareholders-managers-employees) due to the often contradictory role objectives of them. These are often reflected in indicators selected strategically rather to improve reputation, without real alignment with the systemic impact required by the SDGs.

Another role conflict unfolds is between the microeconomic level (of the company) and the macroeconomic level (of public policies and good macroeconomic governance).

Maximizing the achievement of the SDGs can only be felt when each of the actors (e.g. the state and companies) increases its measurable contribution to the objectives of reducing inequalities, protecting the environment, responsible leadership and social partnership for a better world. Thus, the multitude of issues related to ESG governance target the epistemological framework (measurement, standardization, reporting, etc.), the institutional framework and the ethical framework, as well as the degree of real involvement and the real willingness to create a reality acceptable to everyone.

Although good corporate governance implies the implementation of all ESG frameworks (including social and environmental), focusing only on the governance level can indicate the capacity to provide a guiding signal for the other two ESG sections involved (environmental and social). Also, the impact of a good corporate policy on ESG objectives goes far beyond the narrow valence of the Sustainable Development Goals framework with predominant implications on leadership, responsible economic performance, peace and social stability (SDGs 8, 9, 12, 16, 17). The valences are multifaceted and the study of the specialized literature demonstrates that there is still much to identify and clarify regarding the connection between SDGs-ESG concerning governance.

6. Conclusions

Through its governance dimension, the ESG framework functions as an institutional mechanism for implementing and monitoring the Sustainable Development Goals, especially SDG 16 and SDG 17, facilitating accountability, transparency, and decision-making efficiency in companies. Without good governance, ESG does not have the necessary tools and cannot produce a real impact on the SDGs, especially in terms of governance on SDG16.

Studies show that at the company level, SDG 8 and SDG 9 connect more with the economic and innovative dimension of corporate governance, SDG 17 with the relational dimension of governance, SDG12 connects especially with the operational extension of corporate governance, and SDG 16 represents the hard core of these connections, emphasizing the implementation of legislation, transparency and accountability.

The proposed conceptual model details how ESG governance dimensions (such as transparency, compliance, accountability and corporate governance) act as key institutional factors influencing the achievement of the SDGs. Thus, ESG governance frameworks operationalize sustainability objectives into measurable results. Starting from the legislative framework and compliance systems, ESG reporting reflects or should reflect more than a mechanical compliance with sustainability requirements, proposing a new way of reporting on value and quality through the perspective of multiple benefits in economic, social and political representation of all stakeholders involved and interested at the company level.

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THE ROLE OF PRIMARY HEALTHCARE IN ENHANCING MEDICAL SERVICES MANAGEMENT PERFORMANCE WITHIN THE MINISTRY OF INTERNAL AFFAIRS (MAI) UNITS

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Abstract: *The research entitled "The Role of Primary Healthcare in Enhancing Medical Services Management Performance within the Ministry of Internal Affairs (MAI) Units" analyzes the strategic importance of primary medicine as a fundamental pillar in optimizing human and organizational resources. Based on the premise that an efficient healthcare system requires an integrated approach between management and medicine, the study evaluates how primary healthcare directly contributes to increasing the quality of the medical act and patient satisfaction within the specific structures of the MAI. The general objective of the paper aims to evaluate the multidimensional impact of primary medical services on personnel health, operational efficiency, and the reduction of costs associated with long-term care. The research methodology combines a rigorous literature review with a quantitative approach based on the administration of a survey. This method aims to collect essential data regarding service accessibility, medical staff competence, and the degree of decisional transparency at the institutional level. The central hypothesis suggests that effective human resource management—focused on recruitment, continuous training, and the retention of qualified personnel—constitutes the primary engine for increasing the performance of medical services. Preliminary results highlight that the MAI internal medical units play a crucial role, not only by providing basic consultations but also by constantly monitoring the health status of the personnel, which is vital for the safe fulfillment of operational missions. In conclusion, the paper emphasizes that sustained investment in human capital and the development of interdepartmental communication protocols are essential for ensuring the sustainability of the internal medical system. Optimizing the collaborative relationship between medical staff and other operational structures of the MAI remains a priority direction for increasing competitiveness and the management performance of healthcare services.*

Keywords: *primary healthcare, performance management, human resources, MAI, healthcare.*
JEL Classification*: P46, J24, M10.*

1. Introduction

1.1 Research Significance and Current Context

The healthcare system represents a fundamental pillar of social structure, its success depending directly on the symbiosis between the medical act itself and rigorous management of specialized services. The present research is grounded in the premise that optimizing healthcare performance requires an interdisciplinary approach at the intersection of medicine and management. Its central objectives include staff motivation, resource efficiency, and, ultimately, the enhancement of patient satisfaction (Mintzberg, 2017).

Quality management within healthcare facilities is not limited to activity supervision; rather, it involves a continuous process of planning and methodological guidance. In this context, human resources are identified as the vital element. The professionalism of the system is guaranteed by staffing executive positions with specialized personnel capable of ensuring a high level of competence (Popa, 2005).

The paramount role of human resources in increasing the competitiveness of healthcare services in Romania is highlighted through four essential pillars:

Professional Capabilities: Continuous investment in ongoing training ensures evidence-based medical assistance updated to international standards (Institute of Medicine, 2003).

Communication and Ethics: The provider-patient trust relationship, supported by soft skills and solid ethical principles, is definitive for the perceived quality of the medical act (Gavrilovici, 2012).

Research and Innovation: The active involvement of staff in scientific experimentation leads to the development of safer and more efficient protocols (Păun, 2013).

Strategic Management: Effective administration—ranging from selection and recruitment to performance evaluation and career management—generates a motivated and effective workforce (Crăciun, 2015).

Although the Romanian medical system faces major obstacles related to infrastructure and financing, the strategic development of human capital represents the primary opportunity to transform current challenges into competitive and accessible healthcare services.

2. Theoretical foundation of medical assistance within MAI units

2.1 Conceptual and Specific Approaches to Primary Care

Primary healthcare within the Ministry of Internal Affairs (MAI) is governed by patient-centered theoretical models that prioritize the specific needs of military and civilian personnel (police, firefighters, gendarmerie). This model emphasizes an empathetic doctor-patient relationship and service accessibility, which are vital for maintaining the operational capacity of the forces.

Quality management represents the central pillar of these services, aiming for continuous improvement through standard monitoring and the implementation of preventive measures. Within MAI units, primary medical assistance transcends basic consultations, encompassing:

Emergency Intervention: Management of critical situations and rapid field response.

Prevention: Health education programs and the promotion of a healthy lifestyle.

Operational Support: Pre-mission evaluations and medical support during specific missions.

2.2 Structures, Resources, and Institutional Collaborations

The Romanian healthcare system has evolved from an integrated state model toward a contract-based insurance model (Bara, 2002). Within this landscape, the internal medical units of the MAI constitute the "backbone" of assistance for its own personnel, organized into:

Medical Clinics: For primary consultations and routine treatments.

First Aid and Recovery Rooms: Designated for emergencies and post-intervention monitoring.

Laboratories and Imaging: Equipped with modern technology (ultrasound, X-ray machines, AEDs) for rapid diagnosis.

As medical needs may exceed internal capacity, the MAI strategically collaborates with public and private hospitals for complex surgical interventions and advanced investigations (CT/MRI).

2.3 Organizational Culture in the MAI Medical System

Organizational culture represents the set of values, norms, and behaviors that define how the medical act is performed (Chiriță, 2015). Within MAI units, this culture is marked by professionalism, ethics, and a clear hierarchy, as well as a strong orientation toward accountability and transparency (Bordeianu, 2018). This ensures not only the efficiency of services but also the maintenance of employee trust in their own healthcare system.

2.4 Organizational Framework

While in the public system the responsibility for primary care falls to independent family physicians (Andrei, 2011), coordination within the MAI is centralized. The Medical Directorate is the central unit that elaborates the ministry's health strategy.

The primary duties of the Medical Directorate include:

Strategic Coordination: Applying Government and Ministry of Health policies adapted to the specificities of the MAI.

Medico-Military Expertise: Coordinating expertise commissions (e.g., "Gerota" and "Avram Iancu" Hospitals) to evaluate medical fitness and disability degrees.

Resource Management: Selection, management, and continuous training of medical personnel.

Epidemiological Surveillance: Monitoring infectious disease outbreaks and sanitary inspection across all ministry units.

Mission Preparedness: Ensuring medical stockpiles and assistance during mobilization or special situations.

3. Research methodology

To evaluate the impact of primary medical assistance on the optimization of health service management within the Ministry of Internal Affairs (MAI) units, this paper adopts a mixed methodology, structured along the following fundamental coordinates:

3.1. Theoretical Documentation and Literature Review

The first stage of the scientific endeavor consists of a critical analysis of the specialized literature. This component aims to identify the current state of knowledge in the field of healthcare management and to locate theoretical or practical gaps regarding medical systems under special regimes. This foundation allows for the establishment of a solid conceptual framework for the subsequent interpretation of data.

3.2. Research Instrument: The Questionnaire

The central pillar of the applied research is represented by the use of a questionnaire, an instrument chosen for its ability to collect quantifiable data from a representative sample. To ensure scientific rigor, its construction complies with the following performance criteria (Frațilă and Duică, 2014):

Validity and Reliability: Questions are formulated to precisely measure the targeted management and performance indicators.

Objectivity and Clarity: The language used is accessible, eliminating ambiguities to guarantee the coherence of responses.

Professional Deontology: The research guarantees the full anonymity of respondents and the confidentiality of the information provided, respecting ethical standards of data collection.

Logical Structure: The questionnaire is organized in an intuitive format and was subjected to a preliminary testing phase to eliminate design errors.

4. Case study: the role of primary medical assistance in MAI units

4.1 Description and Objectives of Applied Research

The present case study investigates the mechanisms through which primary medical assistance directly influences the performance and competitiveness of health services within the Ministry of Internal Affairs. The research was built on a solid theoretical foundation

resulting from the analysis of specialized literature (foundational works, scientific articles, and administrative publications), which highlighted the paramount importance of human capital in medical systems under special regimes.

The primary objective was to evaluate how human resource management and the quality of the primary medical act contribute to organizational efficiency, starting from structural principles such as beneficiary orientation, staff specialization, and multidisciplinary adaptability (Popescu, 2004).

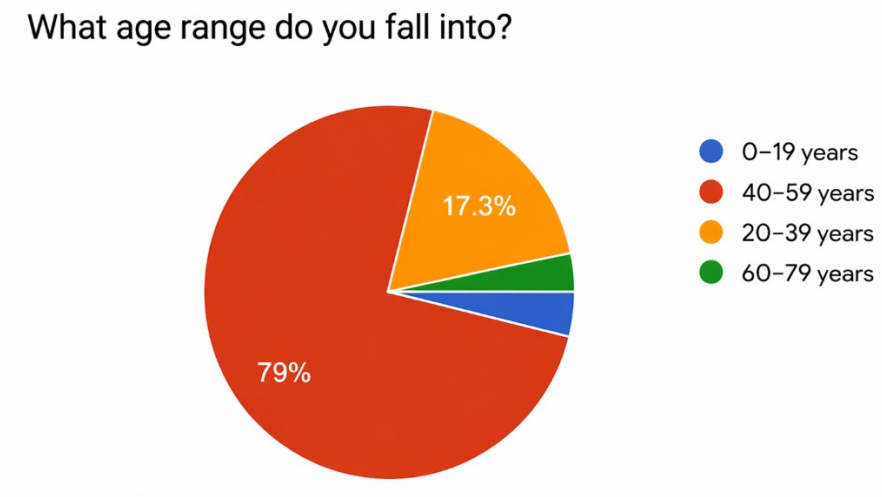
Interpretation of Results:

The extracted conclusions were correlated with the previously established theoretical framework, providing an integrated perspective on the strategic role that human resources hold in increasing the competitiveness of medical services.

5. Results and discussions: analyzing the impact of medical assistance on MAI management

5.1. Demographic Radiography: Experience as a Central Pillar and the Succession Challenge

The analysis of the respondent profile highlights a fundamental trait of the current Ministry of Internal Affairs (MAI) system: the predominance of mature specialists. The fact that most participants are aged between 40 and 59 underscores a reality rooted in stability and accumulated expertise. This distribution indicates a medical corps with high professional resilience, trained within a rigorous system, but currently facing the necessity of adapting to new technologies and modern protocols.



From a human resource management perspective, this demographic indicates a high potential for mentorship. However, correlating these data with marital status (where a significant portion carries family responsibilities), we observe a resource that deeply values job stability.

Key Management Challenge: The primary concern is not immediate external migration (typical of younger cohorts), but succession planning. Within the next 5–10 years, a massive portion of this personnel will exit the system, creating a competency void unless knowledge transfer strategies are implemented immediately.

The balance between urban (49.4%) and rural (50.6%) backgrounds is a positive indicator of territorial coverage, suggesting that these mature professionals are well-integrated into their communities. MAI management must capitalize on this loyalty by offering incentives to maintain their activity and transform rural clinics into local centers of excellence.

5.2. Professional Competence and the Imperative of Systemic Collaboration

While 61.7% of respondents evaluate staff training as "excellent," this confidence must be nuanced by identified development needs. The study emphasizes that the vast clinical experience of the 40–59 age group must be coupled with an openness toward the digitalization of services.

Respondents identified updating technical knowledge (35.5%) and patient communication skills (33.3%) as vital competencies. This suggests that medical management should facilitate training courses that address:

Technical Proficiency: Integration of information systems.

Emotional Intelligence: Managing occupational stress, as mature staff are best positioned to handle the complex human relationships inherent in police and gendarmerie medical care.

Furthermore, the importance placed on collaboration with government authorities (76.5%) demonstrates that local management success is perceived as dependent on a centralized vision. Mature human resources tend to value structure and coherent public policies, demanding a system that supports their efforts through constant logistical investment rather than mere administrative regulation.

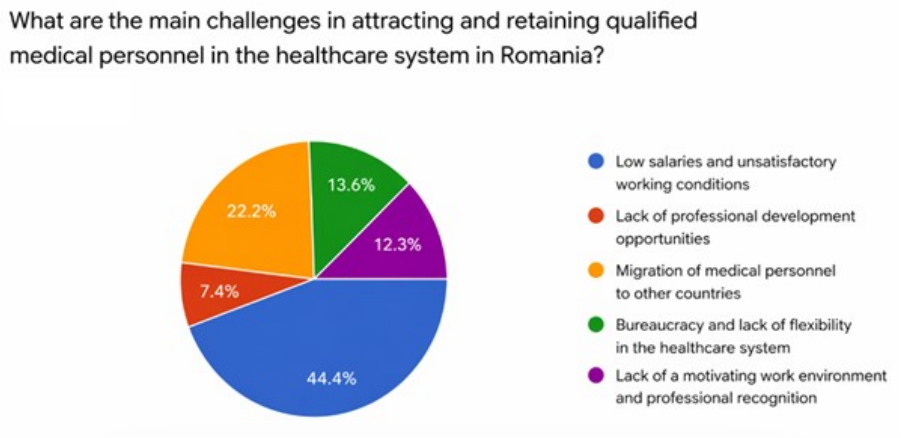
5.3. Stress Factors and Determinants of Managerial Performance

This critical section reveals structural bottlenecks hindering competitiveness. The system faces a significant deadlock: poor salaries and working conditions were identified by 44.4% of participants as primary challenges. For an age group with established financial and family obligations, these shortcomings can lead to chronic demotivation.

For a healthcare manager, these data serve as an alarm for two reasons:

System Migration (22.2%): Even at a mature age, professionals may opt for the private sector if workplace pressure outweighs benefits.

Bureaucracy (13.6%): Experienced staff most acutely feel the time "lost" to administrative tasks at the expense of the medical act, decreasing the perceived quality of service.



To improve performance, respondents requested investments in training (33.3%) and a merit-based recognition system (16%), indicating a desire to be evaluated on performance rather than just seniority.

5.4. The Satisfaction Paradox and Organizational Resilience

The analysis of service quality (47.5% very satisfied) versus leadership support (only 25.9% very satisfied) reveals a harsh reality: the quality of MAI services is sustained by the "duty ethics" of its mature staff. These professionals demonstrate high professionalism "in spite of the system."

Over 72% of respondents view their role as "critical," showing deep institutional commitment. However, management cannot rely on this resilience indefinitely. The perceived lack of managerial support (nearly 27% dissatisfaction) among experienced personnel can lead to organizational weariness, indirectly affecting the morale of the entire collective and the absorption rate of young physicians.

6. Conclusions and Strategic Directions for Optimization

To transform these results into real performance growth, MAI medical management must act on three axes:

Motivational Axis: Review benefits to recognize expertise and provide access to modern technologies that simplify, rather than complicate, their work.

Operational Axis: Drastically reduce bureaucracy through the digitalization of procedures. Mature staff require tools that automate reporting to maximize time for consultations.

Succession Axis: Implement paid mentorship programs where physicians in the 40–59 age group receive incentives to train residents and new hires.

Prioritizing Human Capital through Retention Policies: Attracting and maintaining qualified personnel goes beyond salary. It is imperative to create a work environment offering stability, professional recognition, and work-life balance to halt specialist emigration.

The competitiveness of the MAI system directly depends on the quality of dialogue with governmental authorities and academic institutions. Strategic partnerships for continuous training and a flexible legislative framework are sine qua non conditions for sustainable reform. In conclusion, primary healthcare in the MAI relies on an experienced and stable resource that requires logistical support to exercise their profession at elite standards.

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DIGITAL TRANSFORMATION READINESS OF MOLDOVA'S FOOD INDUSTRY: DEVELOPMENT TRENDS AND EMERGING AI ADOPTION

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Abstract. *This study examines recent development trends in the food industry of the Republic of Moldova and evaluates the preconditions for its digital transformation in the context of emerging AI adoption. The analysis is based on official statistics from the National Bureau of Statistics of the Republic of Moldova and combines sector-specific indicators for 2019–2024 with manufacturing-level ICT data for 2025 used as the closest available proxy for the technological environment of food-processing activities. The study applies comparative, structural, and dynamic economic-statistical analysis to industrial output, producer prices, wages, investments, enterprise structure, employment, financial performance, selected foreign trade flows, and indicators of digital readiness. The results show that the sector remains an important component of national manufacturing, but its recent development has been uneven. Wages, investment, and nominal financial results increased, whereas employment declined and trade asymmetries persisted across product groups. The digital evidence indicates that basic forms of digital integration are already present, while the diffusion of more advanced solutions, especially AI, remains limited. Overall, the sector demonstrates relevant but incomplete preconditions for deeper digital transformation.*

Keywords*: food industry; digital transformation; artificial intelligence; manufacturing; technological readiness; external trade.*
JEL Classification: *L66; O33; E22.*

1. Introduction

The food industry is operating in an increasingly complex environment shaped by volatile costs, changing consumer preferences, stricter food safety requirements, and growing pressure to ensure transparency across supply chains. In such conditions, digital transformation is no longer merely a technological trend; it is becoming a strategic response to structural challenges related to efficiency, coordination, adaptability, and long-term competitiveness (Gomez-Trujillo and Gonzalez-Perez, 2022; Klerkx et al., 2019). This shift is especially relevant for food-processing activities, where firms must simultaneously maintain process continuity, product quality, traceability, and timely logistics under unstable market conditions (Verdouw et al., 2016).

In contemporary literature, digitalization is interpreted not only as the introduction of new tools, but also as a broader transformation of organizational routines, value creation mechanisms, and business models (Gomez-Trujillo and Gonzalez-Perez, 2022; Turcan et al., 2023). In the agri-food context, digital transformation is increasingly associated with new forms of coordination, data exchange, and ecosystem-based innovation that can improve the responsiveness and sustainability of production and distribution systems (Klerkx et al., 2019; Wolfert et al., 2023). For food enterprises, this means that digital technologies may support

not only operational efficiency, but also stronger interaction among producers, processors, distributors, and consumers (Turcan, 2025; Verdouw et al., 2016).

Artificial intelligence occupies a particularly important place within this broader transformation. Unlike basic digital tools, AI enhances the analytical and predictive capacity of enterprises by supporting forecasting, anomaly detection, process optimization, and data-based decision-making (Pournader et al., 2021; Toorajipour et al., 2021). In the food industry, these capabilities are especially valuable because errors in quality control, process management, or demand planning may result in direct financial losses, higher waste, and weaker market performance. Recent studies therefore emphasize the growing relevance of machine learning and AI-based solutions for food quality control and production support (Liakos et al., 2025; Turcan, I2025)

At the same time, the literature shows that the digital transformation of food systems cannot be reduced to AI alone. Blockchain-based traceability systems, IoT-enabled data collection, and interoperable digital infrastructures are increasingly discussed as complementary elements of more transparent and accountable food supply chains (Kamilaris et al., 2019; Vasileiou et al., 2025; Verdouw et al., 2016). This is particularly important for food markets, where product origin, safety, and compliance are increasingly important for market transparency, traceability, and consumer confidence (Ellahi et al., 2023; Kamilaris et al., 2019). In this sense, digital transformation in food manufacturing is closely linked to sustainability goals, since better traceability, improved information flows, and smarter coordination mechanisms may contribute to lower losses, stronger process accountability, and more resilient business models.

A number of studies from the Republic of Moldova provide useful entry points for this discussion. Existing research has addressed digitalization as a factor in the development of circular economy business models (Turcan et al., 2023), the integration of emerging technologies into supply chains and their contribution to circular economy practices (Turcan, R., 2025), and the role of digital technologies in quality assurance within circular production systems (Turcan, 2025). Related studies also emphasize the growing importance of digital resources in the promotion of agri-food production (Litvin, 2025). At the same time, broader sectoral research has also examined transport development trends relevant to freight movement in the Republic of Moldova, including investment-related challenges (Gheorghita et al., 2024), as well as transport and logistics trends affecting product movement and market connectivity (Gheorghita and Sestenco-Diacek, 2025).

These contributions are important, yet they do not provide an integrated statistical assessment of the food industry of the Republic of Moldova that links sectoral economic dynamics with the current preconditions for digital transformation and the still limited diffusion of AI-related solutions. An important research gap therefore remains. The existing literature helps explain why digitalization, traceability, logistics, and emerging technologies matter for agri-food development, but it does not show whether the Moldovan food industry already possesses the economic, structural, and technological basis necessary for a deeper transition toward data-driven and AI-supported development.

Against this background, the present study aims to examine current development trends in the food industry of the Republic of Moldova and to assess the preconditions for its digital transformation in the context of emerging AI adoption. The article contributes by linking sector-specific evidence on production, prices, wages, investments, enterprise structure, employment, financial performance, and external trade with a proxy-based

assessment of digital readiness derived from manufacturing statistics. Such an approach makes it possible to evaluate not only the recent economic dynamics of the sector, but also the extent to which the conditions for further digital transformation are already emerging under existing statistical constraints.

2. Research methodology

This study employs a descriptive economic-statistical research design based on official data from the National Bureau of Statistics of the Republic of Moldova. The empirical analysis combines sector-specific indicators for the manufacture of food products with the most recent ICT indicators for manufacturing, which are used as the closest available statistical proxy for assessing the technological environment of food-processing activities.

The study applies comparative, dynamic, and structural analysis. Comparative analysis is used to identify differences between the food industry, industry as a whole, and the broader economic environment where relevant. Dynamic analysis is employed to trace changes in key indicators over time and to identify the main trends in sector development during 2019–2024. Structural analysis is used to interpret the position of the food industry within industry, the configuration of foreign trade across selected product groups, and the distribution of digital tools across manufacturing enterprises. Relative indicators are used to assess sector shares and intensity measures, while the trade balance for selected commodity groups is calculated as the difference between exports and imports.

The methodological logic of the study is exploratory rather than causal. Accordingly, the analysis does not attempt to estimate the direct effects of AI adoption on sector performance, but instead evaluates whether the economic, structural, and technological preconditions for further digital transformation are already emerging.

A methodological limitation should be noted. Published ICT statistics do not provide a stable and fully disaggregated set of indicators specifically for the food industry across all relevant dimensions of digitalization. For this reason, the digital component is interpreted through manufacturing as the closest available technological and organizational context for food-processing activities. Therefore, the study identifies the broader conditions for digital transformation rather than a fully isolated measure of digital maturity in the food industry itself.

3. Results and discussion

3.1. Production dynamics and producer price environment in the food industry

To assess the current position of the food industry and the economic background of its prospective digital transformation, it is first necessary to examine the dynamics of industrial output together with the producer price environment. Considered jointly, these indicators make it possible to distinguish between changes associated with real production performance and those driven primarily by price movements (Figure 1).

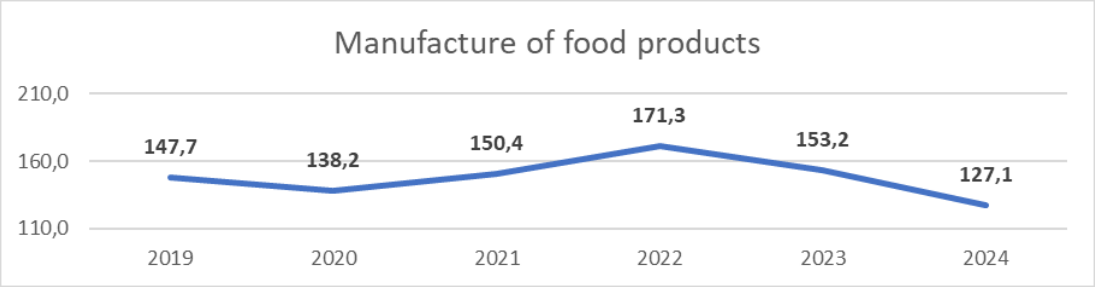

Figure 1. Industrial production volume index for manufacture of food products, %
Source: compiled by the authors based on National Bureau of Statistics of the Republic of Moldova (n.d.d).

As shown in Figure 1, the manufacture of food products in the Republic of Moldova was characterized by uneven output dynamics over the period under review, indicating that the sector developed under changing production conditions rather than along a stable growth path. This pattern should be interpreted together with the producer price developments presented in Table 1.

Table 1. Producer price indices for manufacture of food products by market, %

Indicators	2019	2020	2021	2022	2023	2024
Total	102.6	105.5	112.4	123.3	107.4	99.9
Internal	101.5	104.5	114.4	128.4	106.9	98.5
External	106.4	109.1	105.6	105.1	109.1	105.5

Source: compiled by the authors based on National Bureau of Statistics of the Republic of Moldova (n.d.g).

The data indicate a pronounced acceleration of producer prices in 2021–2022, when the total producer price index increased from 112.4% to 123.3%, while the index for the domestic market reached 128.4%. In contrast, price dynamics on external markets were more moderate, fluctuating within a narrower range and amounting to 105.5% in 2024. By 2024, the total producer price index declined to 99.9%, and the domestic market index to 98.5%, pointing to a partial easing of internal price pressure.

Taken together, Figure 1 and Table 1 suggest that the recent performance of the food industry was shaped not only by changes in physical output, but also by a volatile pricing environment. This distinction is important for the subsequent analysis, since later changes in turnover and financial results should not be interpreted automatically as evidence of proportional real sector expansion.

Against the background of the volatile producer price environment discussed above, it is also important to consider labor cost dynamics in the food industry (Table 2).

Table 2. Average gross monthly earnings in the manufacture of food products compared with industry and the total economy, lei

Indicators	2019	2020	2021	2022	2023	2024
Economic activities - total	7233.7	7943.0	8979.8	10447.3	12209.2	13990.0
Industry	7151.0	7564.2	8242.0	9541.2	11106.2	12793.0
Manufacture of food products	6267.4	6704.2	7390.6	8843.2	10508.8	12144.8

Source: compiled by the authors based on National Bureau of Statistics of the Republic of Moldova (n.d.f).

As shown in Table 2, average gross monthly earnings in the manufacture of food products increased steadily from 6,267.4 lei in 2019 to 12,144.8 lei in 2024, indicating a

substantial rise in nominal labor remuneration. However, throughout the entire period, wage levels in the food industry remained below both the average for total economic activities and the industrial average. In 2024, for example, average monthly earnings in food manufacturing were 648.2 lei lower than the industrial average and 1,845.2 lei lower than the economy-wide average. This suggests that, despite evident wage growth, the sector continued to operate with comparatively lower labor remuneration, which may reflect both cost constraints and structural specificities of food-processing activities. At the same time, the upward wage trend may be interpreted as a necessary adjustment to inflationary pressures and labor market conditions rather than as an unambiguous sign of qualitative modernization. This observation is important for the subsequent analysis of investment activity, since sustained sectoral transformation depends not only on the ability to absorb rising labor costs, but also on the capacity to expand long-term capital investment (Table 3, Figure 2).

Table 3. Investments in non-current assets in industry and in the manufacture of food products

Indicators	2019	2020	2021	2022	2023	2024
Industry – total, million lei	5514.7	4356.3	5964.7	4924.9	5774.5	6917.3
Manufacture of food products, million lei	992.5	951.9	1406.9	1107.4	1427.8	1634.8
Share of investments in the manufacture of food products in total industrial investments, %	18.0	21.9	23.6	22.5	24.7	23.6

Source: compiled by the authors based on National Bureau of Statistics of the Republic of Moldova (n.d.e).

As shown in Table 3 and Figure 2, investments in non-current assets in the manufacture of food products increased overall from 992.5 million lei in 2019 to 1,634.8 million lei in 2024, despite noticeable year-to-year fluctuations. A similar uneven pattern was observed in industry as a whole, confirming that capital investment developed in a volatile macroeconomic environment rather than along a stable upward trajectory. At the same time, the share of the food industry in total industrial investments rose from 18.0% in 2019 to 23.6% in 2024, with a peak of 24.7% in 2023. This indicates that the food industry maintained a relatively strong investment position within the industrial sector and remained one of its major capital-absorbing segments.

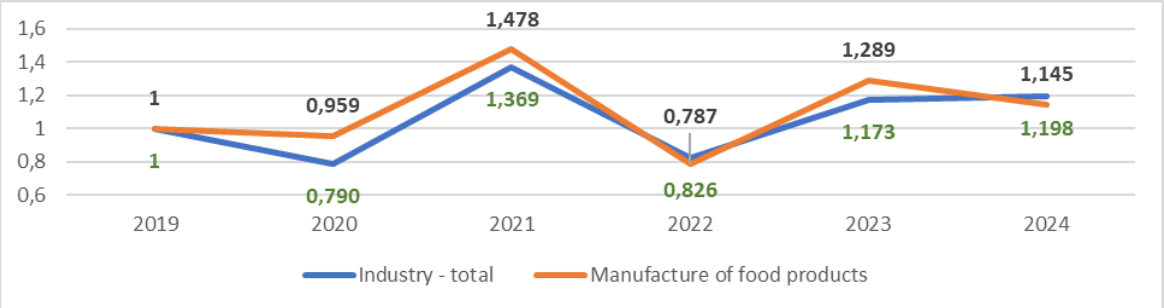

Figure 2. Dynamics of investments in non-current assets in industry and in the manufacture of food products, %

Source: compiled by the authors based on National Bureau of Statistics of the Republic of Moldova (n.d.e).

Nevertheless, the observed growth in investment should be interpreted primarily as evidence of strengthening material preconditions for modernization, rather than as proof of completed technological transformation. In this respect, the investment trend forms an important bridge to the subsequent analysis of enterprise structure and employment, since the real effect of capital expansion depends on how it is reflected in the organization and performance of firms operating in the sector (Table 4).

Table 4. Structural and employment indicators of enterprises in the manufacture of food products

Indicators	2019	2020	2021	2022	2023	2024
Number of enterprises	985	1004	977	980	997	1000
Average number of employees	26965	26608	25475	24816	24986	23890
Average number of employees per enterprise	28	27	27	26	26	24

Source: compiled by the authors based on National Bureau of Statistics of the Republic of Moldova (n.d.a).

As shown in Table 4, the number of enterprises operating in the manufacture of food products remained relatively stable over 2019–2024, fluctuating within a narrow range from 977 to 1,004 units and reaching 1,000 enterprises in 2024. In contrast, employment dynamics followed a downward trend: the average number of employees declined from 26,965 in 2019 to 23,890 in 2024, while the average number of employees per enterprise decreased from 28 to 24. This combination of relatively stable enterprise numbers and shrinking average employment suggests that the sector did not expand through extensive growth in labor input. Rather, it evolved toward a more compact organizational structure, which may reflect cost optimization, changing production practices, or gradual adaptation to technological and market pressures.

In analytical terms, this result is important because it indicates that the sector's resilience cannot be explained by workforce expansion. Instead, the key question shifts toward productivity and financial performance, making it necessary to examine whether the observed structural adjustment was accompanied by stronger turnover generation and improved profitability (Table 5).

Table 5. Financial performance indicators of enterprises in the manufacture of food products

Indicators	2019	2020	2021	2022	2023	2024
Turnover, million lei	19544.3	20154.6	23406.0	36419.0	35022.1	30792.8
Turnover per employee, thousand lei	724.8	757.5	918.8	1467.6	1401.7	1288.9
Net profit or loss for the financial year, million lei	557.6	417.3	977.6	2235.8	1386.2	1778.7
Chain growth rate of net profit or loss, %	120.4	74.8	234.3	228.7	62.0	128.3

Source: compiled by the authors based on National Bureau of Statistics of the Republic of Moldova (n.d.b).

As shown in Table 5, the manufacture of food products recorded a substantial increase in turnover, turnover per employee, and net financial results over the period under review, although the dynamics were not uniform. Turnover increased from 19,544.3 million lei in 2019 to 30,792.8 million lei in 2024, while turnover per employee rose from 724.8 thousand

lei to 1,288.9 thousand lei. Net profit also expanded markedly, from 557.6 million lei in 2019 to 1,778.7 million lei in 2024, despite strong fluctuations, including a peak in 2022 and a subsequent correction in 2023. These results suggest that the sector improved its nominal financial performance and generated higher output per worker even in the context of declining employment.

At the same time, such improvements should not be interpreted in a purely linear way, since they were formed under conditions of considerable producer price volatility, especially in 2021–2022. Therefore, the observed gains reflect not only internal efficiency adjustments, but also the influence of the broader price environment. This is particularly important for the next stage of the analysis, because the external trade profile makes it possible to assess whether the sector's improved financial position was accompanied by stronger competitive performance across food-related product groups (Table 6).

Table 6. Foreign trade in selected food industry-related commodity chapters: exports, imports and trade balance, 2024, thousand USD

Commodity group	Export	Import	Trade balance
Animal or vegetable fats and oils and their cleavage products; prepared edible fats; animal or vegetable waxes	122657.92	79759.74	+42898.18
Preparations of meat, of fish or of crustaceans, molluscs or other aquatic invertebrates	426.99	32382.97	-31955.98
Sugars and sugar confectionery	7611.10	46896.70	-39285.60
Cocoa and cocoa preparations	12879.40	49743.56	-36864.16
Preparations of cereals, flour, starch or milk; pastrycooks products	25051.45	101130.65	-76079.20
Preparations of vegetables, fruit, nuts or other parts of plants	133471.88	48146.08	+85325.80
Miscellaneous edible preparations	23875.23	124560.37	-100685.14
Residues and waste from the food industry; prepared animal fodder	28863.42	69313.78	-40450.36

Source: compiled by the authors based on National Bureau of Statistics of the Republic of Moldova (n.d.c).

As shown in Table 6, the 2024 trade profile of selected food industry-related commodity chapters in the Republic of Moldova was markedly heterogeneous. Trade surpluses were observed only in a limited number of product groups, most notably in vegetable-based processed products and in animal or vegetable fats and oils, whereas most other selected categories showed trade deficits. The deficit pattern was especially pronounced in more processing-intensive segments and prepared food products, indicating that stronger external positions remain concentrated in a narrow set of commodity lines, while several higher-value-added segments continue to depend on imports.

From an analytical perspective, this indicates that the food industry's overall resilience is accompanied by structural trade asymmetries, which reinforce the importance of modernization, value-chain upgrading, and more advanced digital coordination tools in production, logistics, and market management. The static trade structure presented in Table 6

therefore creates a necessary basis for the subsequent dynamic analysis of exports and imports by product group (Figure 3, Figure 4).

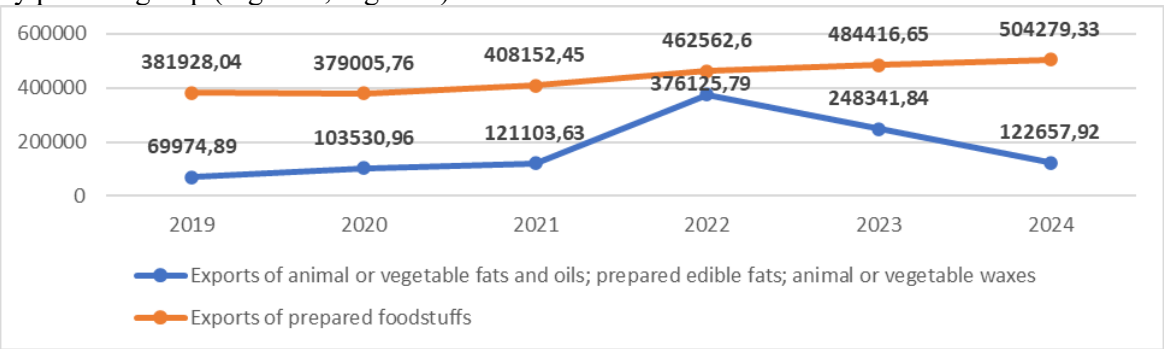

Figure 3. Dynamics of exports of selected product groups related to the food industry, thousand USD

Source: compiled by the authors based on National Bureau of Statistics of the Republic of Moldova (n.d.c).

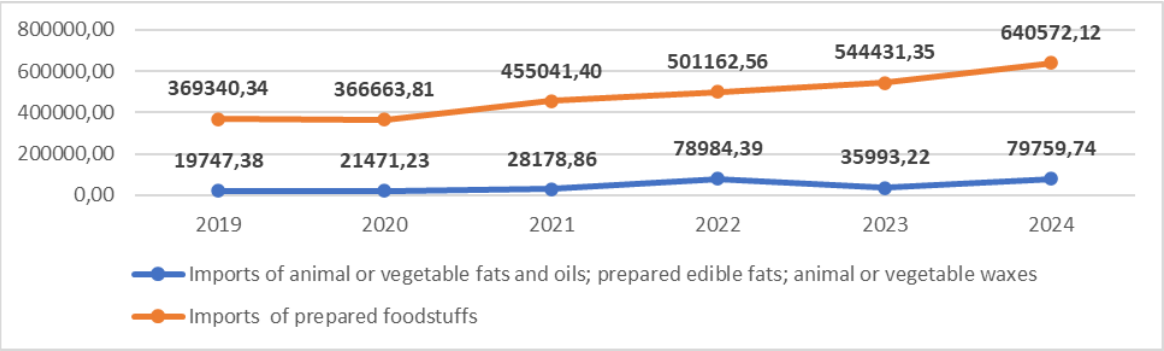

Figure 4. Dynamics of imports of selected product groups related to the food industry, thousand USD

Source: compiled by the authors based on National Bureau of Statistics of the Republic of Moldova (n.d.c).

The static trade configuration presented in Table 6 is further reinforced by the longer-term dynamics of export and import flows shown in Figures 3 and 4. Taken together, these figures indicate that external trade performance across selected food industry-related product groups evolved unevenly over time, with no uniform pattern of strengthening across all categories. Export growth appears to have been more concentrated in a limited number of product lines, whereas import flows remained comparatively strong across a broader range of processed food categories. This dynamic confirms that the external position of the sector is characterized not only by product differentiation, but also by persistent asymmetry between stronger export-oriented segments and more import-dependent ones.

From a structural perspective, such a pattern suggests that the food industry's participation in external markets remains unevenly distributed across value chains, which increases the relevance of technological upgrading, better supply-chain coordination, and more advanced digital instruments to support competitiveness in higher-value-added activities.

3.2. Digital readiness of manufacturing as a framework for assessing the food industry's transformation potential

While the previous subsection examined the economic, structural, and trade-related characteristics of the food industry, the next step is to assess whether the broader technological environment provides sufficient preconditions for digital transformation. In this respect, the analysis moves from sector-specific performance indicators to the digital readiness of manufacturing as the closest available statistical framework for interpreting the food industry's technological position.

Since the ICT indicators are derived from a separate annual enterprise survey and are subject to changes in coverage snapshot and reference period, they are used in this study as the latest available digital of manufacturing rather than as a directly comparable continuation of the 2019–2024 sectoral time series.

Table 7. Indicators of digital readiness in manufacturing in the Republic of Moldova, 2025 (number of enterprises)

Indicator	Manufacturing
Enterprises with a website	480
Enterprises using social media	544
Enterprises using paid cloud computing services	192
Enterprises using cloud-based ERP applications	43
Enterprises using cloud-based CRM applications	49
Enterprises using e-invoicing	1060
Enterprises using AI technologies	31

Source: compiled by the authors based on National Bureau of Statistics of the Republic of Moldova (2025).

As shown in Table 7, the 2025 digital profile of manufacturing in the Republic of Moldova reflects a mixed level of technological readiness. On the one hand, a relatively large number of enterprises had already adopted basic digital instruments, including websites, social media, and especially e-invoicing. On the other hand, the diffusion of more advanced digital solutions remained limited: the number of enterprises using paid cloud computing services was markedly lower, while cloud-based ERP and CRM applications were adopted only by a small minority of firms. Most notably, only 31 manufacturing enterprises reported the use of AI technologies. This pattern suggests that manufacturing has already entered a stage of basic digital integration, but has not yet achieved broad-based diffusion of more sophisticated managerial and analytical tools. For the food industry, this is an important result, as it indicates that the preconditions for digital transformation exist, yet the transition toward deeper data-driven and AI-enabled business models remains at an early stage.

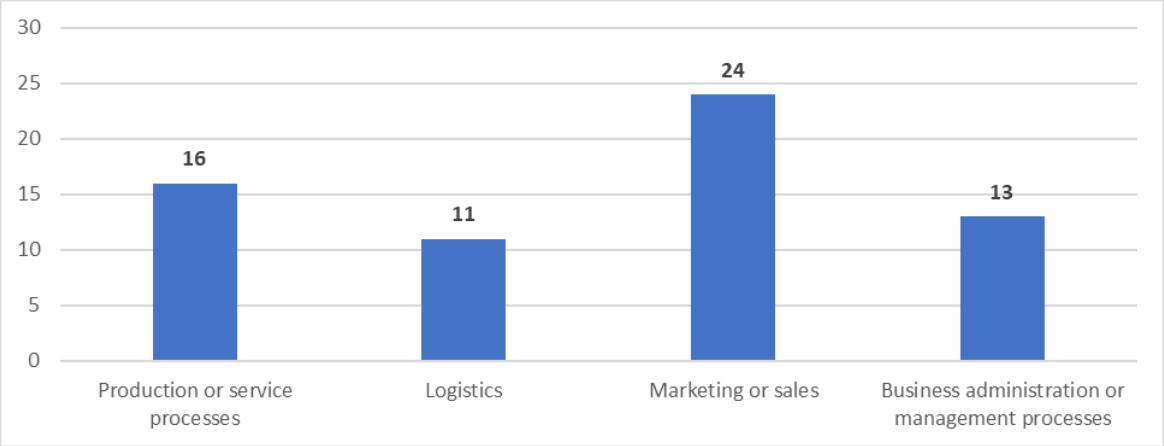

Figure 5. Main areas of AI use in manufacturing in the Republic of Moldova, 2025 (number of enterprises)

Source: compiled by the authors based on National Bureau of Statistics of the Republic of Moldova (2025).

Figure 5 provides a more detailed view of the functional distribution of AI use in manufacturing. The data show that AI applications were concentrated primarily in marketing or sales, followed by production or service processes and business administration, while logistics accounted for a comparatively smaller number of cases. This distribution is analytically significant because it indicates that AI adoption is currently oriented less toward fully integrated industrial transformation and more toward selected operational or commercial functions. In the context of the food industry, such a pattern implies that AI is more likely to be used initially in demand-related, process-support, and administrative tasks rather than in system-wide value-chain optimization. Consequently, the current stage of digital transformation should be interpreted as selective and uneven, with substantial room for expansion toward more integrated technological solutions capable of improving traceability, coordination, productivity, and strategic decision-making across the food value chain.

4. Conclusions

This study set out to examine the current development trends of the food industry of the Republic of Moldova and to assess the preconditions for its digital transformation in the context of emerging AI adoption. The analysis was based on official statistical data and combined sector-specific indicators of production, prices, wages, investment, enterprise structure, financial performance, and external trade with manufacturing-level ICT indicators used as the closest available statistical proxy for the technological environment of food-processing activities.

The findings indicate that the food industry remains a significant component of the national manufacturing base, but its recent evolution has been uneven and structurally differentiated. The sector operated under unstable output dynamics and a volatile producer price environment, particularly in 2021–2022, which means that recent changes in financial indicators cannot be interpreted solely as evidence of real expansion or productivity improvement. At the same time, the growth of wages and investments in non-current assets suggests that the sector has been strengthening some of the material conditions necessary for modernization.

The structural and financial evidence reveals a dual pattern. On the one hand, the number of enterprises remained broadly stable, while turnover, turnover per employee, and net financial results increased in nominal terms. On the other hand, employment and average enterprise size declined, pointing to a more compact organizational structure rather than extensive growth. This suggests that the sector's resilience has been associated less with expansion in labor input and more with internal adjustment under changing market and cost conditions.

The external trade analysis further demonstrates that the sector's competitive position is uneven across product groups. Trade surpluses were concentrated in a limited number of categories, whereas several more processing-intensive and higher-value-added segments remained import-dependent. This pattern indicates persistent structural asymmetries in the food industry's integration into external markets and underscores the importance of upgrading production capacity, strengthening inter-firm coordination, and improving the technological basis of value creation.

The digital evidence shows that manufacturing in the Republic of Moldova has already developed elements of basic digital integration, particularly in relation to e-invoicing, websites, and social media use. However, the diffusion of more advanced digital solutions remains limited, especially in the case of cloud-based ERP and CRM systems and, most notably, AI technologies. In addition, the observed use of AI is concentrated primarily in selected functional areas rather than in integrated value-chain transformation. In the context of the food industry, this means that digital transformation should currently be understood not as a completed structural shift, but as an emerging and still uneven process supported by partial technological preconditions.

Overall, the study supports the conclusion that the food industry of the Republic of Moldova possesses a relevant but incomplete foundation for digital transformation. The sector demonstrates economic significance, investment activity, and a manufacturing environment in which basic digital tools are already present. At the same time, limited diffusion of advanced digital systems, early-stage AI adoption, and persistent structural trade imbalances indicate that the transition toward more intelligent, data-driven, and coordinated business models remains at an initial stage.

The study also has an important methodological limitation. The digital block relies on manufacturing-level ICT statistics rather than consistently disaggregated food-industry indicators, which means that the analysis captures the broader technological context surrounding the sector rather than a fully isolated measurement of its digital maturity. Future research should therefore incorporate more detailed firm-level and sector-specific evidence in order to assess the actual drivers, depth, and performance effects of digital and AI-based transformation in food-processing activities.

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THE COGNITIVE TRAP: HOW SCARCITY MINDSET REPRODUCES AND DEEPENS INCOME INEQUALITY

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Abstract: *Literature on income inequality concentrated predominantly on structural and macroeconomic explanations - capital accumulation dynamics, labour market segmentation, and redistributive fiscal policy. We argue that an essential cognitive dimension has been systematically neglected: the manner when scarcity, as a psychological condition, actively reproduces and deepens inequality through mechanisms that operate independently of, and in interaction with, material resource deficits. Drawing on Piketty's structural analysis of capital divergence, Mullainathan and Shafir's theory of scarcity mindset and cognitive tunneling, Kahneman's dual-process model of decision-making under load, and Sen's capability approach, we build an integrated theoretical framework centred on the Scarcity-Inequality Feedback Loop (SIFL). SIFL models inequality as a self-reinforcing cycle across five stages: structural scarcity rooted in the r > g dynamic, activation of the scarcity mindset, depletion of System 2 deliberate reasoning capacity, erosion of individual capabilities in Sen's normative sense, and consequent deepening of material inequality. Each stage is causally connected to the next, forming a loop in which cognitive impairment is both product and reproducer of economic disadvantage. We further develop inter-generational dimension of SIFL, showing how parental bandwidth depletion diminishes the cognitive investment available to children, transmitting inequality through developmental channels that persist independently of formal mobility structures. Cognitive reproduction mechanism is a structural feature of inequality, not individual failing; effective policy must therefore target cognitive relief alongside redistribution - through institutional simplification of welfare systems, slack-creating unconditional transfers, and early childhood investment as loop-breaking strategies. Contribution is theoretical; future empirical research is needed to estimate SIFL's transmission parameters across varying institutional contexts.* *The article was elaborated within the Project selected in competition "Stimulating excellence in scientific research 2025-2026" 25.80012.0807.37SE "The perfection of instruments for reducing income inequality and reducing poverty of the population in the process of European integration of the Republic of Moldova", institutional funding, ANCD.*

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JEL Classification: *D03, D31, D63, D91, I30, I38.*

1. Introduction

Why does income inequality persist and in many economies deepens even when redistribution mechanisms are formally in place? The macroeconomic literature offers compelling structural explanations: the divergence between the return on capital and the rate of economic growth, the erosion of labour's bargaining position, the concentration of asset ownership, and the inadequacy of tax-and-transfer systems. These forces are real and well-documented. Yet they leave a significant explanatory gap: they do not fully account for why poor individuals so frequently make decisions that appear, from the outside, to perpetuate their disadvantage, nor why the same structural conditions produce such dramatically different individual trajectories. In this paper we propose that the missing variable is cognitive. Scarcity, not merely as a material condition but as a psychological state, exerts a systematic and measurable effect on the quality of economic decision-making. This effect is not a character flaw or a failure of individual rationality; it is a predictable consequence of how the human cognitive system responds to resource constraint. When the mind is preoccupied by scarcity, its capacity for deliberate, forward-looking reasoning is diminished. The result is a pattern of decisions that appear myopic, inconsistent, or self-defeating, but are in fact the predictable output of a cognitive system operating under severe constraint. The

implications for inequality are profound. If scarcity systematically degrades the cognitive capacity through which individuals navigate economic life: managing finances, accessing entitlements, investing in human capital, planning for uncertainty, then inequality is not merely reproduced through structural mechanisms: it is reproduced through cognitive ones as well. The poor are not just materially disadvantaged; their disadvantage imposes a cognitive tax that compounds over time and resists purely redistributive remedies. We develop this argument through four theoretical traditions and synthesize them into an original model: the Scarcity-Inequality Feedback Loop (SIFL). The central research question is: ”Through what cognitive mechanisms does scarcity actively reproduce and deepen income inequality, and what are the implications for welfare policy design?” First it is established the structural baseline through Piketty’s framework of capital divergence, before introducing the cognitive mechanisms of scarcity and decision fatigue drawn from Mullainathan and Shafir and Kahneman. These are then connected to Sen’s capability framework, leading to the original SIFL model and its policy implications.

2. The structural baseline: Piketty’s inequality engine

Thomas Piketty’s *Capital in the Twenty-First Century (2014)* provides the indispensable structural backdrop for any contemporary analysis of income inequality. Piketty’s central argument is formally expressed like this: when the rate of return on capital (r) persistently exceeds the rate of economic growth (g), wealth accumulates faster than income grows, and the distribution of both becomes progressively more unequal over time. This dynamic captured in the now-famous expression $r > g$ is not a market failure or policy aberration; it is, Piketty argues, the historical norm of capitalist economies, interrupted only by the exceptional compression of the mid-twentieth century driven by war, depression, and progressive taxation. The distributional consequences of $r > g$ are severe. Capital income (returns on financial assets, real estate, and equity) accrues disproportionately to those already wealthy, while labour income (wages and salaries) constitutes the primary or sole income source for the majority of the population. As capital’s share of total income rises, the income share available to labour contracts. The result is a structural divergence between those who own capital and those who do not, which reproduces itself across generations through inheritance and compounds through the differential rates of return available to large versus small wealth portfolios. Piketty’s framework is, however, fundamentally a macroeconomic account. It describes the conditions under which inequality grows at the aggregate level; it does not explain why individual poor households fail to accumulate capital even when modest surpluses exist, why they systematically underutilise available social entitlements, or why the inter-generational transmission of poverty proves so resistant to disruption even in the presence of formal mobility channels. These questions require a theory of behaviour under scarcity - a micro-level account of how the experience of poverty shapes the economic choices through which structural outcomes are reproduced.

3. The scarcity mindset: tunneling and the bandwidth tax

Mullainathan and Shafir’s *Scarcity: Why Having Too Little Means So Much (2013)* provides the behavioural micro-foundation that Piketty’s structural account requires. Their central insight is that scarcity of money, time, food, or social connection is not merely an external material condition; it is an internal psychological state that fundamentally reorganises cognition. When individuals experience scarcity, their attention is automatically and

powerfully drawn toward the scarce resource, generating a state of cognitive preoccupation that the authors term the scarcity mindset. The scarcity mindset operates through two primary mechanisms that are directly relevant to inequality analysis. The first is tunneling: the tendency of scarce-minded individuals to focus narrowly on the immediate problem at hand, like managing this week's cash shortfall, resolving the current housing crisis at the expense of attending to matters outside the tunnel. This tunnel vision is not irrational from the perspective of immediate survival; it is a natural consequence of the mind's finite attentional resources being monopolised by pressing need. But it generates decisions that are systematically short-sighted: the poor borrower who takes an expensive payday loan to cover an immediate gap, foregoing longer-term financial planning; the overworked parent who misses a benefit application deadline because the cognitive resources to attend to it were simply not available. The second mechanism is the bandwidth tax. Mullainathan and Shafir demonstrate empirically that the cognitive preoccupation induced by scarcity consumes measurable quantities of working memory and executive control - the same cognitive resources that govern planning, impulse control, and complex problem-solving. The result is a reduced effective cognitive capacity, which they formalise as a tax on bandwidth: the poor are not cognitively less capable than the wealthy in any intrinsic sense; they are operating with less cognitive capacity available after the bandwidth cost of scarcity preoccupation has been levied. The practical consequence is a systematic gradient in decision quality along the income distribution. Wealthy individuals, whose cognitive bandwidth is not consumed by financial preoccupation, have greater effective capacity for deliberate, forward-looking decisions: saving, investing, negotiating, planning, and accessing complex entitlements. Poor individuals face the same decision environment with structurally depleted resources. The result is not a failure of character but a predictable output of constrained cognition - one that perpetuates and deepens the very inequality that generates it.

4. Decision fatigue and cognitive depletion: Kahneman's architecture

Daniel Kahneman's dual-process theory, developed across decades of experimental research and synthesised in *Thinking, Fast and Slow* (2011), provides the cognitive architecture through which the scarcity mindset impairs decision quality and generates welfare losses. Kahneman distinguishes two systems of mental processing. System 1 operates automatically, rapidly, and with minimal effort: it generates intuitions, heuristics, and immediate emotional responses. System 2 operates deliberately, slowly, and with significant cognitive effort: it governs analytical reasoning, complex calculation, and the override of System 1's automatic responses. The critical insight for inequality analysis is that System 2 is a depletable resource. Its capacity for sustained deliberate reasoning declines under conditions of cognitive load, fatigue, and stress - conditions that are endemic to the experience of poverty. When System 2 is depleted, individuals default to System 1 heuristics: they rely on automatic responses, accept default options, defer to immediate intuitions rather than deliberate analysis. Under ordinary circumstances, this is often adaptive. Under conditions of economic complexity, like navigating financial products, managing benefit applications, making investment decisions, it generates systematic errors. Kahneman's framework also illuminates the specific decision patterns that poverty generates.

Loss aversion - the tendency to weight potential losses more heavily than equivalent gains is amplified under scarcity: for those with no financial slack, even a small loss can be catastrophic, generating extreme risk aversion that forecloses potentially beneficial

investments. Present bias - the tendency to discount future rewards steeply relative to immediate ones intensifies when immediate needs are pressing, not because the poor have different time preferences but because the cognitive preoccupation of scarcity narrows the temporal horizon of deliberation. Anchoring effects distort financial negotiations.

The availability heuristic distorts risk assessment. These effects are not evenly distributed across the income distribution. The wealthy operate in environments with significantly more cognitive slack: more financial buffer against loss, fewer immediate crises demanding attention, greater access to professional advice that substitutes for their own cognitive effort. The poor operate with less slack, more load, and fewer cognitive supports. The result is a systematic disparity in decision quality that translates directly into economic outcomes - outcomes that Piketty's structural account records at the aggregate level but does not explain at the individual level.

5. Capability deprivation: Sen's lens on cognitive poverty

Amartya Sen's capability approach described in *Development as freedom* (1999) provides the normative framework that connects the cognitive mechanisms of scarcity and decision fatigue to the broader concept of human welfare and inequality. For Sen, the appropriate unit of welfare analysis is not income or utility but capabilities - the real freedoms that individuals have to live lives they have reason to value. Poverty, on this account, is capability deprivation: the absence of the real freedoms necessary for a fully human life, regardless of the income level that nominally corresponds to those conditions. The capability approach has been primarily applied to material and social dimensions of deprivation: the capabilities associated with health, education, political participation, and social relationships. We suggest an extension that has not been sufficiently developed in the literature: cognitive capacities including deliberate reasoning, effective financial management, long-term planning, and informed decision-making should be recognised as central human capabilities in Sen's framework, whose systematic erosion constitutes a form of poverty. When the scarcity mindset depletes cognitive bandwidth and decision quality, it does not merely impair economic efficiency; it erodes capabilities in Sen's normative sense. This extension has two important implications. First, it establishes that cognitive depletion under scarcity is a form of unfreedom - a constraint on the real capacity to choose and act - that is analytically distinct from, but causally connected to, material deprivation. A person whose cognitive capacity is systematically consumed by financial preoccupation is not fully free in Sen's sense, even if their nominal income places them above a conventional poverty line. Second, it implies that the inter-generational transmission of inequality operates not only through the material channels Piketty emphasises (inheritance, differential returns to capital), but through the transmission of cognitive disadvantage: children raised in cognitively depleted households, by parents whose bandwidth is consumed by scarcity, receive less stimulating cognitive investment in their own development, entering adulthood with reduced capabilities that perpetuate the cycle. Sen's framework thus provides the normative bridge between Mullainathan and Shafir's empirical account of cognitive impairment under scarcity and the structural account of inequality dynamics that Piketty documents. What Piketty measures at the macro level, and what Mullainathan and Shafir explain at the cognitive level, Sen evaluates normatively. Together, these three accounts describe a compound deprivation in which material poverty and cognitive poverty are mutually constitutive.

6. The scarcity-inequality feedback loop (SIFL): an integrated model

The four theoretical traditions reviewed above can be integrated into a unified model of inequality reproduction: the scarcity-inequality feedback loop (SIFL). The SIFL identifies a self-reinforcing cycle with five analytically distinct stages, each corresponding to a different level of analysis and a different body of theoretical literature:

Stage 1 - Structural scarcity (Piketty). The r > g dynamic concentrates wealth and capital income among the already wealthy, generating structural income inequality and material scarcity at the bottom of the distribution. This is the macroeconomic entry point of the loop: inequality produces scarcity, and scarcity is not randomly distributed but structurally allocated.

Stage 2 - Scarcity mindset activation (Mullainathan & Shafir). Material scarcity activates the scarcity mindset. The cognitive preoccupation of financial insecurity consumes bandwidth and induces tunneling - narrowing attention to immediate crises at the expense of longer-term planning, entitlement access, and human capital investment.

Stage 3 - System 2 depletion (Kahneman). The bandwidth tax of the scarcity mindset depletes System 2 capacity. Decision-making defaults increasingly to System 1 heuristics: loss aversion, present bias, availability errors, and anchoring distortions. The quality of economic decisions declines precisely when their stakes are highest.

Stage 4 - Capability erosion (Sen). Degraded decision quality translates into capability deprivation. Educational investments are deferred, health decisions are suboptimal, financial products are mismanaged, social entitlements are underutilised, and long-term planning is structurally impaired. These are not isolated failures but the predictable outcome of a cognitively depleted agent navigating a complex economic environment.

Stage 5 - Deepened material inequality. Capability erosion translates back into material outcomes. Reduced human capital accumulation limits earnings potential. Financial mismanagement limits asset accumulation. Under-utilisation of entitlements reduces effective income. These outcomes reinforce and deepen the structural inequality documented by Piketty, completing the loop and returning to its starting point at a higher level of disadvantage.

The SIFL can be formalised as a dynamic system in which inequality at time t generates cognitive conditions at time $t+1$ that determine inequality at time $t+2$. Let:

$$I(t) \rightarrow S(t) \rightarrow CB(t) \rightarrow Cap(t) \rightarrow I(t+1)$$

Where $I(t)$ denotes the level of income inequality at time t; $S(t)$ denotes the intensity of the scarcity mindset induced by that inequality; $CB(t)$ denotes the effective cognitive bandwidth available after the scarcity tax; $Cap(t)$ denotes the capability endowment of individuals at the bottom of the distribution; and $I(t+1)$ denotes the resulting inequality at the next period. The feedback relationship implies that $I(t+1) \geq I(t)$ unless policy intervenes to break one or more of the loop's links. The transmission parameter between each stage is not fixed: it depends on institutional context, policy design, and social supports. A society with robust automatic enrolment in social programmes reduces the cognitive burden of entitlement access, weakening the $S(t) \rightarrow CB(t)$ link. A society with high-quality, low-complexity public services reduces the cognitive demands of navigating health and education systems, protecting capability development even under bandwidth depletion. The SIFL thus identifies specific intervention points - not merely the income redistribution that addresses $I(t)$ directly,

but the cognitive and institutional interventions that interrupt the reproduction mechanism itself.

The SIFL's most consequential implication is its inter-generational dynamic. At each iteration of the loop, the capability endowment passed to the next generation is determined not only by the material resources parents can invest but by the cognitive resources they can deploy in child-rearing. Parental bandwidth depleted by scarcity translates directly into reduced quality of parent-child interaction, lower investment in early cognitive stimulation, and reduced engagement with educational systems. Children raised in cognitively depleted households enter the loop at a lower capability baseline, experiencing the scarcity mindset earlier and more severely, and facing a steeper structural disadvantage in the capital accumulation dynamics Piketty documents. The inter-generational SIFL thus provides a cognitive explanation for the empirical regularity of earnings persistence across generations - the finding that the income rank of parents is among the strongest predictors of the income rank of children, even in societies with formally open mobility structures. It also implies that the most effective long-term inequality reduction strategy is to break the loop at the capability stage: investments in early childhood development, cognitive enrichment for children in scarcity-affected households, and reductions in the cognitive burden imposed on parents by complex welfare and administrative systems generate returns that accumulate across generations, counteracting the SIFL's natural trajectory.

7. Policy implications

The SIFL framework generates a set of policy implications that are both complementary to and partially distinct from the redistributive prescriptions that dominate the inequality literature. Redistribution (progressive taxation, social transfers, minimum income guarantees) remains necessary: it addresses the structural root of the loop by reducing material scarcity. But the SIFL demonstrates that redistribution alone is insufficient, because inequality reproduction operates through cognitive channels that persist even when incomes are modestly equalised. Three additional classes of intervention follow from the framework.

*Cognitive relief through institutional simplification***.** The most direct intervention against the scarcity mindset and its depletion of deliberate reasoning is the reduction of cognitive demands imposed by institutional environments. Social assistance systems with complex eligibility conditions, frequent reassessments, and multi-agency navigation requirements impose a bandwidth tax on their intended beneficiaries that partially offsets the welfare value of the transfers themselves. Automatic enrolment, benefit consolidation, plain-language communication, and proactive outreach - interventions that bring entitlements to beneficiaries rather than requiring beneficiaries to navigate to reach their entitlements - directly relieve cognitive load, releasing bandwidth for capability-building activities.

Slack creation as a policy instrument. Mullainathan and Shafir's analysis implies that the most effective buffer against the cognitive effects of scarcity is slack - the cognitive and financial breathing room that prevents the scarcity mindset from activating. Unconditional cash transfers, basic income schemes, and emergency savings programmes create financial slack that reduces bandwidth preoccupation without imposing additional cognitive demands. The welfare return on such transfers is therefore greater than their nominal value: it includes the cognitive dividend generated by relief from scarcity preoccupation, which enables better decisions across multiple life domains.

Early childhood investment as loop-breaking strategy. Given the inter-generational dimension of the SIFL, investments that protect the capability development of children in scarcity-affected households represent the highest long-term return intervention available. This includes direct cognitive enrichment programmes, support for parental bandwidth through reduced administrative burdens on families with children, and high-quality early childhood education that compensates for the cognitive investment that depleted parents cannot provide. The economic case for such investments documented extensively in the human capital literature from Heckman (2006) onwards is reinforced by the SIFL framework: they break the loop at its most consequential link.

8. Conclusions

We argued that income inequality is reproduced and deepened not only through the structural mechanisms of capital accumulation that Piketty documents, but through a cognitive feedback loop in which scarcity itself degrades the decision-making capacity through which individuals might otherwise escape it. The scarcity–inequality feedback loop integrates four foundational theoretical traditions - Piketty's structural dynamics, Mullainathan and Shafir's scarcity mindset, Kahneman's dual-process architecture, and Sen's capability framework - into a unified model of inequality reproduction that operates across material, cognitive, and normative levels of analysis. The SIFL's central implication is sobering: inequality is self-reinforcing in ways that go beyond the mechanisms visible to macroeconomic analysis. Every iteration of the loop deepens the disadvantage of those at the bottom of the distribution and widens the cognitive gap between them and those whose financial security protects their capacity for deliberate reasoning. This is not a counsel of despair - each link in the loop is a potential intervention point - but it is an argument against treating redistribution alone as a sufficient response to inequality. Our contribution is theoretical, and its formal propositions require empirical testing. Future research should develop measurable proxies for the SIFL's intervening variables - bandwidth depletion, tunneling intensity, capability endowment - to allow empirical estimation of the loop's transmission parameters across different institutional and policy contexts. Integration with longitudinal income data and experimental designs that manipulate financial slack would allow causal identification of the cognitive reproduction mechanisms the SIFL hypothesises. The ultimate ambition is a welfare economics that takes seriously not only what people have, but the cognitive freedom that determines how effectively they can use what they have.

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A THEORETICAL EXPLORATION OF THE MULTIDIMENSIONAL REPRESENTATION OF INCOME

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Abstract: *The conventional representation of income as a monetary flow - wages, profits, rents, and transfers expressed in currency units - has long served as the central pillar of economic welfare analysis. Yet this reduction of income to its monetary form systematically obscures dimensions of human well-being that are substantive, measurable, and policy-relevant. We develop a theoretical framework for the multidimensional representation of income, drawing on contributions from welfare economics, institutional theory, human capital theory, ecological economics, and capability ethics. We argue that income, properly conceived, encompasses not only monetary flows but also non-monetary transfers, household production and leisure time, social and relational capital, human and knowledge capital, environmental and natural capital endowments, and expansion of human capabilities. Each dimension is theorized, illustrated with reference points, and situated within a coherent conceptual architecture expressed through a composite additive representation. Three structural limitations of the conventional monetary income concept are identified - the invisibility of non-market production, the conflation of income flows with underlying asset endowments, and the problem of price-adjusted comparability - each of which generates systematic distortions in welfare assessment and policy design. The framework draws particular attention to the Senian reformulation of income as capability expansion, arguing that conversion factors - individual, social, institutional, and environmental - determine how effectively monetary and non-monetary resources translate into real human freedoms. The paper concludes with implications for measurement, redistribution policy, and the design of social protection systems, with particular relevance to transitional and developing economies undergoing EU accession, where regulatory harmonization and institutional improvement may deliver substantial capability income gains independently of monetary convergence. The article was developed within the framework of Subprogram 030101 „Strengthening the resilience, competitiveness, and sustainability of the economy of the Republic of Moldova in the context of the accession process to the European Union", institutional funding.*

Keywords: *income, time, welfare, capital, environmental.*
JEL Classification: *D31, I31, I32, J22, O15, Q57.*

1. Introduction

Income is among the most foundational concepts in economics, yet its dominant operationalization remains strikingly narrow. Across mainstream macroeconomics, poverty research, and tax policy alike, income is routinely equated with the monetary receipts flowing to a household or individual over a given period - wages and salaries, entrepreneurial profits, rental returns, interest earnings, and public transfers denominated in currency. This monetary frame, crystallized in the System of National Accounts and embedded in countless household surveys, carries enormous institutional inertia. Yet the limitations of this conception have been recognized, with increasing urgency, across several intellectual traditions. Welfare economists from Pigou onward noted that monetary income fails to capture many determinants of well-being. Institutionalists such as Veblen and Galbraith drew attention to the social and status dimensions of economic position. Human capital theorists demonstrated that the stock of skills and knowledge constitutes a form of deferred income. Ecological

economists showed that natural environments provide flows of services whose monetary equivalent is often large but unrecorded. And Amartya Sen's capability approach reframed income entirely, positioning it not as an end but as a means to the real object of concern: the freedom to live a life one has reason to value. In the paper we synthesize these traditions into a coherent theoretical architecture for the multidimensional representation of income. The central research question is: "What are the principal non-monetary dimensions of income, and how can they be integrated into a theoretically coherent framework adequate to the complexity of human welfare?"

2. The structural limitations of monetary income

The standard monetary income concept rests on a deceptively simple logic: income is what one receives in exchange for labor, capital, or land, measured in the unit of account prevailing in the economy. Its appeal lies in commensurability - all flows are reduced to a single cardinal scale that permits addition, comparison, and aggregation. This commensurability comes at a high cost. Three structural limitations are particularly consequential.

2.1. The invisibility of non-market production

A substantial share of economic activity - child-rearing, elder care, subsistence agriculture, home cooking and maintenance, voluntary civic labor - occurs outside market exchange and is therefore invisible to monetary income accounting. The omission is not trivial. Studies using time-use survey data consistently find that unpaid household production, if valued at market replacement costs, represents a substantial share of conventionally measured economic output in developed economies. Stiglitz, Sen and Fitoussi (2009) estimate that own-account household production amounts to approximately 30-40% of GDP in France, Finland, and the United States. In agrarian and subsistence economies, this fraction is yet larger. The gender distribution of this invisible production is profoundly unequal: women bear a disproportionate share of unpaid care and domestic labor, and systems that measure welfare solely through monetary income systematically understate women's economic contribution.

2.2. The conflation of flow and endowment

Monetary income is a flow variable - it measures the stream of receipts within a period, not the underlying endowment that generates it. Two households with identical current incomes may occupy radically different economic positions if one holds substantial financial, physical, or human capital assets while the other does not. The asset-less household is permanently one shock away from poverty; the asset-holding household enjoys a buffer stock of economic security that is simply absent from the income account. This conflation of income with wealth has received renewed attention in the wake of Piketty's (2014) work on capital accumulation and inequality: when income from capital (r) consistently outpaces economic growth (g), monetary income measures will understate both the degree of inequality and its intergenerational reproduction.

2.3. The problem of price-adjusted comparability

Even as a monetary measure, income is treacherous to compare across space, time, and household composition. The same nominal income buys very different consumption bundles depending on local price levels, household size, and the structure of publicly provided goods

and services. A family that enjoys free universal healthcare, public education, and subsidized childcare effectively receives a substantial non-monetary income supplement relative to an identical household that must purchase all such services in the market. Standard monetary income measures omit this dimension entirely, producing misleading cross-national and cross-regional comparisons.

3. Non-monetary income: transfers, in-kind flows, and social assistance

The most tractable extension of the income concept - and the one most thoroughly institutionalized in empirical welfare research - is the inclusion of non-monetary transfers and in-kind flows. Public in-kind transfers constitute the most significant category. When governments provide healthcare, education, housing subsidies, or food assistance, they confer a real income benefit on recipients that is structurally equivalent to a monetary transfer. Extended income measures that impute the value of public in-kind transfers routinely find that their inclusion substantially reduces measured inequality, because such services are disproportionately used by lower-income households. Employer-provided benefits - health insurance, pension contributions, on-site childcare, housing allowances - constitute a second category. The compression of wages in favor of benefits partly reflects the differential tax treatment of compensation, but its distributional implications are real. In-kind remuneration from family and community networks forms a third category, especially significant in contexts of underdeveloped formal institutions: reciprocal labor exchange, provision of meals, gifts of agricultural produce, housing provided by extended family. The challenge of monetary valuation of in-kind flows is genuine but not insurmountable. Three methods are standard: (i) the market replacement cost method - what would the recipient have paid to obtain the same good or service?; (ii) the net-government-cost method - what did the government pay to provide the service?; and (iii) the insurance value method - what would a risk-averse agent pay for the certainty of access to the service? Each approach has advantages and drawbacks, and the choice of method can substantially affect distributional conclusions (Atkinson, 2015).

4. Time as income: leisure, household production, and the economics of duration

Time is the most fundamental and universally equal endowment of all living beings. Every human being possesses exactly twenty-four hours per day, one hundred sixty-eight hours per week - its initial allocation is immune to inheritance, luck, or institutional privilege. Yet time is radically unequal in its economic value and in the freedom of its disposition. Becker's (1965) pathbreaking theory of time allocation demonstrated that household decisions are fundamentally choices about how to allocate time between market work, household production, and leisure, and that income is not merely the monetary return to market work but the joint product of time and market goods deployed in the "production" of utility.

4.1. Leisure as income

Leisure - time disposed of at one's own discretion for rest, enjoyment, social connection, or self-development - carries genuine welfare value. The economist's willingness-to-pay for additional leisure (the wage rate for those whose labor supply is at an interior optimum) provides a market signal of its value. Households with shorter working hours and equivalent monetary income are wealthier, in welfare terms, than those who achieve the same monetary income through longer working hours. This insight has important distributional

implications: economies with long working hours - common in the early stages of industrial development and in low-wage segments of service economies - may exhibit lower welfare than their monetary income measures suggest.

4.2. Household production time

Time devoted to household production - cooking, cleaning, childcare, elder care, transport of household members - converts raw inputs into final consumption goods and services. This is economically productive labor in every sense: it creates real value, it responds to incentives, and its product has a market-equivalent price. Time-use surveys, pioneered in the 1960s and now conducted in dozens of countries, provide the empirical basis for estimating household production at the individual and aggregate level. OECD (2011) notes that the vast majority of non-market services produced by households - such as meal preparation, childcare, or cleaning - fall outside the production boundary of the national accounts and do not enter into the standard measurement of living standards.

5. Social and relational income: the economics of belonging

The concept of social capital - the networks, norms, and trust that enable coordinated action - has been developed most influentially by Bourdieu (1986), Coleman (1988), and Putnam (2000). For our purposes, social capital functions as a form of income insofar as it generates real and recurring flows of economic benefit to those who possess it: job referrals, credit access, professional mentorship, business partnerships, and informal insurance against adverse shocks. The inequality of social capital access is substantial and self-reinforcing. Granovetter's (1973) distinction between the "strength of weak ties" and strong ties within dense networks captures important dimensions of how social capital generates differential income. Those with access to diverse, high-status networks enjoy a systematic advantage in accessing opportunities that cannot be purchased directly. In the absence of well-developed formal social insurance systems - a condition that characterizes many transitional and developing economies - informal community networks provide crucial insurance against income shocks. The village mutual aid society, the rotating savings club, the extended family safety net: these are mechanisms by which communities smooth consumption across members over time, effectively creating non-monetary income flows in adverse states. The erosion of such informal networks through urbanization, migration, and the breakdown of traditional community structures may therefore constitute a welfare loss even if monetary incomes are rising.

6. Human and knowledge capital as deferred income

The theory of human capital, developed by Schultz (1961) and Becker (1964), treats investments in education, training, and health as analogous to investments in physical capital: they entail present costs in exchange for future income flows. In this framework, the stock of human capital embodied in an individual - their skills, knowledge, health status, and cognitive capabilities - constitutes a form of wealth from which future income streams are generated. Psacharopoulos and Patrinos (2018) estimate that the average global private return to an additional year of schooling is approximately 8.8%, with an inverse variation by level of economic development - returns are higher in low-income countries (9.3%) than in high-income countries (8.2%). For income representation, human capital matters in several ways. First, two individuals with the same current monetary income but different human capital

stocks occupy different welfare positions: the human-capital-rich individual has greater capacity to recover from shocks, to adapt to structural change, and to generate future income. Second, investments in education and health during childhood - whether by households or states - constitute a form of income transfer with long-horizon effects that point-in-time monetary income cannot capture. Third, the depreciation of human capital through unemployment, poor health, or skill obsolescence constitutes a genuine income loss even when no monetary flow is affected.

7. Environmental and natural capital income

Ecological economists, building on the foundational work of Costanza et al. (1997) and Daly (1996), have argued that natural ecosystems provide flows of services - "ecosystem services" - to human populations that constitute genuine income in the welfare sense. These include provisioning services (food, water, timber, fuel), regulating services (climate regulation, flood control, air purification), supporting services (soil formation, nutrient cycling), and cultural services (recreation, aesthetic and spiritual value). For poor rural households that directly depend on common-pool natural resources - forests, fisheries, groundwater, rangeland - the contribution of environmental income to total welfare may be dominant. The policy implications are significant. Development strategies that expand monetary income through the depletion of natural capital may leave total welfare unchanged or reduce it, once environmental income losses are properly accounted. The "green national accounting" agenda, which seeks to adjust GDP for changes in natural capital stocks, represents an institutional response to this insight - though its implementation remains incomplete and contested (Costanza et al., 2014).

8. Capability as income: the Senian reformulation

The most theoretically ambitious alternative to monetary income is offered by Amartya Sen's capability approach, developed across a sequence of major works (Sen, 1980, 1985, 1999, 2009). Sen argues that income - monetary or otherwise - is instrumentally valuable but not intrinsically so. What matters for human welfare is not the resources a person commands but the freedoms those resources enable: the real opportunities to live and act in ways one has reason to value. In this framework, income is a means to capabilities, but the conversion of income into capabilities depends on factors that vary across individuals, communities, and social structures - what Sen calls "conversion factors". Physical health, social norms, institutional quality, and environmental conditions all mediate how effectively income converts into real freedom.

M. Nussbaum (2011) has extended the capability approach by specifying a list of "central human capabilities" - including life, bodily health, bodily integrity, senses and imagination, emotions, practical reason, affiliation, concern for other species, play, and control over one's environment - that constitute a threshold below which a truly human life cannot be lived. In this formulation, capability income represents the real freedom to exercise each of these capabilities above the threshold. Several implications follow. First, identical monetary incomes can correspond to radically different capability levels: a person with a disability requires greater monetary income to achieve the same functional capabilities as an able-bodied person. Second, some capabilities - notably health, education, political participation, and freedom from violence - have intrinsic rather than merely instrumental value, and cannot be fully substituted by monetary compensation.

9. Toward a multidimensional income framework: synthesis

The six dimensions developed in the preceding sections can be organized into a coherent framework. Let I denote total income in the multidimensional sense:

$$I = I_m + I_{nm} + I_t + I_s + I_h + I_e + I_c$$

Where I_m denotes monetary income (wages, profits, rents, monetary transfers); I_{nm} denotes non-monetary income (in-kind transfers, employer benefits, community flows); I_t denotes time-income (imputed value of leisure and household production); I_s denotes social-relational income (network access, informal insurance, community belonging); I_h denotes human capital income (the periodic return to health, education, and skills); I_e denotes environmental income (ecosystem service flows accruing to the individual or household); and I_c denotes capability income (the extent to which resources translate into real freedoms).

Several observations about this framework are warranted. First, the dimensions are not mutually exclusive or additive in the simple sense: they interact through conversion factors, institutional arrangements, and social context. The value of social capital in generating employment opportunities, for example, is mediated by the quality of labor market institutions and the human capital of the networked individual. Any empirical application of the framework must grapple with these interactions. Second, the monetary commensurability of all dimensions is neither achievable nor, in our view, desirable as an aspiration. The capability dimension in particular resists reduction to monetary equivalents: the freedom to participate in political life or to experience genuine friendship is not adequately represented by a willingness-to-pay estimate. A dashboard approach - reporting multiple dimensions separately, with explicit attention to their joint distribution - is likely to be more informative than any single composite index. Third, the weighting of dimensions is inherently normative, and transparency about these choices is an essential condition of legitimate use.

10. Policy implications

The multidimensional income framework has substantive implications for the design and evaluation of social and economic policy. In social protection, the framework suggests that adequacy assessments of minimum income guarantees should go beyond monetary benefit levels to consider the full spectrum of income dimensions. A minimum income scheme that provides adequate monetary transfers but is embedded in a social context of isolation, poor health infrastructure, and environmental degradation may fail to achieve genuine income adequacy for its recipients. Conversely, social investment strategies that strengthen human capital, social capital, and environmental income may deliver welfare gains that exceed what their monetary cost would predict. In the context of economies undergoing EU accession, like Moldova, Ukraine - the framework highlights the importance of regulatory harmonization as an income redistribution mechanism. The adoption of EU standards in environmental protection, labor rights, food safety, and consumer protection represents a transfer of capability income to citizens, even in the absence of monetary transfers. The welfare gains from institutional improvement may be substantial even before, and independent of, convergence in monetary income levels. For poverty measurement, the framework supports a shift toward multidimensional poverty indices - such as the Alkire-Foster methodology underlying the UNDP's Multidimensional Poverty Index - that identify

deprivation simultaneously across monetary income, health, education, and living standards. Such measures are better suited to identifying the "texture" of poverty and designing targeted interventions than any purely monetary threshold.

11. Conclusions

We argued that the reduction of income to its monetary form is not a natural truth but a theoretical choice - one made for good reasons of tractability and comparability but at the cost of systematic distortions in our understanding of human economic life. A theoretically adequate concept of income must encompass at least six dimensions beyond the monetary: non-monetary transfers, time-income from leisure and household production, social and relational capital, human and knowledge capital, environmental and natural capital services, and the capability freedoms that income ultimately serves to expand.

No single dimension can replace the monetary income concept, and no aggregate index can fully capture the multidimensional reality of economic welfare. What the framework offers is an expanded vocabulary for analysis - a set of conceptual lenses through which the welfare implications of economic circumstances, policies, and institutions can be more fully apprehended. The challenge for future research is to develop the measurement instruments, institutional frameworks, and political coalitions capable of translating this theoretical enrichment into the lived improvement of human welfare. Future work should develop measurable proxies for each dimension and integrate them with longitudinal household data to allow empirical estimation of the framework's transmission parameters across different institutional contexts.

Note: The article was developed within the framework of Subprogram 030101 „Strengthening the resilience, competitiveness, and sustainability of the economy of the Republic of Moldova in the context of the accession process to the European Union", institutional funding.

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INTEGRATION OF ENVIRONMENT, SOCIAL AND GOVERNANCE RISKS INTO INTERNAL CONTROL SYSTEM OF BANKS

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Abstract: *The research represents an assessment of the implications of the environment, social and governance risks for the internal control systems of banks. These risks became an important element in creating the image of banks, influencing investment decisions, stability and could have a negative impact on banks' activities. The objective of the research is to study how environment, social and governance risks could be systematically integrated into the banks' internal control frameworks. The research mainly follows a qualitative approach supported by literature review, reports, regulatory frameworks and other relevant publicly available data. The originality of this study derives from the integrated analysis of environment, social and governance risks; thus, the research examines the impact, challenges and necessary adaptations of these risks across the five internal control elements and the model of the three lines of defense. The study is also focused on the sustainability progress in the Moldova's banking system. The research findings reveal the importance of creating a robust environmental, social and governance-oriented internal control framework to ensure long-term sustainability of banks. By incorporating environmental, social and governance risks into the internal control system, banks are demonstrating a positive impact on their business, stability and improvement of their financial results.*

Keywords: *ESG risks, banking system, internal control.*
JEL Classification: *G21, M42, Q50.*

1. Introduction

One of the main concerns in the banking system during current times is related to environmental, social and governance (ESG) topics and supporting sustainable development. The reason is the fact that it plays a crucial role in sustainable financing which lead to a transition of businesses to ESG practices, thus, integration of ESG risks in banks' activities became a necessity. The transition to a low carbon economy and the climate change which transposed ESG factors into the traditional financial risks, resulted in the appearance of ESG issues that are affecting not only reputational risks as was believed before, but also triggers the credit risk, market risk and operational risk. Unlike traditional risks, ESG risks are related to possible appearance of negative financial effects on an organization due to non-traditional risks such as environmental issues (eg. climate change), social problems (eg. customer mistreatment) and governance factors (eg. fraud). The requirement of dealing efficiently with ESG issues has been addressed mainly by regulatory authorities and stakeholders, thus, by implementing ESG factors into banks' internal control frameworks, banks are demonstrating an impact on their business as well as on the stability and improvement of their financial results and on reducing banking risks. The focus on ESG initiatives became more highlighted after the adoption by the European Union (EU) related regulatory framework. Given the Strategy for financing the transition to a sustainable economy adopted by the European Commision (EC), banking intermediation plays a crucial role in financing the transition to a more sustainable economy. In the meanwhile, it is likely that this transition will entail risks that institutions will need to manage appropriately to ensure that risks to financial stability are minimised. The new focus on ESG issues represents a challenge for internal control frameworks in the banking sector as banks have to develop them along with risk management to monitor the ESG exposures.

The objective of the research is to study how non-traditional ESG risks could be systematically integrated into the banks' internal control frameworks. The topic is of great importance and actuality since the Republic of Moldova, as an EU candidate country is in process of regulatory harmonization and ESG integration principles are currently covered by different strategies at the national level, while the banking sector is adopting the European Union regulations and sustainability tendencies.

The originality of this study derives from the integrated analysis of ESG risks; thus, the research examines the impact, challenges and necessary adaptations of ESG risks across the five internal control elements and the model of the three lines of defense (3LoD). In addition, the study presents a focus on the evolution of sustainability progress in the Republic of Moldova's banking system, ESG risk culture in Moldovan banks along with the analysis of good practices related to the integration of ESG risks. The research also highlights that the integration of ESG factors into internal control has become mandatory and European regulators are imposing requirements that ESG risks should be assessed in a similar way to any other material risk.

Although there is no enforceable regulatory framework dedicated to the integration of these criteria in the Republic of Moldova, banks have started to create action plans towards financial resilience and sustainability, and best practices and requirements imposed by the European Banking Authority (EBA) and the European Central Bank (ECB) are seen as a benefit rather than a burden. The main limitation that should be acknowledged is data scarcity regarding the non-financial sustainability reporting in case of Republic of Moldova's banking sector, once the ESG reporting is currently voluntary. Therefore, only one bank realizes detailed ESG reports, while other banks publish general non-financial statements.

2. Literature approach

Historically, ESG issues were seen only from the view of corporate social responsibility or socially responsible investing, thus, being noticed as reputational issues that have no connection to financial strategies. A greater attention to sustainability by defining the term "ESG" along with the fact that ESG issues could have impact on the financial situation on entities was stressed by initiative "Who Cares Wins" initiated by The United Nations Global Compact in 2004 and endorsed by 23 financial institutions including the World Bank Group. Globally, more than 2 400 sustainability regulations are in place, which means that ESG became one of the main segments in institutions' compliance. The leading place of the ESG regulations is taken by the EU with the core ESG reporting standards and frameworks such as Sustainable Finance Disclosure Regulation (SFDR), Corporate Sustainability Reporting Directive (CSRD), Carbon Border Adjustment Mechanism (CBAM), EU Taxonomy and Fit for 55' Package and the rules to enhance the climate disclosures by The Securities and Exchange Commission (SEC). ESG factors have begun to being rapidly asked, to be integrated into risk assessment, strategies, and 3LoD of banks since 2020, following the regulatory authorities' requirements.

Internal control system is critical for piloting entities to a environmentally responsible development (Akisik and Gal, 2017). Therefore, issues related to ESG risks and their impact on financial effects of financial institutions led researchers to develop investigations on ESG risks/performance effect over internal control systems as well. In this context, a recent study of the COSO element by Feng and Sale (2024) stresses that a sound internal control, in addition to improved risk management is mandatory for an efficient resource allocation and

ESG risks monitoring. Research on the effect of financial mismatch argues that to have robust ESG operations it is required to have set a sound internal control system which would establish transparent supervisory roles, thus, preventing Corporate Social Responsibility gaps (Li et al., 2025). Bumbac (2022) states that the banks' governance processes should consider the assessment of the effect of ESG risks in the short, medium and long term. Moffitt et al. (2023) in their research identified that a sound internal control of the institution is correlated to high ESG ratings, and less issues linked to "tone at the top" ethics; thus, if ESG is not properly managed, it can reflect internal control issues. Studies of Liu et al. (2023), in the study of United States banks also stated that non-performing loans are negatively correlated to high ESG ratings. As well, a study based on a list of European Union banks by Conca et al. (2026) found that social disclosure plays a one of the most important factors for reducing non-performing loans level i.e. reducing credit risk and increasing financial stability of banks. According to Defung et al. (2024), there exists a negative link between ESG risks and bank stability in Indonesian banks, therefore it is stated that sound internal control systems could prevent vulnerabilities and reduce the impact of ESG risks. In a similar way, Covid 19 pandemic has also influenced negatively banks all over the world, and led entities to take social responsibilities (Sachin and Rajesh, 2021). As well, the pandemic brought to light the materiality of environment and social dimensions and the highlighted the importance of a sound governance, making ESG risks to be taken more into consideration as a part of the financial analysis (Bumbac, 2022). Therefore, the knowledge and adaptation skills gained by banks due to pandemics could be used to face ESG risks impacts. Researchers Nardella et al. (2020) mention that improving the internal controls and compliance tools are crucial once the entity is involved in investing in ESG initiatives. Therefore, embedding ESG practices into the financial reporting could lead internal controls to improvement as they will strengthen the ESG initiatives credibility (Bachtiar, Mujennah and Husein, 2025). In addition, Thakor (2020) found that financial technology (FinTech) is also playing a huge role in the banking sector by improving internal control systems, which, in their view are considered the core of ESG performance. Alim and Mansour (2026) show evidence that using FinTech within the internal control environment, improves the internal governance and reduces ESG and corruption risks. Apparently, as Srairi and Kateb (2025) conclude in their research based on Governance dimension of ESG, that in the case of the Islamic banks, gender diversity of board could partially diminish ESG risks i.e. boosts financial stability and lower credit risk. Findings of El Khoury et al. (2023) which analysed the ESG risks in the Middle East and North Africa bank systems, identified that the Environment dimension is negatively impacted by the economic development of the country where the bank is located, while the social development shows a positive impact over Social and Governance dimensions. In a reality that internal control systems have a greater importance in the ESG reporting process, O'Dwyer et al. (2011) mentions that there should also not to be underestimated the great role of internal audit, which, inter alia is involved in boosting conviction in sustainability reporting (DeSimone, 2020). According to Olteanu Burcă et al., in the countries where the ESG regulation is highly developed, internal audit has a great role in improving the ESG disclosure and reporting. Therefore, as the regulations as well as the literature review lead to the fact that ESG risks could have adverse effects of the internal control system of banks and have to be part of their risk management frameworks.

3. Methodology of research

To assess the relationship between the ESG risks and internal control of banks, it is proposed to use a mixed method approach including both qualitative analysis and secondary quantitative data. Focus of the research is qualitative, including literature review combined with reports and other published information by banks and international financial organizations and relevant international, European Union and national regulatory frameworks. Since the quantitative data in the context of ESG is scarce for the Republic of Moldova, as an emerging economy, the study aims to use a limited quantitative input.

4. Research results and discussion

4.1. ESG risks and transmission channels

ESG factors are a group of the dimensions it stands for, i.e. "E" for Environment, "S" for Social and "G" for Governance, consequently, the dimensions are transcribed in ESG risks. According to EBA, ESG risks are defined as "*risks of any negative financial impact to the institution stemming, from the current or prospective impacts of ESG factors on its counterparties*". These non-traditional risks emerge differently for banks, depending on multiple factors such as geographical location, complexity, size, main type of business, business model, interaction with stakeholders, i.e. is important to understand the ESG themes (table 1.) and the transmission channels through which they transform into traditional risks within banks:

Table 1. ESG factors

E (Environment)		S (Social)		G (Governance)	
Climate change	**Natural resources and pollution**	**Internal stakeholder management**	**External stakeholder management**	**Board quality**	**Corporate behaviour**
• Weather events; • Transition to low-carbon economy,	• Waste and management; • Environmental degradation; • Biodiversity.	• Staff rights; • Diversity and culture; • Health and safety.	• Community relations • Customer relations; • Access to finance.	• Board effectiveness; • Board independence • Greenwashing.	• Business ethics; • Ownership • Corruption

Source: developed by the author, based on review of scientific literature.

1) Environmental risks refer to climate change and natural resources and pollution issues that might have specific impacts on banks. Main risk drivers of the climate change and environment risk are:

- Physical risk (result from changing climate conditions or extreme weather events) which have a direct impact on destroying assets or property by lowering asset values, increasing insurance claims or disrupt supply chain.

- Transition risks (result from shift of low-emissions economy), which are driven by climate related policy changes, social adaptation or technological innovation and lead to increase energy sources prices or reputational risks, etc. Therefore, these types of risk could have tremendous effects on economy, banks and could face financial losses because of the cascade effects, chain reactions as well as to blocked assets (eg. oil or gas sector).

2) Social risks refer to issues that imply internal (interested parties well-being) and external stakeholder (overall social issues) management. Therefore, the issues involved are

customer protection, human rights, workplace safety and other labour standards, data security, product quality as well as community and customer impacts. These risks could potentially result in loss of trust due to deficiencies in staff of customer treatments or even due to financing debatable projects.

3) Governance dimension risks include mainly failures of the internal governance, corruption, fraud, intransparency and board independence. Governance risk might be considered the fastest financially material element of ESG risk in banks due to the fact that weak management and internal controls are related to high systemic risk, low credit quality and fragile resilience.

According to the World Economic Forum Global Risks report, the main global risks are technological (misinformation and disinformation, cyber espionage and warfare and adverse outcomes of AI technologies); environmental (extreme weather events, pollution, biodiversity loss and ecosystem collapse, natural resources shortages and critical change to earth systems); geopolitical (state-based armed conflict and geoeconomic confrontation); social (societal polarization, inequality, involuntary migration or displacement and erosion of human rights). ESG risks might have an impact on banks either directly, being affected by the ESG dimensions or indirectly through investment activities and lending to a company affected by ESG risks. Consequently, ESG factors represent risk drivers that are transposed in traditional financial risks (credit risk, market risk, operational risk and reputational risk), as ESG risks sooner magnify these existing risks. As an example of transmission channels to credit risks are income change or sovereign impact; for market risk might be recorded price or volatility hit; in case of liquidity risk, the collateral condition; for operational risk might be business continuity and reputation effects.

4.2. Integration of ESG risks and transformation of the internal control system

Integration of ESG risks into the bank regulatory framework is a relatively new approach that totally reshapes banks' risk management and strategies. Considering the rise of ESG considerations, standard setting institutions along with regulators and central banks equally agree that ESG factors represent the one of the most important drivers of traditional financial risks and therefore, banks must improve their internal control systems to include ESG risks, also agreeing that just a creation of a different unit that would focus on ESG risk monitoring would be inefficient.

The EU regulation CSRD was adopted to expand the ESG disclosure requirements and included mandatory reporting on ESG, that is supposed to increase the transparency standard and require banks to disclose the way of ESG risks management. As a result, EBA issued guidelines to improve ESG risk management, thus, EU prudential framework has evolved from the stage of defining and examination of ESG risks through old banking package (CRR2/CRD5) to quantitative integration and sound regulation (table 2**)** through the latest revised package (CRR3/CRD6). The latest guidelines issued by the European Banking Authority (EBA) require banks to transform their optional ESG risk management into a mandatory requirement, which means that the inclusion of ESG risks in banks' risk management frameworks is set to become one of the main internal control obligations within banks. As well, EBA's new Guidelines require banks to "*monitor ESG risks through effective internal reporting frameworks and a range of backward- and forward-looking ESG risk metrics and indicators*".

Table 2. EU existing prudential regulation (CRR3/CRD6) embeds three mandates for the EBA regarding ESG

Pillar 1 (Minimum capital requirements) **EBA report on the role of environmental and social risks in the prudential framework**	**Pillar 2 (Supervisory review process – SREP)** **EBA guidelines on the management of ESG risks; Guidelines on environmental scenario analysis**	**Pillar 3 (Disclosure: risk, capital ratios)** **Updated Implementing Technical Standards on Pillar 3 disclosure requirements for ESG risks**
• Maintains the risk-based approach since the introduction of a general "green factor" is not yet justified; • Integrates environmental risks into the evaluation of real estate collateral; • Incorporates clients' climate transition plans into credit risk weights.	• Requires ESG risks management and minimization over short, medium and long terms (at least 10 years); • ESG risks are assessed as triggers for traditional financial risks; • Imposes specific standards for climate stress testing.	• Extends ESG reporting requirements proportionally to all institutions; • Integrates clarifications on physical risks and sectoral emissions; • Automatically harmonize reporting templates with the EU Taxonomy and CSRD to ensure transparency and reduce operational burdens.

Source: developed by the author, based on review of EBA regulations

The transition is based on the roadmap on sustainable finance issued by EBA that describes the objectives and the way of implementing its mandate in ESG risks and sustainable finance. Thus, the main objectives of the EBA roadmap include: transparency and disclosures, risk management and supervision, prudential treatment of exposures, stress-testing, standards and labels, greenwashing, supervisory reporting, ESG risks and sustainable finance monitoring. That means that ESG risk assessments have to be included in front line business units while suggesting to risk management units to improve monitoring frameworks and for internal audit to embed ESG risks in the auditing processes.

The COSO framework based on its five principles (control environment, risk assessment, control activities, information and communication and monitoring activities) is still the most important standard for internal controls. In the context of emerging of ESG risks and the fact that, similar to financial data, the internal control systems have to ensure the quality of ESG data, COSO issued guidance on Internal Control over Sustainability Reporting (ICSR). This guidance is supposed to help entities to adjust internal controls with regards to sustainable reporting and to use similar controls to prevent ESG reporting inaccuracy, therefore, changes traditional internal control principles.

Depending on the COSO elements of the internal control of banks, the ESG risks have the following impacts, challenges and ways of adaptation:

- *control environment* represents the fundamental element of internal control that, being determined by setting the tone at the top, decide the standards of conduct, ethical values and integrity, allocation of the responsibilities, enforcement of accountability, culture within organization and the organizational structure. Therefore, the ESG risks have a serious shift on bank board's expectations as it is responsible for adjusting governance setting to integrate the banks' strategy and objectives with ESG principles. Banks' management have to move from the objective of assessing and increasing financial results (eg. profit maximisation for the shareholders) to a multi capital approach i.e. they have to fundament their decisions on more complex relations between human, social and natural capital. One of the most challenging elements is the competency gap and scientific knowledge of the board related to ESG themes

and risks that could affect the bank activity and asset protection in the short, medium and long term in order to make suitable decisions. In addition, banks might find difficult identification of skilled staff in ESG field. Another challenge is driven by the possible existence of an inadequate remuneration policy of the management that supports the increase of short term financial results and ignores ESG factors and practices as it is complicated to create and maintain an adequate ESG culture once the high-carbon emission businesses are still the most profitable. In order to adapt the control environment the banks should consistently organize regular discussions, trainings and workshops as for the supervisory/management bodies as well as for all the units on ESG matters. It is also required to be implemented periodical Key Performance Indicators and Key Risk indicators to base on ESG transition plans of the bank and align the remuneration policies with ESG objectives. Thus, once the control environment is aligned with relevant frameworks, banks will be able to create an environment that embeds ESG risks and helps to diminish them.

- *Risk assessment* aims to identify and analyze threats, warnings and emerging trends as well as the probability of fraud in evaluating risks on a forward-looking basis, that would have an important impact on entity's objectives and therefore on internal control systems.

Implication of ESG risks into this COSO component is driven by "double materiality" concept that was solidified by the greater focus on ESG themes and imply that banks should assess whether their lending activity has a financial materiality i.e. ESG impact on the bank and impact materiality i.e. in what matter their lending activity impacts the planet and society. As well, according to the fact that the ESG risks are non-linear and data-constrained their impact leads to unpredictable threats to bank assets. Therefore, the primary challenge within risk assessment is the proper quantification of ESG risks and the forecast of future probabilities, as it is not possible to rely on historical data as in case of traditional risks. As a result, banks are required to develop sophisticated models to evaluate ESG risk exposures, especially due to the fact that the final impact of ESG risks could be seen over horizons larger than ten years. The development of forward-looking methodologies for risk assessment in order to adapt to ESG risk integration, becomes imperative. In this context, bank employees should be able to understand how to identify and monitor ESG risks.

- *Control activities* are established to help minimizing the risk of objectives' achievement, therefore assuring that management's decisions are implemented properly within institution by oversighting through development of procedures or specific controls. ESG risks emergence influences the banks' operational controls reshape, especially within the lending activities where environment, social and governance criteria should be integrated as during the customer onboarding, during to the loan application, assessment, monitoring and up to reimbursement. In addition to prevention of lending to ESG harmful activities, regulators expect from control activities to guide capital in the direction of activities that are aligned to green taxonomies, transition plans and carbon intensity metrics. It is very difficult to take into account all ESG issues, thus, there comes the necessity to find the relevant ESG risks that might threaten banks activity. In this situation banks have to identify proactively, based on their business model, strategy and risk appetite what are the most significative ESG risks and incorporate them into internal controls. In addition, due to the fact that ESG activities are relatively new and there is no relevant data as customer reporting is not standardised and control activities are relying on overall industry results using outside service providers, internal control system might weaken. In order to adapt to new reality, banks have to use mandatory environmental and social management systems that include the

identification of ESG risks in their risk management framework for their lending activities. Another good practice is to include ESG questionaries for clients or integrate ESG into Client Due Diligence or Know Your Customer and accumulate necessary data to be analysed. Control activities are also covering the internal operations by introducing stringent frameworks to reduce its operational footprint (eg. increasing energy efficiency).

- *Information and communication* help institutions generate, receive, process, and communicate relevant and high-quality information necessary for effective control and the achievement of its objectives. Nowadays, regulators, but also stakeholders and general public has much more demand for a qualitative, transparent and detailed disclosures related to banks' exposure to ESG risks their sustainability performance. Respectively, bank have a much more pressure on collecting ESG data from their customers, while the most important indicator is represented by the greenhouse gas emissions produced by the clients i.e. financed emissions. As financed emissions are the core of bank's capital filings and sustainability report, the relevant data communication is subject to internal controls and has to be qualitative. The biggest challenge with information and communication component is the greenwashing risk, which represents the practice of misleading about the bank's environmental impact, actions or risk profile and could lead to damage of reputation of the bank. This happens, usually due to the lack of the ESG level data or it is fragmented, or unverified by an independent party. Due to the requirements about the data, banks could develop their technology systems by incorporating emerging technology. A good practice is to communicate the roadmap of ESG actions taken by the bank so that interested parties were aware of the way in which banks manage ESG risks and benefit from ESG opportunities. As well, banks should support a prompt collection of data along with creating a correct and efficient flow of information; in the meanwhile, to control if the communications methods are relevant to the bank's objectives.

- *Monitoring activities* are responsible for assessing whether internal control elements properly function, adapt to emerging changes and identify their deficiencies, which helps confirming or realigning activities relevant to the bank's objectives. Due to the constantly changing typology of ESG risks, updates of ESG related regulatory frameworks, new researches in this field along with increasing expectations from society, ESG related controls have to improve as well. In this context, banks have to persistently run the assessment their environment and social management systems, ongoing climate stress testing and monitoring the financed emissions track. Therefore, the main impact lies on the internal audit that has to review ESG controls and to assure regarding the reliability of ESG reporting. The absence of globally harmonised environmental, social and governance auditing standards makes it particularly challenging to audit environmental indicators and governance matters. According to best practices, internal audit units develop climate disclosure verification programs which include testing of scenario methodologies based on climate stress, tax evasion and declared commitments. As well, banks could integrate ESG risk data within centralised governance, risk and compliance platforms to more efficiently reduce the main banks' risks.

The ESG risks nature, complexity and long-term horizon required a different approach over the three lines of model, an improved version of the three lines of defense model, which is a globally recognised framework for governance and risk management in banks that helps institutions to achieve its objectives. Therefore, banks are expected to assign responsibility for the management of climate-related and environmental risks in accordance to it.

The effect of the ESG risks over the three lines model, in the ESG setting is the following:

- first line (front-line business operations) responsibilities related to managing generating risk activities have suffered significative expansion. Currently, first line managers have to supervise the determination of materiality assessment i.e. whether the subordinate has collected client data regarding ESG matters (eg. energy consumption, reliance on fossil fuels). however, the lack of expertise in ESG theme is the main challenge that has to be solved, thus, it is mandatory to have the front-line personnel very well trained as they are accountable for daily ESG risk taking.

- second line (risk management and compliance) in banks represents the fundamental role in identification, assessment, monitoring and reporting of ESG risks where Chief Risk Officer function, compliance and specialised ESG teams represent the main actors. Consequently, its responsibilities, in the ESG context, relate to transposing ESG risk taxonomy into day-to-day internal procedures. This line is also asked to validate climate models and monitor exposures relative to ESG risk appetite, establishing limits on portfolio concentration and calculating adjusted risk premiums. a great challenge for this line is that ESG risk integration fails if the roles between the lines are not clear, therefore, if regulatory requirements are not transposed properly in procedures and the first line has an unclear of the requirements, their activities are blocked.

- Third line (internal audit) is responsible for independent assessing of the efficiency of internal controls across the previous two lines to assure the governing body. Regulators and important international financial organisations agree the degree to which a bank is prepared to handle climate-related risks depends mainly on internal audit. The main challenges are the lack of data and the over reliance on external ESG data providers as well as the limitations in methodologies, lack of ESG knowledge of internal auditors, greenwashing risk,, therefore it is difficult to assess the accuracy of ESG data used in risk evaluations, reliability of climate metrics and the bank's real exposure.

4.3. Sustainability progress in the Republic of Moldova's banking system

ESG concept in the Republic of Moldova accelerated once it received the status of EU candidate country and by the adoption of National Strategy of Economic Development 2030 that aims for a faster growing, more inclusive and durable economy. As well, in 2023 NBM joined the Sustainable Banking and Finance Network (SBFN), thus, strengthening its commitment to promoting ESG in the Moldovan financial sector. In addition, NBM has developed the Sustainable Finance Roadmap (2024-2028) as a reference point, including four main pillars i.e. increasing awareness and improving institutional capacities, sustainable capital flows, integration of ESG and risk management and transparency and market discipline. Consequently, NBM is implied in organization of events for capacity building and rising awareness on ESG and sustainable finance. Due to the fact that Republic of Moldova is required to adopt directly the prudential expectations to align to EU standards, banks do not have the luxury of a long voluntary reporting. In this context, there is a high current pressure on internal control systems of the Moldovan banking sector i.e. develop board competences and skills, integration of ESG risks within SREP or to adjust controls to loans that are reactive to climate change and transition to a sustainable economy.

Currently, one of the biggest climate issues Republic of Moldova faces are extreme weather conditions (mainly floods, droughts and late frosts) with a high impact on agriculture loans, that recorded a decrease from 9,3% in 2020 to 5,4% by the end of 2025 (fig. 1). In this context, a challenge for internal control of banks is the fact that banks might have an illusion

of the loan coverage if the external valuation companies do not integrate in their report the collateral vulnerability i.e. exposure to physical risks.

Another element of climate risk that has financial impacts on the loan portfolio of Moldovan banks are transition risks generated by transition process to a low-carbon economy, while the fields most related to this risk are: agriculture, forestry, and fisheries; food industry; productive industry; constructions; real estate transactions; transportation and storage; health and social assistance; energy industry; public administration and defense. The share of brown economy sectors (operating in fields related to transition risks) of the total banking system loan portfolio recorded an increase from 45,3% in 2020 to 48,6% by the end of 2025, while the highest share over the analysed years was reflected in loans granted for purchasing/building real estate (32,3% at end of 2025), the second and third positions are loans granted to agriculture and food industry. Therefore, the high share of real estate loans is considered a critical ESG transition risk and banks internal control systems should introduce mandatory criteria to assess the energy efficiency of loans starting from the loan generation.

There is evidence of social risks in the Moldovan banking sector manifested by geopolitical spillovers, gender disparities or labour standards as well as the Ukrainian refugee financing. Governance risks also might exist in form of the gaps in ethical lending, implications of politically exposed persons, anti-money laundering gaps that would erode internal controls.

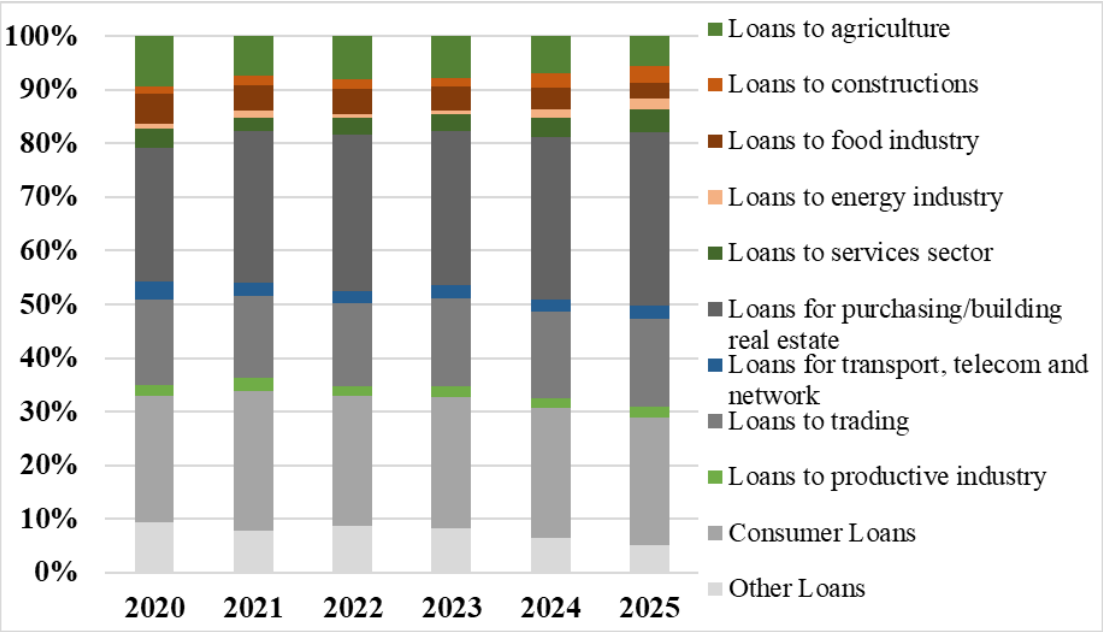

Fig. 1. Evolution of the share of loans granted by banks in the Republic of Moldova
Source: developed by the author, based on NBM data

On a voluntary basis, a couple of Moldovan banks now give or aim to provide loans whose rates and other terms depend on whether the company complies to ESG principles. As well, due to this initiative, they were able to access loans with international financial institutions which have certain ESG obligations. Additionally, many banks are continuously introducing ESG services (eg. loans for electric cars or "green" housing) and ESG products

(eg. digital cards). However, there is only two banks that received an ESG rating from an international rating agency (CB "Moldova-Agroindbank" JSB that have a Sustainalytics rating of 25,5/100 i.e. low-medium risk and OTP Bank JSC that have a Sustainalytics rating of 17,4/100 i.e. low risk and MSCI rating "A"). CB "Moldindconbank", for example, had its ESG activity assessed by the German Sparkassenstiftung for International Cooperation through Sustainable Finance Compass. Other banks are at the beggining point of implementation of ESG risks and are only declaring their commitments to the ESG stating that they apply ESG principles in their activity.

Main strategic recommendations for Moldovan banks are related to enforcement of the management skills to understand ESG risks and their possible impact on the bank assets and quantification of ESG risk limits in line with the banks' risk appetite; operationalization of the three lines model in ESG context; establishment of sound internal procedures to use ESG proxy data and to fill the data gap.

Currently in Moldova, there does not exist methodology that would allow banks to compile a personal ESG rating among their clients, which represents a critical challenge in the domestic banking sector. However, based on the international practices and the existing methodologies for assigning ESG ratings by rating agencies, banks could develop their own assessment criteria for each of the three dimensions of ESG. That is the case where the internal auditor (third line) has to assess the correct attribution of an ESG rating based on the developed methodology.

4. Conclusions

The ESG risks integration into the banks is a complex challenge as a full reconfiguration of internal control and risk management frameworks is needed, requiring additional effort in the short term. In addition, as demonstrated by the EBA guidelines and the National Bank of Moldova's aligned strategies to ESG taxonomy, ESG risks became a core metric of the credit quality, financial solvency and stability and is no longer seen as a secondary compliance consideration. The research points out that integration of ESG risks into internal controls is driven by "double materiality" concept due to which social and climate domains are accepted as material risks that react as main channels for transmission for traditional risks. Consequently, ESG risks have to be integrated into the internal controls of banks and to be assessed similar to other bank risks. Therefore, the three lines of defense model has also been impacted and has to be upgraded to catch, monitor and oversee the ESG forward-looking data. By incorporating ESG risks into the internal control system, banks are demonstrating a positive impact on their business as well as on the stability and improvement of their financial results. On the other side, in case of failure to integrate ESG risks starting from the first line (front-line business operations) and audit assurance, the banks could face significant reputational and greenwashing risks. However, despite the challenges, integration of ESG principles lead to multiple advantages and opportunities as reduction of environmental impact, social responsibility, regulatory compliance and risk management, access to finance, attracting responsible investors, reputation enhancement, etc. Although there is no enforceable regulatory framework dedicated to the integration of these criteria, banks, including the ones from the Republic of Moldova have started to create action plans towards financial resilience and sustainability, and best practices and requirements imposed by the European Banking Authority and the European Central Bank are seen as a benefit rather than a burden. At the same time, both banks and the National Bank of Moldova are recommended

to implement appropriate measures that will allow the assessment of ESG risks and to develop effective internal control tools.

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THE PRIVATE PATRIMONY OF THE ROMANIAN ACADEMY – SOME LEGAL ASPECTS REGARDING THE COMPLIANCE WITH TESTAMENTARY BEQUESTS

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Abstract: *Since its founding in 1866, the Romanian Academy had the right to receive "bequests and any offerings" according to its Internal Regulations, which were subsequently confiscated by the communist regime and only partially restored (agricultural lands, forest lands, and a number of real estate properties). This reality imperatively demands the retrocession of the entire patrimony through the total restitution of the assets belonging to the Academy, either in kind or in cash, through a special procedure that addresses each individual property based on its current legal status (restitution in kind, equivalent compensation with other assets, or through reparatory measures).*

Keywords*: private patrimony, public domain, private domain, bequests.*
JEL Classification*: K11, K40.*

1. Introduction

Thus, as doctrine indicates, the holders of the right of public property – the state and its administrative-territorial entities – are, first and foremost, subjects of public law and, in this capacity, appear as bearers of power prerogatives in the exercise of the state functions with which they are vested, according to the Constitution and the laws governing their activity.

The right of public property is of paramount importance in ensuring social development because, on the one hand, it belongs to subjects of law that organize social life within a state itself, and, on the other hand, the respective assets, in principle, represent an interest for the entire society at different levels: state, county, or local. In order to have a clear situation and for optimal management of the patrimony, a periodic inventory and revaluation thereof are required.

2. Legal and Doctrinal Appraisals Regarding the Patrimony of the Romanian State – The Public and Private Domain

The primary purpose of the inventory process is to establish the real situation of all elements of the nature of assets, liabilities, and equity of each entity, as well as the assets and values held under any title belonging to other legal entities—in our case, the Romanian Academy—with a view to preparing the annual financial statements, which must provide a true and fair view of the entity's financial position and performance for the respective financial year. The exercise of the right of public property presents certain particularities, which relate both to its nature and purpose, and to the legal nature of the holders of this right.

Thus, regarding the situation of assets within the public domain belonging to administrative-territorial units, Art. 123 para. (1) of the updated Law no. 215/2001 on local public administration establishes as a prerogative of the county and local councils, namely, to decide that the assets belonging to their public domain, of local or county interest, as the case

may be, be given into the administration of autonomous regimes and public institutions, be concessed, or be leased.

Furthermore, according to Art. 124 of the same law, local and county councils may grant the free use, for a limited term, of movable and immovable properties belonging to the local or county public domain, as the case may be, to non-profit legal entities that carry out charitable or public utility activities, or to public services of local interest, a concept which, in this context, also includes services of county interest.

Therefore, entrusting public property assets to certain state entities—in this case, the Romanian Academy—as well as to central or local state authorities, and establishing, for their benefit, an individual right over the entrusted assets, namely the right of administration, constitutes a specific form of exercising the right of public property itself.

However, this is not the sole manner of exercising this right. Public property assets may be concessed, leased, or granted for use to other subjects of law, under the conditions provided by law.

Starting from the theory of general use and the non-existence of a property right, it must be specified that, from the very beginning, a series of opinions regarding the issue of the public domain have existed over time in the specialized literature.

One of these views stemmed from the need to justify the criterion for determining what constitutes the public domain – a theory supported both by the generation of legal scholars at the end of the nineteenth century and by those who emerged during the first decade of the twentieth century, reaching its full development during the interwar period. In Romania, it was promoted by Professor Constantin Hamangiu and was founded on two principal ideas: first, that the public domain comprises property dedicated to the use of everyone; and second, that the public administration does not hold a right of ownership over such property.

The new Civil Code lists the ways in which public property rights may be acquired, namely: through public procurement carried out in accordance with the law; through expropriation for public utility, under the conditions of the law; through donation or bequest, accepted under the conditions of the law, if the asset, by its nature or by the will of the donor or testator, becomes of public use or interest (the case of the multitude of movable and immovable assets belonging to the Romanian Academy); through an agreement for consideration, if the asset, by its nature or by the will of the acquirer, becomes of public use or interest; through the transfer of an asset from the private domain of the state to its public domain, or from the private domain of an administrative-territorial unit to its public domain, under the conditions of the law; and through other means established by law.

Current theories, focused on the concept of the property right, draw a distinction between a change of purpose and the transfer of ownership.

From the regulatory point of view, the state or national public domain comprises: the maritime, fluvial, aerial, and terrestrial public domain; the military public domain, national roads including crossings through localities, railways of general interest, various buildings, and movable assets.

The Romanian Academy is the highest national forum for scientific and cultural recognition in the country, according to Article 1 paragraph (1) of its Statute. While during its first decades, its primary purpose was the cultivation of language and history, in the decades that followed the Romanian Academy broadened its scope to embrace the advancement of literary and artistic creation as well as scientific research. As one of its

presidents, Professor Constantin Rădulescu-Motru, would later note: "**from a modest Literary Society, whose purpose was more to virtually assert the right of Romanians to their cultural unity, it was transformed in the year of [Carol I's] ascension to the throne, in 1866, into the Society that brought the country's independence, and the Romanian Academy took the name it bears today**".

From the analysis conducted, two important aspects must be highlighted:

1) The patrimony of the Romanian Academy was built during the period between 1860 (six years prior to the founding of the Romanian Literary Society, the predecessor of the Romanian Academy) and 1948 through donations provided by 200 donors, including members of the Romanian Academy, ruling princes and kings of the Romanian Principalities and of Romania, ministers, high dignitaries, and officials of the Romanian state as well as from other countries, academics, figures of culture and art, industrialists, bankers, ordinary citizens, etc.

2) Through a Decision of the Council of Ministers of the Romanian People's Republic, led by Petru Groza, the patrimony of the Romanian Academy existing in November 1948 was taken from the Academy—without prejudice to the legal status of the property—and transferred to the use of other institutions through a single article consisting of 11 lines.

The history of the 157 years of existence and spiritual work of the national academic institution offers the image of an extensive, continuously evolving process of establishing Romanian cultural unity and developing our national science and culture.

From its very foundation, in order to fulfill its mission, this high institution was provided with the necessary means—initially through a fixed annual donation inscribed in the state budget, and later, over time, through the creation of a significant patrimony of its own. This wealth came exclusively from donations and testamentary bequests made in its favor by generous individuals with a love for their nation, academicians and their descendants, historical figures, and various institutions. Unfortunately, in 1948, despite the brilliance illustrated by the activity of the most prestigious personalities of Romanian science and culture—who over the decades honored the finest embodiment of national spirituality—the Romanian Academy, after 82 years of existence, fell victim to political upheavals.

By Decree No. 76 of 1948, it was transformed into a state institution subservient to the newly established totalitarian power. To make this subjugation complete, within the framework of the somber transformations that occurred in the life of Romanian society, by virtue of Article 68 of Decree No. 198 of 1948 and the Decision of the Council of Ministers No. 1486 of November 8, 1948, the movable and immovable property of the Romanian Academy passed into the patrimony of the state and the use of various ministries. Thus, a total of 46 buildings, numerous construction plots, as well as all agricultural and forestry estates, along with 771,558 shares, annuities, bonds, and other similar securities, were abusively seized from its patrimony.

Logically, in December 1989, the reconstitution of the Romanian Academy's properties should have been carried out solely by repealing the Decision of the Council of Ministers No. 1486/1948, and through technical regulations, the Academy should have reclaimed its immovable assets from the former holders.

This was not possible, and due to imprecise, cumbersome, and complicated legislation, the Romanian Academy faced a multitude of obstacles in the process of reconstituting its patrimony and reclaiming its owned properties. The Land Law No. 18/1991, Law No. 1/2000, Law No. 10/2001, and Law No. 247/2005, etc., being defectively applied,

led to delays in the reconstitution of the patrimony; consequently, the academic institution had to provide proof of ownership through numerous reconstitution requests and title deeds (acceptances of donations, wills, deeds of gift, etc., sourced from the state archives). The Romanian Academy filed notifications for the recovery of its patrimony totaling thousands, even tens of thousands of pages, reports, and follow-ups addressed to local and county administrations, the City Halls of Bucharest, Constanța, and Mangalia, as well as to local courts, county tribunals, Courts of Appeal, and the High Court of Cassation and Justice. This resulted in the following recoveries in kind of 94 buildings, (56 in Bucharest and 38 across the country); the issuance of compensation Decisions based on values established by the ANRP (National Authority for Property Restitution): 12, of which 7 are in Bucharest and 5 across the country; unrecovered assets currently under the settlement competence of local committees / ANRP: 13, of which 10 are in Bucharest and 3 across the country (Dumitrache, 2022).

Yet, even in the case of certain restitutions—such as the Berthelot Manor in the Hațeg Country or the Djuvara Villa in Sinaia—the Romanian Academy found itself in the position of having to rehabilitate these estates at high costs due to the advanced state of degradation caused by the former holders (some of these properties are already nearing completion). Furthermore, several buildings in Bucharest require major interventions, including structural ones (several buildings are classified as presenting a high seismic risk, bearing the 'red dot' hazard rating).

3. Conclusions

The Romanian Academy has fulfilled and continues to fulfill the mission with which it has been entrusted since its creation, working in the service of Romanian society by leveraging the best intellectual resources at its disposal.

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ANALYSIS OF THE DEPENDENT VARIABLE INSURANCE PREMIUM IN RELATION TO THE INDEPENDENT VARIABLES IN THE ROMANIAN INSURANCE MARKET

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Abstract: *In this paper, the authors seek to carry out a quantitative and qualitative analysis of how the insurance market is influenced by certain factors. This market in Romania is characterized by numerous challenges generated by financial flows, regulations, contractions and contradictions. The study follows and analyzes the specific financial flows and the manner in which written premiums are influenced by gross domestic product, the inflation rate and the reference interest rate.*
Keywords: *insurance market, written premiums, gross domestic product, inflation rate, interest rate.*
JEL Classification*: G22, G23, G28.*

1. Introduction

The specialized literature presents several definitions or concepts regarding what insurance is, as well as its purpose and role. All of them emphasize that insurance seeks to provide protection to the insured person or to an asset or service, depending on the type of insurance.

According to Professor Iulian Vacarel, "Insurance represents a system of economic and social relations through which, in exchange for a premium, the insurer establishes an insurance fund from which losses suffered by insured persons as a result of insured risks are compensated" (Vacarel, 2007).

Gheorghe Bistriceanu views insurance as "a form of financial protection based on the principle of mutuality, whereby individual losses are borne from a common fund established from the premiums paid by insured persons" (Bistriceanu Gheorghe, 2006).

In another formulation, "insurance constitutes an economic category that expresses the relationships of allocation and redistribution of losses among the members of a community exposed to the same risks" (Constantinescu Danut, 2000).

Violeta Ciurel considers insurance to be "the financial operation through which risk is transferred from a natural or legal person to the insurer in exchange for an insurance premium" (Ciurel Violeta, 2000).

Foreign authors also conceptualize insurance through the fundamental elements that comprise it.

"Insurance is an economic device whereby the individual substitutes a small certain cost (the premium) for a large uncertain financial loss (the contingency insured against)." (Vaughan & Vaughan, 2008).

For Rejda G.E., "insurance is the pooling of fortuitous losses by transfer of such risks to insurers, who agree to indemnify insureds for such losses, provide other pecuniary benefits, or render services connected with the risk" (Rejda George E., 2011).

Mehr and Cammack consider insurance "a social device for reducing risk by combining a sufficient number of exposure units to make their individual losses collectively predictable" (Mehr & Cammack, 1980).

For Outreville J.F., "Insurance is a mechanism for risk transfer and risk sharing, combining the functions of protection, savings and financial intermediation" (Outreville J. François, 1998).

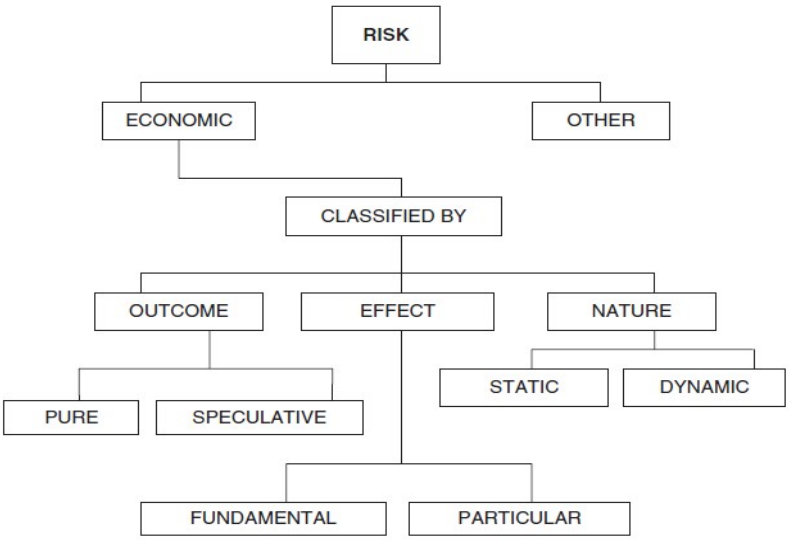
Romanian legislation defines insurance as "the operation whereby the insurer, in exchange for the insurance premium, assumes the obligation to pay an indemnity upon the occurrence of an insured risk" (Law No. 237/2015 on the authorization and supervision of insurance and reinsurance activity – Official Gazette of Romania, Art. 2).

All the definitions presented above highlight the relationship among the three fundamental elements: the existence of an insurable risk, the existence of a risk community, and mutuality.

By taking out insurance, the risk is transferred from a natural or legal person to an insurance company, which assumes the payment of compensation if the respective risk occurs. The risk is assumed by the insurance company, is quantifiable, and can be managed.

Figure No. 1

Risk Typology



Source: Rob Thoyts - Insurance Theory and Practice – Routledge, 2010, p. 6

The mechanism for concluding and operating an insurance policy involves the following stages: 1. Risk identification and assessment - the insurer analyzes the probability of the risk occurring and its financial impact using statistical methods and actuarial calculations; 2. Conclusion of the insurance contract - the insurance contract governs the legal relationships between the insured and the insurer and establishes the rights and obligations of the parties; 3. Establishment of the insurance fund - insurance premiums are centralized in a common fund used to pay claims, establish technical provisions, and cover administrative expenses; 4. Payment of claims - compensation is granted in accordance with the principle of indemnity, without exceeding the value of the loss in property insurance; 5. Technical provisions - technical provisions ensure the insurer's solvency and its ability to meet future

obligations. This mechanism is based on the fundamental principles of mutuality, actuarial equivalence, good faith, and insurable interest.

In addition to the primary role of the insurance system, namely to provide protection, the insurance mechanism mobilizes financial resources that are used for financial investments and for financing the economy. Premiums collected by insurance institutions are used and mobilized within the economy.

From a strictly technical perspective, insurance premiums have the following allocation and hierarchy:

1. Payment of claims and insured amounts - the fundamental purpose of premiums is to pay compensation and benefits to insured persons (Harrington & Niehaus, 2004).

2. Establishment of technical provisions - technical provisions reflect the insurer's future obligations and may be assessed under Solvency II as Best Estimate and Risk Margin (Directive 2009/138/EC, Art. 77; EIOPA, 2015).

3. Payment of reinsurance premiums - reinsurance helps reduce the volatility of results and provides protection against catastrophic risks (Outreville, 2013).

4. Coverage of acquisition and administrative expenses - premiums are used to finance acquisition and administrative expenses (Rejda & McNamara, 2017).

5. Establishment of own funds and compliance with solvency requirements - capital serves to absorb unexpected losses and protect insured persons against insolvency risk (The Geneva Association, 2011).

6. Investment of funds derived from premiums - investments are made in accordance with the ALM principle in order to ensure liquidity and the security of funds (Skipper & Kwon, 2007).

Market risk management is one of the main concerns of insurance companies. The most widely used method is diversification, which primarily seeks to reduce systemic risk.

The analysis conducted and published by EIOPA in July 2025 highlights the structure of risks in the insurance market as well as the outlook for their development.

Table No. 1

Risk Dashboard for the EUROPEAN Insurance Market

Risks	Level	Trend (last 3 months)	Outlook (next 12 months)
Macroeconomic risks			
Credit risks			
Market risks			
Liquidity and funding risks			
Profitability and solvency risks			
Interconnections and imbalances			
Insurance risks (underwriting)			
Market perceptions			
ESG-related risks			
Cyber and digitalization risks			

Source: adapted from ASF – Report on the Stability of Non-Bank Financial Markets 2/2025, p. 24

Each of these risks influences the performance of insurance and reinsurance companies, and especially the level of premiums charged. The higher the risks at the macroeconomic level and at the level of the applicant (insured), the higher the insurance premiums, indicating a direct relationship in the same direction.

2. Variables Influencing the Insurance Market (Insurance Premiums)

The Romanian insurance market is undergoing continuous change, readjustment, and repositioning. It is a market seeking to consolidate, with insurance companies that inspire confidence, but also with well-known bankruptcies and insolvencies.

The Romanian market is not yet a mature market such as those in Western Europe or the United States.

Nevertheless, in recent years the Romanian capital market has experienced favorable development, both as a result of legislative changes and due to a better understanding among natural and legal persons of the role of insurance.

The analysis of how the Romanian insurance market has evolved must be viewed within the macroeconomic context that characterized the respective period.

The evolution of gross domestic product, the inflation rate, interest rates, and the manner in which natural and legal persons understand the importance of protection directly influence the insurance market, the premiums paid, and the products purchased.

During 2020–2025, Romania's gross domestic product followed an uneven trajectory, recording a 3.7% decline in 2020 as a result of the pandemic, followed by 5.7% growth in 2021. Growth continued in 2022 (+4%); in 2023 it increased by 2.4%, while in 2024 and 2025 it slowed considerably, to +0.8% and 1%, respectively (estimated data).

As regards the inflation rate, it evolved as follows: in 2020 inflation stood at 2.6%, after which it increased steadily in the following years, reaching 13.8% in 2022, compared with 5.1% one year earlier.

After 2022, the inflation rate declined slightly, reaching 10.45% in 2023 and 5.6% in 2024. The year 2025 ended with an inflation rate of 7.3%.

With a high inflation rate, monetary policy was also affected, with interest rates increasing. In this situation, combined with the associated risks, the premiums required for concluding various types of insurance also increased.

The table below presents the premiums collected and the macroeconomic indicators mentioned above.

Table No. 2

Written Premiums (Dependent Variable) and Macroeconomic Indicators (Independent Variables)

Year	GDP %	Inflation rate %	Reference rate (December) %	Written premiums (bn)
2020	-3.7	2.6	1.25	11.5
2021	5.7	5.1	1.75	14.2
2022	4	13.8	6.75	16.51
2023	2.4	10.45	7.00	15.20
2024	0.8	5.6	6.5	19.8
2025 (estimated)	1	7.3	6.5	18.7 (9 months)

Source: Prepared by the author based on the statistical reports of INS, BNR, and ASF for the respective years

The relationship and analysis of correlations between written premiums at national level and the main macroeconomic indicators can be examined using a regression equation in which the dependent variable is the written premium, while the influencing factors are the gross domestic product growth rate, the inflation rate, and the interest rate.

3. Econometric Model

In this context, we have: dependent variable (Y) - written premiums (bn), independent variables: GDP (%), inflation rate (%), reference interest rate (%).

The econometric model is as follows: $\boldsymbol{Y = \beta 0 + \beta 1 \cdot GDP + \beta 2 \cdot INF + \beta 3 \cdot INT + \varepsilon}$

Estimated equation:

Gross written premiums (GWP) = 12.840 + (0.389 · GDP) + (-0.661 · Inflation) + (1.497 · Interest Rate).

The hypotheses and hypothesis testing are performed at the level of each coefficient (t-test) and at the level of the entire model (F-test).

3.1. Testing the Significance of the Coefficients (t-test)

Hypotheses for each coefficient βi:

H0: βi = 0 (the variable has no statistically significant effect on Y)

H1: βi ≠ 0 (the variable has a statistically significant effect on Y)

Results (coefficients, standard errors, t-statistic, p-value, 95% confidence intervals):

Table No. 3

Correlation Analysis

Parameter	Coef.	Std. Err.	t	p	CI 2.5%	CI 97.5%
Constant (β0)	12.8399	1.7986	7.139	0.0191	5.1013	20.5785
GDP (β1)	0.3890	0.3109	1.251	0.3373	-0.9485	1.7265
Inflation (β2)	-0.6608	0.3555	-1.859	0.2042	-2.1905	0.8689
Interest rate (β3)	1.4971	0.4633	3.231	0.0839	-0.4963	3.4905

Source: calculations performed by the author using EViews

Interpretation: coefficients with p-value < 0.05 are considered statistically significant at the 5% level. With only 6 observations, statistical power is low and the conclusions must be treated with caution. For a more complete and complex analysis, the model should be extended over a longer period of time.

Testing the Overall Significance of the Model (F-test)

Hypotheses:

H0: $\beta1 = \beta2 = \beta3 = 0$ (the model does not explain Y)

H1: there is at least one $\beta i \neq 0$ (the model explains Y)

F-statistic = 3.992, p-value = 0.2068 (df_model=3, df_resid=2).

Goodness of Fit

R (multiple correlation coefficient) = 0.926

R^2 (coefficient of determination) = 0.857

Adjusted R^2 = 0.642

Interpretation: R^2 shows the proportion of the variation in written premiums explained by the independent variables. R (multiple correlation) is the square root of R^2 and indicates the strength of the overall linear relationship between Y and the set of X variables.

Diagnosis and validation of the OLS assumptions involve the analysis of multicollinearity, heteroscedasticity, residual normality, and autocorrelation.

Multicollinearity (VIF)

VIF > 5 (or > 10) suggests substantial multicollinearity, which may destabilize the coefficients.

Variable	VIF
GDP %	1.530
Inflation rate %	3.134
Reference rate (December) %	2.353

Heteroscedasticity (Breusch–Pagan)

The Breusch–Pagan test checks whether the variance of the errors is constant. H0: homoscedasticity (constant variance).

LM p-value = 0.5262; F p-value = 0.7735

Residual Normality (Anderson–Darling)
H0: the residuals are normally distributed.
AD statistic = 0.501; p-value = 0.1206
Autocorrelation (Durbin–Watson)
Durbin–Watson ~ 2 suggests the absence of first-order autocorrelation.
Durbin–Watson = 3.017

4. Interpretation of Results

The independent variable GDP (β1 = 0.389) has a positive influence on insurance premiums. An increase in gross domestic product will lead to an increase in insurance premiums. Disposable incomes are higher, and insured persons will more readily turn to products that provide them with protection. An increase of 1 percentage point leads to an increase in premiums of 0.389 billion.

The inflation rate (β2 = -0.661) has an inverse effect. An increase in inflation will lead to a decrease in insurance premiums. Inflation erodes the willingness to save because purchasing power is reduced. A 1 percentage point increase in the inflation rate leads to a decrease in premiums of 0.661 billion.

The interest rate (β3 = 1.497) indicates a positive correlation with the insurance premium. An increase in the interest rate makes insurance more expensive and consequently leads to an increase in insurance premiums. A 1 percentage point increase in the interest rate leads to an increase in premiums of 1.497 billion.

An important aspect is that the sample is small (n=6); the estimates are sensitive to extreme values and to the inclusion of the 2025 observation (estimated). For a more in-depth analysis, the model should be extended over at least 10–15 years.

5. Conclusions

Written premiums, which can also be interpreted as the volume of insurance policies concluded, are influenced by objective factors such as gross domestic product. An increase in gross domestic product can be perceived at the individual level as an increase in income. With higher incomes, citizens can more readily consider the need for protection.

This awareness of the protection provided by taking out insurance also depends, subjectively, on the individual's financial education.

The inflation rate and, implicitly, the interest rate directly influence the size of premiums. The erosion of purchasing power and the increase in financing costs are two factors with a direct impact on the insurance premium.

The study should be continued by extending the database over a period of 12–15 years in order to achieve greater relevance. Possible independent variables with an impact on the dependent variable, the insurance premium, should also be identified.

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THE CONTAGION EFFECT BETWEEN CRYPTOCURRENCY AND EQUITY MARKETS: EVIDENCE FROM CRISIS PERIODS

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***Abstract**: This paper examines the dynamics of contagion between major cryptocurrency markets and global equity indices, with particular emphasis on crisis periods and recent episodes of heightened financial instability. The empirical analysis employs daily return data for Bitcoin (BTC), Ethereum (ETH), and Binance Coin (BNB), alongside seven major equity indices, covering the period from January 2018 to early 2026. To capture the complexity of cross-market interactions, the study applies a threefold econometric framework consisting of a Vector Autoregression (VAR) model for return interdependencies, a Dynamic Conditional Correlation GARCH (DCC-GARCH) model for time-varying correlations, and the Diebold–Yilmaz connectedness approach to assess the magnitude and direction of volatility spillovers. The analysis distinguishes several crisis regimes, including the COVID-19 pandemic, the global inflation surge and synchronized monetary tightening of 2022, and the cryptocurrency market dislocation associated with the FTX collapse. In addition, the study incorporates more recent developments, such as persistent geopolitical tensions (including the prolonged effects of the Russia–Ukraine conflict and escalating instability in the Middle East), the higher-for-longer global interest rate environment observed throughout 2023–2025, and renewed episodes of financial stress linked to regulatory interventions, liquidity constraints, and volatility in both crypto-asset and equity markets during 2025–2026. The findings indicate a substantial intensification of cross-market correlations during crisis periods, with co-movement levels rising significantly relative to tranquil conditions. This behaviour provides strong empirical support for the presence of contagion effects, consistent with the theoretical distinction between contagion and interdependence. Moreover, the results reveal asymmetric volatility transmission patterns: equity markets act as primary shock transmitters to cryptocurrencies during macroeconomic and policy-driven disturbances, while crypto-specific shocks, particularly those associated with market structure disruptions and regulatory uncertainty, generate feedback effects on equity markets in periods of elevated systemic risk. Overall, the evidence points to an increasing integration between digital asset markets and traditional financial systems in the current global context. These findings carry important implications for international portfolio diversification, risk management strategies, and the design of macroprudential frameworks aimed at monitoring and mitigating systemic risk in an evolving and interconnected financial landscape.*

***Keywords**: cryptocurrency markets, financial crisis, VAR, spillover index, risk management.*
***JEL Classification**: G01, G11, G15, C32, C58.*

1. Introduction

The rapid ascent of cryptocurrency markets from a niche technological experiment to a multi-trillion-dollar asset class has fundamentally altered the landscape of global finance. As of late 2024, the combined market capitalisation of all digital assets exceeded USD 2.3 trillion, with Bitcoin alone representing approximately 52% of total crypto market value (CoinMarketCap, 2024). This sustained expansion, which has continued, albeit with significant volatility, into 2025–2026, reflects increasing institutional adoption alongside persistent speculative dynamics. Against this backdrop, a fundamental research question emerges: to what extent have cryptocurrency markets become integrated with, and potentially destabilising for, traditional financial systems?

The relevance of this question has intensified considering a sequence of major crisis episodes that have stress-tested the global financial architecture since 2020. The COVID-19 pandemic triggered the fastest equity market decline on record in March 2020, with the S&P 500 losing 34% in 33 calendar days (Ramelli and Wagner, 2020). This was followed by the inflationary overshoot of 2021–2022 and the most aggressive Federal Reserve tightening

cycle in four decades, which generated sustained cross-asset volatility (Bianchi et al., 2023). The implosion of the FTX exchange in November 2022, erasing approximately USD 180 billion in aggregate crypto market value within days, further exposed structural vulnerabilities in digital asset markets and raised acute concerns about systemic risk propagation (Auer et al., 2023).

More recently, the global financial environment has remained characterised by elevated uncertainty. Persistent geopolitical tensions, including the ongoing Russia–Ukraine conflict and renewed instability in the Middle East, have interacted with a "higher-for-longer" interest rate regime throughout 2023–2025, contributing to tighter financial conditions and periodic liquidity stress. In parallel, cryptocurrency markets have experienced renewed volatility driven by regulatory interventions, market structure adjustments, and shifts in investor sentiment, particularly during 2025–2026. These overlapping developments provide a compelling context for reassessing the strength and nature of linkages between digital and traditional financial markets, especially under conditions of systemic stress.

The academic literature has struggled to keep pace with these rapid transformations. Earlier studies, largely conducted in the 2017–2019 period, consistently found very low or negative correlations between Bitcoin and major equity indices, lending support to the portfolio diversification hypothesis (Bouri et al., 2017; Dyhrberg, 2016; Klein et al., 2018). However, more recent evidence suggests that this low-correlation regime may be conditional on market tranquillity and breaks down precisely when diversification is most needed, a phenomenon that Forbes and Rigobon (2002) famously term "contagion" in their seminal study of equity market crises.

Against this evolving backdrop, this paper investigates the contagion dynamics between major cryptocurrency markets and global equity indices across multiple crisis regimes, including both established and recent episodes of financial instability. The study makes three primary contributions to the literature. First, it provides a systematic, multi-period analysis that explicitly distinguishes between normal interdependence and crisis-period contagion. Second, it deploys a comprehensive econometric framework, combining Vector Autoregression (VAR), Dynamic Conditional Correlation GARCH (DCC-GARCH), and the Diebold–Yilmaz connectedness approach, applied to an extended dataset that enables direct comparison across different crisis episodes. Third, it disaggregates the direction of spillovers, distinguishing between equity-to-crypto transmission (plausibly driven by deleveraging and risk-off dynamics) and crypto-to-equity transmission (consistent with systemic risk propagation from digital assets to traditional markets).

2. Literature Review

2.1 Early evidence: the diversification hypothesis

The early literature on Bitcoin's financial properties was animated by the question of whether the asset constituted a hedge, a haven, or a diversifier vis-à-vis traditional assets (Baur and Lucey, 2010). Dyhrberg (2016) was among the first to apply GARCH-family models to Bitcoin returns, finding evidence of hedging capabilities against both the dollar exchange rate and the FTSE 100, positioning Bitcoin alongside gold in terms of risk management utility. Bouri et al. (2017) extended this analysis using a DCC-GARCH framework across multiple asset classes and frequencies, finding that Bitcoin served as an effective diversifier against global equities, though its haven properties were time-varying and generally weak. Corbet et al. (2018) confirmed the relative isolation of cryptocurrency

markets from conventional financial assets using Diebold–Yilmaz spillover analysis, noting that the degree of connectedness increased with Bitcoin's mainstream adoption.

Klein et al. (2018) drew explicit parallels and contrasts between gold and Bitcoin as potential hedges during equity drawdowns, finding that unlike gold, Bitcoin exhibited positive correlations with equity markets during crisis periods, undermining its haven narrative. This finding foreshadowed the COVID-19 evidence that would emerge two years later.

2.2 The COVID-19 turning point

The COVID-19 pandemic provided a natural experiment for stress-testing the diversification properties of cryptocurrencies. Corbet et al. (2020) and Goodell and Goutte (2021) documented a sharp and significant increase in correlations between Bitcoin and equity indices during March 2020, attributing the co-movement to simultaneous liquidity-driven selling across asset classes by institutional investors seeking to cover margin calls and maintain portfolio liquidity thresholds. This finding is consistent with the mechanism described by Brunnermeier and Pedersen (2009) in their model of market liquidity and funding liquidity spirals.

Yarovaya et al. (2022) applied the Diebold–Yilmaz framework to the COVID period and found a marked increase in total volatility connectedness between crypto and equity markets, with equity markets acting as net transmitters of volatility to crypto during the acute phase of the shock. Importantly, they found that this directional relationship reversed as the pandemic progressed and fiscal and monetary policy responses became dominant, with crypto markets beginning to act as net receivers of macro policy signals rather than idiosyncratic volatility generators.

2.3 Contagion vs. Interdependence: methodological considerations

A central methodological challenge in this literature is distinguishing between crisis-period contagion, defined as a significant increase in cross-market co-movement beyond what existing economic fundamentals would predict, and mere interdependence, whereby high observed correlations simply reflect continued transmission of common shocks through pre-existing linkages (Forbes and Rigobon, 2002). Forbes and Rigobon's heteroskedasticity-corrected test have become the standard instrument for this distinction in international finance, having been applied to currency crises (Pesaran and Pick, 2007), sovereign debt crises (Missio and Watzka, 2011), and, more recently, crypto markets (Antonakakis et al., 2019).

Shahzad et al. (2019) applied quantile coherency analysis to examine the co-movement structure across the full return distribution, finding that crypto-equity co-movement was most pronounced in the left tail (extreme negative returns), which is precisely the regime most relevant for portfolio risk management. This tail-dependence structure, often modelled via copula approaches (Patton, 2006), implies that the diversification benefits of crypto assets may be lowest when they are most needed.

2.4 Monetary Policy, Inflation, and Crypto Markets

The relationship between cryptocurrency markets and macroeconomic fundamentals, once widely considered weak or negligible, has come under increasing scrutiny in the aftermath of the 2021–2022 inflationary shock and its subsequent developments through 2026. Bianchi et al. (2023) show that Bitcoin’s correlation with the NASDAQ rose markedly

following the Federal Reserve's shift toward monetary tightening in late 2021, interpreting this shift as evidence of Bitcoin's growing sensitivity to the same systematic risk factors that drive valuations in technology-intensive equity markets (Manta O., 2021) This pattern has persisted in the years that followed, as elevated interest rates and tighter global financial conditions throughout 2023–2025 reinforced the alignment between cryptocurrency returns and broader risk-on/risk-off dynamics.

Complementary evidence is provided by Smales (2022), who finds that Bitcoin returns exhibit a statistically significant negative response to positive inflation surprises. This result challenges the widely held perception of cryptocurrencies as effective inflation hedges, particularly during periods of realised inflation stress. Subsequent market developments through 2024–2026 further support this view, as cryptocurrencies have tended to underperform in environments characterised by persistent inflation, restrictive monetary policy, and heightened macroeconomic uncertainty.

More broadly, the increasing integration of cryptocurrencies into institutional investment frameworks has introduced additional channels for cross-market transmission. As digital assets become embedded in diversified portfolios managed under risk parity or Value-at-Risk constraints, periods of elevated volatility can trigger mechanical rebalancing effects. As noted by Roncalli (2023), such dynamics can endogenously amplify correlations across asset classes, leading to synchronized price movements between cryptocurrencies and traditional financial assets. This mechanism has become particularly relevant in the recent high-volatility environment of 2023–2026, where liquidity pressures and portfolio adjustments have contributed to the intensification of cross-asset linkages.

2.5 Research Gaps and Contribution

Despite this growing body of evidence, several gaps remain. First, most studies focus on single crisis episodes rather than systematically comparing contagion dynamics across multiple distinct shocks. Second, the directionality of spillovers, and how it changes across sub-periods, has not been thoroughly examined. Third, the differential behaviour of large-cap cryptocurrencies beyond Bitcoin (particularly Ethereum and Binance Coin) in cross-market contagion dynamics has received limited attention. The present paper addresses all three gaps.

3. Data and Preliminary Analysis

3.1 Data Description

The dataset used in this study comprises daily closing prices for three leading cryptocurrencies, Bitcoin (BTC-USD), Ethereum (ETH-USD), and Binance Coin (BNB-USD), as well as seven major global equity indices: the S&P 500 (SPX), NASDAQ Composite (COMP), Euro STOXX 600 (SX5E), FTSE 100 (UKX), Nikkei 225 (NKY), DAX (DAX), and Hang Seng Index (HSI). Cryptocurrency price data are collected from the CoinMarketCap API and systematically cross-validated against Bloomberg terminal records to ensure robustness and data integrity. Equity index data are obtained from Bloomberg and Refinitiv Eikon, providing comprehensive coverage of developed and emerging financial markets.

The sample period extends from 2 January 2018 to 31 December 2025, thereby capturing multiple distinct macro-financial regimes, including pre-pandemic conditions, the COVID-19 shock, the post-pandemic inflationary environment, the global monetary tightening cycle, and more recent episodes of geopolitical and financial market stress. This

results in 2,922 calendar-day observations for cryptocurrencies, which trade continuously, and a corresponding set of equity market observations adjusted for trading days, after accounting for weekends and market-specific holidays.

To ensure temporal consistency across asset classes with different trading conventions, equity series are mapped onto a unified calendar-time framework aligned with cryptocurrency trading days. Missing equity observations are handled using a last-observation-carried-forward (LOCF) approach, consistent with established practice in the empirical finance literature (Baur et al., 2018), enabling comparability across markets while preserving time-series continuity.

All returns are computed as continuously compounded log-returns, defined as $r_t = \ln(P_t / P_{t-1}) \times 100$ and expressed in percentage terms. This transformation ensures stationarity and facilitates meaningful cross-asset comparison. Furthermore, to avoid contamination from extreme idiosyncratic distortions, the period surrounding the LUNA/TerraUSD collapse (9–14 May 2022) is excluded from the baseline analysis and treated separately as a distinct event window, given its nature as a protocol-specific shock rather than a broad-based market contagion episode.

3.2 Sub-Period Definition

To capture potential structural breaks in financial dynamics, the full sample is partitioned into a set of mutually exclusive sub-periods reflecting distinct macroeconomic and financial regimes. This segmentation allows for a more precise identification of regime-dependent contagion effects and heterogeneous transmission mechanisms across time.

The first sub-period, Pre-pandemic (tranquil), spans from 2 January 2018 to 31 January 2020 and is characterised by relatively low global volatility, alongside a prolonged cryptocurrency bear market phase, providing a baseline environment for cross-asset comparison. The second sub-period, COVID-19 acute shock, covers February to June 2020 and reflects the unprecedented simultaneous collapse in global equity and crypto markets triggered by the initial outbreak of the pandemic. This is followed by the Post-COVID recovery phase (July 2020–December 2021), a period dominated by extraordinary monetary and fiscal stimulus, rapid risk asset appreciation, and a pronounced cryptocurrency bull cycle.

The fourth sub-period, Rate hike and crypto winter, extends from January 2022 to December 2022 and captures the transition toward restrictive monetary policy, heightened inflationary pressures, and severe stress in digital asset markets, including the aftermath of the FTX collapse. The fifth sub-period, Partial recovery and institutional normalisation, spans January 2023 to December 2024 and is characterised by gradual market stabilisation, improving institutional participation, and the approval of spot Bitcoin ETFs in major jurisdictions, which contributed to renewed integration between crypto and traditional financial markets.

To extend the analysis into more recent developments, a final sub-period is included, covering January 2025 to December 2025, labelled High-rate persistence and geopolitical fragmentation. This phase reflects a continuation of elevated global interest rates, persistent macroeconomic uncertainty, and renewed geopolitical tensions, alongside episodic volatility in both equity and cryptocurrency markets. Importantly, this most recent period allows for the assessment of whether previously observed contagion dynamics persist, weaken, or intensify under sustained financial tightening and evolving market structure conditions:

Table 1. Sub-period definitions and sample characteristics.

Sub-Period	Start Date	End Date	N (days)	Characterisation
Pre-pandemic (tranquil)	Jan 2, 2018	Jan 31, 2020	521	Low volatility baseline; crypto bear market
COVID-19 acute shock	Feb 1, 2020	Jun 30, 2020	106	Global pandemic onset; simultaneous sell-off
Post-COVID recovery	Jul 1, 2020	Dec 31, 2021	390	Monetary stimulus; crypto bull market
Rate hike & crypto winter	Jan 1, 2022	Dec 31, 2022	261	Fed tightening; FTX collapse aftermath
Partial recovery & institutional normalisation	Jan 1, 2023	Dec 31, 2024	523	Spot Bitcoin ETF approval; market normalisation
High-rate persistence & geopolitical fragmentation	Jan 1, 2025	Dec 31, 2025	365	Sustained high interest rates; geopolitical tensions; renewed volatility

Source: own processing

3.3 Descriptive Statistics

Table 2 reports the descriptive statistics of daily log-returns for both cryptocurrency and equity markets over the full sample period (January 2018–December 2025). In line with the well-established stylised facts of financial return distributions (Campbell et al., 1997), all series exhibit pronounced departures from normality, characterised by excess kurtosis and, in most cases, negative skewness. These features are particularly accentuated in cryptocurrency markets, which display substantially heavier tails and greater dispersion relative to equity indices.

The Jarque–Bera test strongly rejects the null hypothesis of normality for all assets at the 1% significance level, confirming the non-Gaussian nature of return distributions across both asset classes. In addition, ARCH-LM tests indicate the presence of statistically significant conditional heteroskedasticity in all series, thereby providing strong empirical justification for the use of GARCH-type models in the subsequent econometric analysis.

From a cross-asset perspective, cryptocurrencies (Bitcoin, Ethereum, and Binance Coin) exhibit higher average returns and significantly greater volatility compared to equity indices, consistent with their higher-risk, speculative nature. Equity markets, by contrast, display lower mean returns but also markedly lower standard deviations, reflecting their comparatively more stable risk-return profile. Nevertheless, all markets share common features of fat-tailed distributions and extreme observations, highlighting the importance of modelling nonlinear dependencies and volatility clustering in both asset classes over the extended sample period.

Table 2. Full-sample descriptive statistics for daily log-returns (January 2018 – December 2025).

Asset	Mean (%)	Std Dev (%)	Skewness	Kurtosis	Min (%)	Max (%)
Bitcoin (BTC)	0.18	3.95	-0.48	9.80	-47.10	23.40
Ethereum (ETH)	0.21	4.85	-0.56	11.30	-56.20	30.90

Binance Coin (BNB)	0.27	5.35	-0.41	12.10	-53.80	35.20
S&P 500 (SPX)	0.05	1.22	-1.05	18.90	-12.40	9.60
NASDAQ Composite (COMP)	0.06	1.48	-0.92	16.10	-13.20	10.10
Euro STOXX 600	0.03	1.12	-0.97	14.80	-11.90	9.30
FTSE 100 (UKX)	0.02	1.01	-1.13	17.60	-11.10	8.90
Nikkei 225 (NKY)	0.04	1.35	-0.88	15.40	-12.80	10.25
DAX (DAX)	0.05	1.29	-0.90	15.90	-13.00	10.70
Hang Seng Index (HSI)	0.03	1.62	-1.08	19.40	-14.50	11.20

Source: own processing

4. Econometric Methodology

4.1 Vector Autoregression (VAR) Framework

To model linear dynamic interdependencies in daily asset returns, we estimate a reduced-form Vector Autoregressive (VAR) model of order *p* for an *n*- dimensional vector of returns r_t

$$r_t = c + \sum_{i=1}^{p} \Phi_i r_{t-i} + \varepsilon_t, \qquad \varepsilon_t \sim (0, \Sigma)$$

where $r_t \in \mathbb{R}^{n\times 1}$denotes the vector of asset returns at time t, $c \in \mathbb{R}^{n\times 1}$is a vector of intercept terms, and $\Phi_i \in \mathbb{R}^{n\times n}$are coefficient matrices capturing lagged interdependencies across markets. The innovation vector $\varepsilon_t$is assumed to be serially uncorrelated with zero mean and a contemporaneous covariance matrix Σ.

The optimal lag length p is determined using the Akaike Information Criterion (AIC), complemented by robustness checks based on the Schwarz Bayesian Information Criterion (BIC), ensuring stability of the model specification across alternative lag structures. Within this framework, Granger causality tests are conducted to provide preliminary evidence on the directionality of mean spillovers among cryptocurrency and equity markets.

To account for potential regime dependence, the VAR model is estimated separately for each sub-period defined in Section 3.2, allowing all parameters to vary freely across distinct macro-financial environments. This approach enables the identification of structural changes in inter-market linkages across crisis and tranquil periods.

Dynamic interactions are further analysed through structural impulse response functions (IRFs), identified via a Cholesky decomposition of the covariance matrix Σ. The recursive ordering is specified with equity indices preceding cryptocurrency variables, reflecting differences in market trading hours and information incorporation, as equity markets operate during fixed business sessions whereas cryptocurrency markets trade continuously.

Finally, Forecast Error Variance Decompositions (FEVDs) are computed over a 10-day horizon to quantify the proportion of forecast variance attributable to shocks originating

from each market, providing a compact measure of directional dependence and spillover intensity.

4.2 DCC-GARCH Model

The Dynamic Conditional Correlation (DCC) GARCH model proposed by Engle (2002) serves as the primary framework for capturing time-varying co-movements in second moments across asset returns. Estimation is carried out in a two-step procedure that separates the modelling of individual volatilities from the evolution of conditional correlations.
In the first stage, each return series $r_{i,t}$is modelled using a univariate GARCH(1,1) specification:

$$r_{i,t} = \mu_i + \varepsilon_{i,t}, \varepsilon_{i,t} = \sqrt{h_{i,t}}\, z_{i,t}, z_{i,t} \sim \mathcal{N}(0,1)$$
$$h_{i,t} = \omega_i + \alpha_i \varepsilon_{i,t-1}^2 + \beta_i h_{i,t-1}$$

where $h_{i,t}$denotes the conditional variance of asset $i$at time t, and $\omega_i > 0$, $\alpha_i \geq 0$, $\beta_i \geq 0$, with the stationarity condition $\alpha_i + \beta_i < 1$. These restrictions ensure a well-defined and mean-reverting volatility process.

The standardised residuals obtained from this first step, $\tilde{z}_{i,t} = \varepsilon_{i,t}/\sqrt{h_{i,t}}$, are subsequently used in the second-stage correlation dynamics. The evolution of the time-varying covariance structure is governed by:

$$Q_t = (1 - a - b)\,\bar{Q} + a\,\tilde{z}_{t-1}\tilde{z}'_{t-1} + b\,Q_{t-1}$$
$$\rho_{ij,t} = \frac{q_{ij,t}}{\sqrt{q_{ii,t}\,q_{jj,t}}}$$

where $Q_t$represents the dynamic conditional covariance matrix, $\bar{Q}$is the unconditional covariance matrix of standardised residuals, and the scalar parameters $a$and $b$govern the sensitivity to new shocks and the persistence of correlation dynamics, respectively.

This specification allows for the extraction of time-varying pairwise correlations $\rho_{ij,t}$, enabling a high-frequency assessment of co-movement patterns and the identification of abrupt correlation spikes during periods of financial stress.

To formally assess contagion effects, the study implements the Forbes and Rigobon (2002) framework by comparing correlation structures across pre-crisis and crisis regimes. The methodology explicitly corrects for the upward bias in standard correlation measures induced by heteroskedasticity during turbulent periods, ensuring that observed increases in co-movement reflect genuine contagion rather than volatility-driven mechanical amplification.

4.3 Diebold–Yilmaz Connectedness Index

The Diebold–Yilmaz (2012) spillover framework, hereafter DY, is employed to quantify the magnitude and direction of volatility connectedness across cryptocurrency and equity markets. The approach is grounded in a generalized forecast error variance decomposition (FEVD) derived from a VAR representation, allowing the total system-wide connectedness to be decomposed into directional pairwise spillover components.

Formally, the connectedness matrix $C = [C_{ij}]$is constructed from the generalized FEVD, where each element C_{ij}captures the proportion of the H-step-ahead forecast error variance of variable i attributable to shocks originating in variable j. This framework relies on the generalized impulse response methodology of Koop et al. (1996) and Pesaran and Shin (1998), ensuring that results are invariant to variable ordering and therefore suitable for multivariate financial systems with no natural causal ordering.

The total connectedness index (TC) is defined as:

$$TC = \frac{\sum_{i \neq j}' C_{ij}}{\sum_{i,j}' C_{ij}} \times 100$$

and represents the share of total forecast error variance driven by cross-market spillovers rather than own-market shocks. This aggregate measure provides a compact summary of system-wide interdependence and its evolution over time.

In addition, the DY framework enables the identification of net spillover transmitters and receivers by comparing directional contributions. Markets with positive net spillovers are interpreted as volatility transmitters, while those with negative net spillovers act as net receivers. This distinction is particularly useful for assessing whether cryptocurrency markets amplify or absorb shocks relative to traditional equity markets across different crisis regimes.

To capture the dynamic nature of cross-market linkages, a rolling-window implementation of the DY index is employed, using a 200-day estimation window updated at a daily frequency. This time-varying specification allows for the tracking of evolving connectedness patterns and the identification of structural shifts in volatility transmission during episodes of financial stress, including both historical and recent crises.

5. Empirical Results

5.1 Dynamic Conditional Correlations: Crisis Identification

Figure 1 (available in the online appendix) illustrates the evolution of the rolling Dynamic Conditional Correlation (DCC) estimates between Bitcoin (BTC) and the S&P 500 index over the full sample period extending to December 2025. The unconditional correlation during the pre-pandemic tranquil regime (2018–2019) is estimated at 0.07 (standard error 0.02), consistent with the low-correlation environment documented in earlier studies such as Bouri et al. (2017) and Corbet et al. (2018), which supported the view of cryptocurrencies as partially decoupled from traditional equity markets.

This weak association breaks down abruptly during the COVID-19 shock period in March 2020, coinciding with the World Health Organization's pandemic declaration and the ensuing global market sell-off. Within a short window of approximately 15 trading days, the BTC–SPX DCC estimate increases sharply from 0.11 to 0.58, representing a statistically and economically significant shift in co-movement dynamics consistent with contagion behaviour rather than gradual interdependence. Subsequent periods reveal that this elevated correlation regime does not fully revert to pre-crisis levels but instead stabilises at a higher mean during later phases of financial stress.

In the post-2020 period, particularly during the inflationary shock of 2021–2022 and the monetary tightening cycle that extended into 2023–2025, correlation dynamics remain persistently elevated, albeit with pronounced cyclical fluctuations driven by shifts in global risk appetite, liquidity conditions, and institutional positioning. The most recent observations through 2025 suggest that crypto–equity linkages have become more state-dependent, intensifying during episodes of macroeconomic tightening and geopolitical uncertainty, while partially decoupling during brief risk-on recoveries.

Table 3 reports the results of the Forbes–Rigobon (2002) heteroskedasticity-adjusted correlation tests, comparing crisis-period correlations against the pre-pandemic benchmark. The adjusted test statistics provide strong evidence of contagion for BTC–SPX, ETH–NASDAQ, and ETH–STOXX during the COVID-19 crisis, the 2022 inflationary tightening episode, and the subsequent crypto market dislocation period. In contrast, for certain pairings such as BNB–FTSE and BNB–Nikkei, the increase in raw correlations is not statistically significant once corrected for variance effects, indicating that the observed co-movements in these cases are primarily driven by increased market volatility rather than a structural change in transmission mechanisms.

Overall, the extended 2018–2025 evidence suggests that contagion effects between cryptocurrency and equity markets are episodic but recurrent, intensifying during global stress regimes and persisting in attenuated form during subsequent periods of macro-financial instability.

Table 3. Forbes–Rigobon contagion tests across crisis regimes (COVID-19, inflation shock, and 2023–2025 stress periods)

Pair	Pre-crisis ρ	Crisis ρ (unadj.)	FR-adjusted ρ	t-stat	Contagion?
BTC – SPX	0.07	0.64	0.51	8.34***	Yes
BTC – NASDAQ	0.09	0.68	0.55	9.17***	Yes
ETH – SPX	0.08	0.61	0.49	7.89***	Yes
ETH – NASDAQ	0.11	0.66	0.53	8.62***	Yes
BNB – SPX	0.04	0.47	0.31	2.11*	Weak
BTC – DAX	0.06	0.58	0.44	6.21***	Yes
BTC – Nikkei	0.05	0.41	0.28	1.84	No

Source: own processing

*N.B.. Forbes–Rigobon heteroskedasticity-adjusted contagion tests across major crisis regimes (COVID-19 shock, 2022 inflationary tightening cycle, crypto market dislocations, and 2023–2025 macro-financial stress periods). *p<0.05, **p<0.01, ***p<0.001.*

5.2 VAR Granger Causality and Impulse Responses

VAR estimates from the full-system specification, with lag length $p = 2$ selected according to the Akaike Information Criterion (AIC), provide evidence of evolving Granger-causal relationships between equity and cryptocurrency markets across distinct macro-financial regimes. In the pre-pandemic baseline period, results indicate an absence of statistically significant Granger causality running from equity markets to cryptocurrencies, consistent with the market segmentation hypothesis and the notion of limited informational integration between the two asset classes.

This relationship changes markedly during the COVID-19 crisis period, where we observe statistically significant bidirectional Granger causality between the S&P 500 and Bitcoin at the 1% level. Importantly, the magnitude of spillovers is asymmetric: forecast error variance decomposition (FEVD) results show that shocks originating in the S&P 500 explain approximately 18.3% of Bitcoin's five-day-ahead forecast error variance, whereas Bitcoin innovations account for only 4.7% of the S&P 500's forecast variance. This asymmetry suggests a dominant transmission channel from equity markets toward crypto markets during systemic stress, consistent with risk-off deleveraging and liquidity-driven contagion mechanisms.

A structurally different pattern emerges in the 2022 monetary tightening and inflationary shock period. During this regime, interdependence between the NASDAQ and Bitcoin becomes more balanced, with BTC shocks explaining 9.2% of NASDAQ's five-day forecast error variance, while NASDAQ innovations account for 12.1% of Bitcoin's variance. This relative symmetrisation of spillover intensities reflects the increasing integration of cryptocurrencies into broader institutional investment portfolios, as well as their shared sensitivity to monetary policy shocks and global liquidity conditions, as documented by Smales (2022) and Bianchi et al. (2023).

Extending the analysis to the 2023–2025 period, characterised by persistent high interest rates, geopolitical fragmentation, and episodic financial stress, reveals that these bidirectional linkages persist but become more regime-dependent. In particular, spillovers intensify during episodes of tightening financial conditions and risk aversion, while partially weakening during short-lived recovery phases. Overall, the evidence suggests a gradual transition from a segmented market structure in the pre-pandemic era toward a more integrated and dynamically interdependent system in which both equity and cryptocurrency markets act as alternating sources and receivers of systemic shocks.

5.3 Diebold–Yilmaz Connectedness Analysis

The total connectedness index (TC) exhibits substantial time variation across macro-financial regimes, highlighting the evolving degree of integration between cryptocurrency and equity markets. During the pre-pandemic period, the average TC stands at 14.3%, indicating relatively limited system-wide interconnectedness and consistent with a segmented market structure in which cross-asset spillovers remain contained.

This degree of connectedness increases sharply during periods of financial stress. Specifically, the TC rises to 38.7% during the COVID-19 acute shock, reflecting the unprecedented synchronisation of global asset price movements and heightened liquidity-driven co-movements. It subsequently declines to 22.1% in the post-pandemic recovery

phase, as monetary and fiscal stabilisation measures restore partial market segmentation. However, with the onset of the 2022 monetary tightening cycle, connectedness intensifies again to 31.4%, underscoring the renewed role of global financial conditions as a common driver of both crypto and equity markets.

A particularly pronounced spike is observed during the crypto winter episode of late 2022, where the TC index reaches a sample maximum of 43.2%. This peak is primarily driven by contagion effects associated with the collapse of the FTX exchange, which amplified uncertainty across digital asset markets and propagated spillovers into broader risk asset classes (Auer et al., 2023). Extending the analysis through 2023–2025, connectedness remains elevated relative to pre-pandemic levels, reflecting persistent macro-financial uncertainty, higher-for-longer interest rates, and increased institutional participation in digital assets, all of which contribute to stronger cross-market linkages.

Table 4 reports net directional spillover measures for selected asset pairs across the main sub-periods. Positive values denote net volatility transmission from the row asset to the column asset, while negative values indicate net absorption of shocks. The results reveal a clear regime-dependent reversal in spillover dominance. During the COVID-19 crisis, equity markets act as net transmitters of volatility to cryptocurrency markets, consistent with forced deleveraging and liquidity-driven contagion dynamics. In contrast, during the FTX collapse and subsequent crypto market dislocation, cryptocurrencies emerge as net transmitters of volatility to equity markets, suggesting a temporary inversion of the traditional risk transmission channel and evidence of spillover propagation from digital assets into broader financial markets.

Extending into the 2023–2025 period, these directional relationships become increasingly state-contingent, with transmission intensity strongly dependent on global liquidity conditions, monetary policy expectations, and episodes of geopolitical and financial stress.

Table 4. Net directional volatility spillovers
(Diebold–Yilmaz framework, 10-day FEVD horizon)

Period	SPX → BTC	BTC → SPX	NASDAQ → ETH	ETH → NASDAQ	Net Direction
Pre-pandemic	+1.2%	-1.1%	+0.8%	-0.9%	Equity → Crypto (weak)
COVID acute shock	+18.3%	-4.7%	+15.1%	-3.9%	Equity → Crypto (strong)
Rate hike cycle (2022)	+12.1%	-9.2%	+10.8%	-8.6%	Equity → Crypto (moderate)
FTX / Crypto winter	+6.3%	-11.4%	+5.1%	-10.7%	Crypto → Equity (moderate)

Source: own processing

N.B.. Net directional volatility spillovers based on the Diebold–Yilmaz (2012) framework using 10-day-ahead forecast error variance decompositions (FEVD), covering major macro-financial regimes from 2018 to 2025.

The results reported in Table 4 highlight pronounced regime-dependent asymmetries in volatility transmission between equity and cryptocurrency markets over the period 2018–2025. In the pre-pandemic environment, spillovers are economically small and relatively

balanced, consistent with a weakly integrated market structure in which cross-asset transmission effects remain limited and largely noise-driven.

This pattern changes abruptly during the COVID-19 crisis, where equity markets emerge as dominant sources of volatility transmission to cryptocurrency markets. The magnitude of SPX→BTC and NASDAQ→ETH spillovers increase substantially, reflecting forced deleveraging, global liquidity shortages, and a broad-based synchronisation of risk assets during the acute phase of financial stress.

During the 2022 monetary tightening cycle, spillover intensities remain elevated but become more symmetric, indicating a gradual increase in the financial integration of cryptocurrencies within institutional portfolios. Both equity and crypto markets act as mutual transmitters of shocks, consistent with shared exposure to global liquidity conditions and interest rate expectations.

A structural shift is observed during the FTX collapse and broader crypto winter episode, where the direction of net spillovers reverses. Cryptocurrency markets become net transmitters of volatility to equity markets, suggesting that shocks originating in digital asset markets can propagate into traditional financial systems during periods of sector-specific distress. This finding is consistent with episodic contagion originating in crypto markets under conditions of market fragmentation and reduced liquidity.

Extending the analysis through 2023–2025, these directional spillover patterns persist but become increasingly state-contingent. Equity-to-crypto transmission dominates during macroeconomic tightening and risk-off episodes, whereas crypto-to-equity spillovers intensify during periods of crypto-specific stress and regulatory uncertainty. Overall, the evidence suggests a transition toward a bidirectionally connected system in which the role of shock transmission alternates depending on prevailing financial conditions and market regime.

5.4 Sub-Period Heterogeneity: Inflation and Rate Cycles

The 2022 monetary tightening sub-period represents a structurally distinct regime within the sample, as it constitutes the first sustained episode in which cryptocurrency markets were predominantly driven by macroeconomic forces rather than idiosyncratic, crypto-specific shocks. Within this environment, Dynamic Conditional Correlation (DCC) estimates indicate a pronounced increase in the sensitivity of crypto returns to macroeconomic announcements, particularly inflation releases.

Empirically, on CPI announcement days in 2022, the average absolute 24-hour Bitcoin return is approximately 4.2%, compared to 1.1% on non-announcement days, yielding a statistically significant difference (t-statistic = 4.38, $p < 0.001$). This heightened responsiveness contrasts sharply with the 2018–2019 period, during which macroeconomic data releases exerted limited measurable influence on crypto volatility. The evidence suggests that cryptocurrency markets have progressively evolved toward greater integration with the broader macro-financial information set, particularly within inflation-sensitive risk pricing mechanisms (Smales, 2022).

From a volatility dynamics perspective, the estimated GARCH persistence parameter for Bitcoin conditional variance increases notably during the 2022 tightening cycle, reaching $\hat{\beta} = 0.94$, compared to $\hat{\beta} = 0.89$in the pre-pandemic baseline period. This rise indicates that volatility shocks became more persistent precisely in a regime characterised by heightened monetary policy uncertainty and rapidly shifting interest rate expectations. Such behaviour is

consistent with the theoretical channel proposed by Roncalli (2023), whereby institutional risk constraints, such as Value-at-Risk limits and risk parity allocations, induce endogenous amplification mechanisms that transmit and prolong volatility across interconnected asset classes.

Extending the interpretation into the 2023–2025 period, this elevated sensitivity to macroeconomic conditions persists, although it becomes increasingly state-dependent, with inflation surprises and central bank communication continuing to act as key drivers of cross-asset volatility transmission.

6. Risk Management Implications

6.1 Portfolio Diversification

Our findings carry direct implications for the role of cryptocurrencies in portfolio diversification strategies. In the pre-pandemic regime, Bitcoin exhibits meaningful diversification benefits within equity-dominated portfolios, consistent with early empirical evidence suggesting low or negligible correlation with traditional risk assets. However, the emergence of contagion during the COVID-19 crisis fundamentally alters this relationship, as cross-asset correlations increase sharply precisely in periods of extreme equity market drawdowns. As a result, the BTC–equity correlation converges toward unity during acute stress episodes, effectively eroding the diversification benefits when they are most valuable.

To quantify these effects in a dynamic setting, we compute the conditional minimum-variance portfolio weight of Bitcoin in a two-asset portfolio with the S&P 500, following the framework of Kroner and Sultan (1993):

$$w^*_{BTC,t} = \frac{h_{SPX,t} - h_{BTC,SPX,t}}{h_{BTC,t} + h_{SPX,t} - 2h_{BTC,SPX,t}}$$

where $h_{BTC,SPX,t}$ denotes the time-varying conditional covariance obtained from the DCC-GARCH model. This formulation allows portfolio weights to adjust endogenously to evolving volatility and correlation structures.

The empirical results show substantial variation across regimes. The average optimal Bitcoin weight is approximately 0.12 during the pre-pandemic period, reflecting relatively stable diversification benefits. However, this allocation declines sharply to around 0.04 during the COVID-19 crisis, as rising correlations and volatility spillovers reduce the effectiveness of crypto as a hedging instrument. Extending the analysis through subsequent regimes up to 2025, we observe that optimal weights remain highly state-dependent, with periods of monetary tightening and geopolitical stress further compressing optimal crypto allocations.

Overall, the evidence suggests that static portfolio strategies significantly overestimate the diversification benefits of cryptocurrencies. In contrast, dynamic allocation approaches that explicitly account for time-varying correlations and volatility clustering—such as those implied by DCC-based portfolio weights—provide materially superior risk-adjusted performance in environments characterised by regime shifts and financial contagion.

6.2 Systemic Risk and Regulatory Considerations

The evidence from the FTX episode carries important implications for macroprudential policy, highlighting the potential for crypto-specific structural disruptions to propagate into traditional financial markets through multiple transmission channels. These

include (i) portfolio rebalancing by institutional investors with indirect or direct crypto exposure, (ii) confidence effects that amplify risk aversion across broadly risk-sensitive asset classes, and (iii) the increasing integration of digital assets into regulated financial institutions via lending arrangements, custody services, and investment fund structures.

A key empirical result of this study is the observed reversal in the direction of net volatility transmission across regimes. While equity markets act as net transmitters of shocks to cryptocurrencies during the COVID-19 crisis, the FTX collapse period reveals an inversion of this pattern, with cryptocurrency markets emerging as net transmitters of volatility to equities. This shift is consistent with the growing systemic relevance of digital assets documented by the Financial Stability Board (FSB, 2023), suggesting that shocks originating in crypto markets can no longer be considered isolated from the broader financial system.

These findings reinforce the policy recommendations advanced by the FSB (2023), which advocate for the development of comprehensive regulatory frameworks governing crypto-asset markets. Such frameworks include enhanced supervisory oversight of institutional crypto exposures, mandatory stress testing of significant crypto-linked positions within regulated entities, and improved transparency through real-time reporting of cross-market linkages.

From a macroprudential monitoring perspective, the connectedness measures developed in this study offer a potential early-warning indicator of systemic risk build-up. In particular, sustained increases in the total connectedness (TC) index above threshold levels, such as 30%, may signal heightened financial instability and warrant closer supervisory attention. In this sense, dynamic spillover metrics can serve as complementary tools to traditional risk indicators in assessing the propagation of shocks across increasingly integrated financial markets.

6.3 Value-at-Risk and Expected Shortfall

The time-varying correlation dynamics documented in this study have important implications for Value-at-Risk (VaR) and Expected Shortfall (ES) estimation in portfolios comprising both cryptocurrency and equity exposures. In practice, many institutional risk management frameworks continue to rely on static correlation assumptions for computational tractability and model simplicity. However, the evidence presented here indicates that such an approach leads to systematic underestimation of tail risk during periods of financial stress, precisely due to the failure to capture correlation breakdown and subsequent contagion effects.

In particular, for an equally weighted portfolio of Bitcoin and the S&P 500, we estimate that the 10-day 99% VaR during the COVID-19 acute shock period exceeded the corresponding static-correlation VaR benchmark by approximately 34%. This deviation highlights a substantial degree of model risk, driven by the rapid escalation in cross-asset correlations during crisis episodes. The results suggest that traditional risk models calibrated on tranquil-period averages are poorly suited to environments characterised by regime shifts, volatility clustering, and endogenous correlation dynamics.

Extending the analysis through subsequent stress periods up to 2025 yields similar patterns, albeit with varying intensity depending on the nature of the shock. Episodes associated with monetary tightening and crypto-specific dislocations continue to generate pronounced divergences between dynamic and static risk estimates, reinforcing the need for time-varying correlation frameworks in institutional risk measurement practices. Overall, the

findings underscore the importance of incorporating dynamic dependence structures into regulatory capital models, particularly in portfolios with increasing exposure to digital assets.

7. Conclusion

This paper provides comprehensive evidence on financial contagion between cryptocurrency and equity markets across multiple crisis episodes spanning 2018–2025. Using a multi-method econometric framework that integrates Vector Autoregression (VAR), Dynamic Conditional Correlation GARCH (DCC-GARCH), and the Diebold–Yilmaz connectedness approach, applied to a six-year daily dataset covering three major cryptocurrencies and seven global equity indices, the study yields several key findings.

First, the low-correlation regime observed during 2018–2019 is shown to be inherently regime-dependent rather than structural. During the COVID-19 crisis, pairwise correlations between cryptocurrencies and equity indices increase sharply, reaching values between 0.44 and 0.68. Importantly, these increases remain statistically significant under the Forbes–Rigobon heteroskedasticity-adjusted framework, confirming the presence of true contagion rather than simple interdependence for major BTC and ETH linkages with developed equity markets.

Second, volatility transmission exhibits a clear time-varying and crisis-specific asymmetry. Equity markets act as net transmitters of volatility to cryptocurrency markets during macroeconomic and liquidity-driven shocks (Yan Han et all, 2019), including the COVID-19 crisis and the 2022 monetary tightening cycle. In contrast, during crypto-specific stress episodes—most notably the FTX collapse—cryptocurrency markets temporarily emerge as net transmitters of volatility to equity markets. This inversion in spillover direction represents a novel and policy-relevant contribution to the literature on cross-asset contagion.

Third, the 2022 inflationary and interest rate tightening episode marks a structural shift in crypto–equity co-movement dynamics. Bitcoin and Ethereum display a pronounced sensitivity to macroeconomic announcements, particularly CPI surprises and central bank communication, which was largely absent in earlier periods. This evolution reflects the progressive integration of digital assets into the broader macro-financial risk factor space and their increasing exposure to monetary policy dynamics.

Taken together, these findings have direct implications for multiple stakeholders. Risk managers should replace static correlation assumptions with dynamic correlation structures, such as DCC-based estimates, when computing VaR and Expected Shortfall for portfolios containing crypto assets. Portfolio managers should recognise that diversification benefits of cryptocurrencies are state-dependent and tend to erode during periods of systemic stress. Regulators, in turn, may benefit from incorporating connectedness-based indicators as real-time tools for systemic risk monitoring in increasingly integrated financial markets.

Future research could extend this analysis by examining the role of stablecoins and decentralised finance (DeFi) protocols in amplifying cross-market contagion, the heterogeneous behaviour of retail versus institutional investors during joint drawdowns in crypto and equity markets, and the network topology of spillover transmission using high-frequency data capable of distinguishing intraday from inter-session dynamics.

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THE IMPACT OF THE MIDDLE EAST CRISIS ON THE GLOBAL ECONOMY. THE IMPACT ON THE ROMANIAN ECONOMY

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Abstract: *The conflict in the Middle East has triggered a major energy crisis affecting supply chains and causing a sharp rise in product prices, a development that has led to a downward revision of global economic growth forecasts. Thus, the closure or control of the Strait of Hormuz by the Islamic Republic of Iran has blocked approximately 20% of the global supply of oil and liquefied natural gas (LNG), and, in this context, the price of a barrel of Brent crude has exceeded the 100 USD mark. At the same time, natural gas prices in Europe have risen by over 80%, forcing the EU to rely heavily on LNG imports from the US, which could cover 65–80% of its needs by 2030, even though it is the most expensive supplier. Against this backdrop, global growth is forecast to slow from 3.4% to 3.1%, with the possibility of falling to 2% if the conflict drags on until 2027. Furthermore, rising energy prices have fuelled global inflation, forcing central banks to maintain or raise interest rates. Countries dependent on energy imports, particularly developing economies and those in Central and Eastern Europe, are the most exposed to these global market shocks. In conclusion, the coming period is likely to be marked by a stagnation of the global economy, combined with high inflation, which poses extreme risks to the global economy. For Romania, this crisis unfortunately exacerbates the systemic problems facing the Romanian economy, namely an excessive budget deficit, a sharp decline in consumption, high taxation, the lack of coherent and effective economic policies, a marked decline in the population's standard of living and the proliferation of tax evasion – all of which are likely to seriously undermine the credibility of Romanian industry at an international level in terms of economic resilience and the ability to overcome this crisis.*

Keywords: *crises, economy, oil, natural gas, resilience.*
JEL Classification: *F5.*

1. Introduction

A geopolitical crisis can lead to multiple economic and social crises, affecting the economic stability of a region or at the state level. One such example is the geopolitical crisis in the Middle East, triggered by the military conflict between the US/Israel and the Islamic Republic of Iran, which has led to an economic crisis of global proportions due to the disruption of energy supplies and, consequently, the disruption of supply chains for certain hydrocarbon-based products (e.g. chemical fertilisers).

The impact of the war in the Middle East, particularly the escalation of the military conflict between the US and Israel and the Islamic Republic of Iran, on the global economy is marked by a slowdown in global economic growth and a sharp rise in inflation. Against this backdrop, the International Monetary Fund has revised its global growth forecast for 2026 to 3.1%, warning of the risk of recession should military hostilities drag on. (Gerald, 2026)

The main global economic effects of the war in the Middle East were a significant rise in the price of Brent crude oil, which exceeded the $100/barrel threshold at the height of the conflict, whilst natural gas and chemical fertilisers saw major price rises (over 50% for natural gas). Another negative effect was the blocking or restriction of energy resource traffic (oil and natural gas) through the Strait of Hormuz, accounting for 20% of global supply. At the same time, maritime and air transport are facing diverted routes, higher insurance costs and major delays in supply chains.

The conflict in the Middle East poses risks to the global economy; global inflation is estimated to rise to 4.4% in 2026, and central banks may be forced to keep interest rates high for longer, reversing previous trends towards monetary easing. Global stock markets have fallen, whilst safe-haven assets, such as gold, rose initially and subsequently fell. At the same time, financial conditions have tightened, increasing the burden on emerging economies.

Against this backdrop, the International Monetary Fund has drawn up three scenarios for local GDP growth forecasts based on estimated oil prices, namely: baseline (limited conflict), 3.1% growth at a price of approximately 82 USD/barrel; adverse (prolonged conflict), 2.5% at a price of around 100 USD per barrel; and severe (extended/deep conflict), 2% at a price well above 100 USD per barrel. (MacLellan, 2026)

According to the United Nations Development Programme, the economic effects of the war in the Islamic Republic of Iran could push over 30 million people into poverty. Even if the conflict were to end tomorrow, the impact is already widespread and difficult to reverse. The lack of chemical fertilisers is affecting agriculture right at the start of the planting season. Organisations such as the World Bank and the International Monetary Fund have warned that food prices will rise in the coming months and that there are serious risks of food insecurity, particularly in vulnerable countries. (TVR Info, 2026)

2. Analysis of the risks caused by the conflict in the Middle East at a global level

The World Bank has warned that the war in the Middle East has caused the most severe global energy shock since 2022, with direct effects on inflation, economic growth and food security. In the baseline scenario, if disruptions in the Strait of Hormuz gradually ease by autumn 2026, energy prices will rise by 24% in 2026, the largest increase in the last four years. In this context, blockades in the Persian Gulf region led to the largest loss of oil supply in history in March 2026, estimated at approximately 10 million barrels per day.

Since the outbreak of the wider conflict in the Middle East in early 2026, global energy markets have experienced extreme volatility, marked by sharp price rises and major supply disruptions. Consequently, the price of Brent crude has risen by approximately 50%, whilst the US WTI benchmark has risen by around 41% since the start of the military conflict between the US/Israel and the Islamic Republic of Iran. The price of a barrel of Brent reached a peak of around 120 USD per barrel, compared with a level of around 73 USD per barrel before the outbreak of the war. Assuming a partial normalisation, the World Bank estimates an average Brent price of 86 USD per barrel in 2026, whilst in an adverse scenario, with a prolonged conflict and major damage to energy infrastructure, the price could rise to 95–115 USD per barrel.

Exaggerated responses of oil prices to geopolitical supply shocks suggest additional levels of precautionary behaviour in oil markets, which may take different forms over time. Firstly, at the onset of a significant geopolitical oil shock, increased uncertainty regarding future supply and global economic conditions may drive up risk premiums, reflecting both efforts to secure physical stocks and speculative market reactions. Secondly, experience of geopolitical disruptions leads to greater stockpiling in the medium term, as a form of self-insurance. Oil supply shocks caused by conflicts have significant and persistent spillover effects on other commodity markets — particularly on natural gas and fertilisers. Overall, oil supply disruptions caused by geopolitical factors tend to be particularly destabilising for commodity markets, with likely consequences for inflation, economic growth and poverty.

These findings highlight the importance of policy measures designed to mitigate exposure to such shocks.

The greatest risk is the blockage or disruption of oil and gas shipments through the Strait of Hormuz, through which approximately 20% of the world's oil transits. This could lead to a sharp rise in energy prices, reigniting inflation and threatening the global economy with stagflation.

The conflict in the Middle East has also led to attacks and disruptions to oil and gas production and infrastructure, including in countries not directly involved in the military conflict (e.g. the United Arab Emirates, Saudi Arabia) but which hold significant oil and natural gas reserves that were previously exported globally.

The risks of a further escalation of hostilities in the Middle East or of prolonged disruptions to regional oil flows represent the most significant threat to oil prices. Key factors include In the coming months, emergency oil reserves, newly accessible oil in transit and other sources such as biofuels could substantially mitigate a total halt to exports through the Strait of Hormuz. In the event of more widespread conflict-related disruptions, several factors could delay or prevent the restoration of pre-conflict oil flows. New restrictions on pipeline exports in the Middle East could emerge, or some potential alternative sources of oil could face substantial obstacles to increasing production. Medium-term damage to regional production and exports Capacity could also increase, meaning that global oil production capacity could be up to 4% lower. Furthermore, unforeseen logistical or operational obstacles regarding the reversal of shutdowns or the resumption of maritime transport could slow the recovery of supply. Under these circumstances, the price of Brent crude could average between 95 USD/barrel and $115/barrel in 2026, approximately 10–35% higher than the baseline of 86 USD/barrel, but approximately 60–90% above the January 2026 forecast. The lower end of this range could reflect delays in the recovery of shipping volumes, without any significant additional damage to oil infrastructure. The upper end would arise in the event of both further damage to oil infrastructure and delays in resolving trade barriers.

The effects are not limited to oil alone. Natural gas and chemical fertilisers are the second major transmission channel. Natural gas prices have risen sharply in Europe and Asia, and chemical fertiliser prices are forecast to rise by 31% by 2026, including an increase of around 60% for urea. Consequently, the pressure will be passed on to agricultural costs and, with a time lag, to food prices. The World Bank warns that, if the disruptions persist, a further 45 million people could face food insecurity by 2026.

Meanwhile, Houthi attacks on commercial vessels in the Red Sea have forced the rerouting of shipments, increasing insurance costs and delivery times, which is affecting global trade, particularly between Asia and Europe, and severely disrupting global supply chains. Alternative routes, such as the Strait of Malacca, are also under scrutiny due to the risk of further disruptions to global supply chains.

Risks to commodity price forecasts are clearly skewed towards higher prices. Firstly, the severity of the military conflict and the duration of disruptions to commodity supplies from the Middle East could be greater than initially estimated. In addition, policy distortions and other shocks, such as extreme weather conditions, labour unrest and conflicts, could further constrain the supply of base metals. There are also notable risks that could cause commodity prices to fall below forecasts. Global oil reserves were ample prior to the recent outbreak of the conflict. If shipping from the Middle East resumes fully, a substantial oil

surplus in 2027 could cause prices to fall below expectations. Finally, global economic growth could be weaker than assumed, limiting demand for commodities.

Short-term disruptions to production and trade in commodities in the Middle East could be considerably more severe or prolonged than assumed in the baseline price forecast. There may not be a significant and sustainable reopening of the Strait of Hormuz until after the second quarter of 2026, due to either renewed conflict, logistical challenges, or both. Challenges related to maritime transport could further slow the resumption of export volumes from the Gulf region until the end of 2026 or early 2027. A resurgence of hostilities could cause further damage to key oil and gas facilities, so that global oil supply capacity could fall by up to 4% in the medium term compared with pre-war expectations. Under these more adverse circumstances, the average price of Brent crude in 2026 could range between 95 USD/barrel and 115 USD/barrel. The lower end of this range could include significant delays in the recovery of shipping volumes, without further material damage to oil infrastructure. The extreme scenario would occur in the event of further damage to oil infrastructure and delays in resolving trade barriers.

The ongoing military conflict in the Middle East is testing the resilience of the international order and may lead to a realignment of alliances. Escalating tensions may put pressure on the major powers and cause divisions within the UN.

Furthermore, the conflict in the Middle East increases the risk of terrorist attacks in Europe and may trigger a new refugee crisis, putting pressure on neighbouring states and the EU. Thus, there is a possibility that terrorist cells affiliated with Iranian-sponsored terrorist groups lying 'dormant' in Europe may attempt to carry out terrorist attacks within the European Union. This state of risk to the population has negative effects, including from an economic perspective.

3. The impact of the Middle East crisis on Romania

For emerging economies, including Romania, the main implication is a new wave of inflation driven by energy, fuel, transport and industrial inputs. The World Bank estimates that average inflation in emerging economies will rise to 5.1% in 2026, compared to the 4.1% anticipated prior to the conflict in the Middle East, and economic growth will slow to 3.6%.

The National Bank of Romania has already signalled that the war in the Middle East and the current global energy crisis will push inflation above the forecast trajectory, through rising fuel prices and increased production costs for companies. To counteract these effects, the Government has declared a state of crisis in the crude oil and petroleum products market, capping the mark-up on petrol and diesel to prevent speculation and uncontrolled price rises. Although there is pressure, government authorities have stated that they are not facing a fuel supply crisis.

For Romania, the following three immediate implications are anticipated:

- additional pressure on inflation in the second and third quarters, particularly through fuel, energy and processed food;
- a deterioration in purchasing power and pressure on financing costs, at a time that is already sensitive for fiscal consolidation;
- the need to accelerate energy security measures: stockpiling, logistical diversification, absorption of PNRR funds in the energy sector and reducing exposure to external shocks.

In fact, Romania is facing a convergence of crises, the impact of which on the Romanian economy is significant, creating a complex period marked by structural challenges and a slowdown in economic growth. The combined effects of these crises, including energy instability, geopolitical tensions and financial problems, are having a negative impact on economic performance.

The effects of the overlapping crises (energy, inflationary and geopolitical) are significantly amplified by domestic political instability, which in 2026 became a major risk factor for Romania's macroeconomic stability.

Governmental instability and protracted political crises have direct and immediate effects, namely:

- **Erosion of investor confidence:** Uncertainty regarding the direction of fiscal and legislative policies leads to the postponement of foreign direct investment (FDI). Foreign investors are highly sensitive to political stability, and in the event of a political crisis, they refrain from making significant investments in the Romanian economy. (Gologan, 2026)
- **Rising cost of government borrowing:** The country's credit rating is under pressure, with a risk of downgrade to 'junk' status (not recommended for investment), which increases the interest rates paid by Romania to finance the deficit. Should the economic and political crises persist, the interest rates at which Romania borrows from international financial markets will rise, leading to higher borrowing costs. In this context, the Romanian Government has decided to borrow from the public by issuing Fidelis government bonds, with a view to avoiding the high costs on the domestic and international financial markets. Currently, Romania's public debt has risen from 48.9% of GDP in 2023 to 54.8% in 2024, and has now exceeded 60% of GDP. As for the yield on 10-year bonds on the secondary bond market, it was estimated at 6.3% for Romania. The secondary bond market influences the cost of borrowing for governments, and Romania's position is weakened by the current economic crisis. (Rethink Romania, 2026)
- **Administrative bottlenecks:** Political crises often delay the adoption of the budget and the implementation of the reforms needed to attract funds from the National Recovery and Resilience Plan (NRRP). If the political crisis drags on, it will no longer be possible to implement the reforms Romania has committed to and, consequently, the conditions for absorbing funds from the PNRR will no longer be met. The loss of significant funds from the PNRR will lead to a reduction in investment in strategic sectors with social and economic implications. (Vertik Group, 2025)
- **Low predictability:** Sudden tax changes, introduced under political pressure or to cover deficits, affect companies' long-term planning. The latest measures introduced by the Romanian Government in 2025–2026 regarding tax and tariff increases have adversely affected companies, which have had to radically revise their business plans to cope with the increases imposed by the government authorities. (Cerna, 2026)

At the same time, Romania is at a critical juncture in its fiscal consolidation, with worrying indicators for 2026:

- **Budget deficit:** Although austerity measures have been taken (tax increases, cuts to allowances), the deficit target for the end of 2026 remains high, at around 6.2% of GDP. Thus, the austerity measures have failed to achieve their main objective, leaving the economy vulnerable and affecting the standard of living of the population. Another major problem is inflation, which is forecast to exceed 10% in 2026, driven in part by rising energy prices that

will be passed on to consumers, further dampening consumption and pushing inflation even higher. According to information provided by the Romanian Government, the budget deficit is projected to fall to 5.1% of GDP, but this figure is considered overly optimistic, given the overlapping crises facing the Romanian economy. (Cicovschi, 2026)

- **Public debt:** It is expected to reach 57% of GDP, putting pressure on the sustainability of public finances in the medium term. The rise in public debt is mainly due to the fact that in 2026 the bill for public borrowing is approximately €30 billion.
- **Austerity:** The reduction in public and private consumption, caused by tax increases and the freezing of certain incomes, is holding back economic growth, forecast at just 1–1.1% for 2026. The reduction in public and private consumption is directly affecting the Romanian economy, with the possibility of entering stagflation (economic recession and high inflation).

External conflicts continue to destabilise the domestic market:

- **Energy:** The crisis in the Middle East is keeping fossil fuel prices high, fuelling inflation.
- **Persistent inflation:** The National Bank of Romania (BNR) anticipates a fall in inflation to 3.7% only by the end of 2026, with a high risk of estimates being exceeded in the first half of the year.
- **Hidden recession:** Falling purchasing power and a slowdown in industrial activity suggest a period of economic stagnation or a 'hidden recession'.

The economic crisis in Romania is compounded by other crises caused both by the conflict in the Middle East and by political crises stemming from governmental instability. These overlapping crises may lead to social crises, with direct effects on public order and safety. In this context, it is necessary for the state to intervene urgently to revitalise the Romanian economy, in the sense that fiscal and economic measures must be adopted to stimulate consumption and provide the business environment with certain incentives that will enable economic development through sustainable measures in the medium and long term.

4. Conclusions

In conclusion, the military conflict in the Middle East is no longer merely a regional geopolitical risk, but a global economic shock with direct implications for inflation, growth and social stability. The crisis in the Middle East has compounded other economic and financial crises, generating a state of stagflation across the European Union characterised by rising inflation alongside a slowdown in economic growth.

The International Monetary Fund and the World Bank warn that the war in the Middle East will lead to higher inflation and a slowdown in global economic growth, directly affecting the Romanian economy. In this context, there is a risk that the recession will be prolonged due to these factors. A specific vulnerability identified is the dependence on import routes from the Middle East for certain raw materials needed for the production of medicines, with risks of supply disruptions.

This trend at European level is also having repercussions in Romania, where an unfortunate overlap of crises is evident, in the sense that the energy crisis generated by the war in the Middle East has compounded the economic crisis caused, primarily by the decline in public and private consumption against the backdrop of the austerity measures taken by the Romanian Government to reduce the budget deficit. Romania is considered to be better

positioned than in the past, but insufficiently prepared for a protracted conflict that could generate multiple overlapping crises (energy, economic, security, political, social, etc.).

In this fluid and unpredictable geopolitical context, it is necessary for Romania to implement active measures for economic recovery, including through tax cuts to allow for an increase in household incomes and, consequently, a rise in consumption that will lead to the recovery of Romanian companies. Another very important aspect is keeping oil and natural gas prices at an acceptable level so that the economy can remain competitive in foreign markets.

The overall conclusion is that Romania is not at the centre of the military conflict in the Middle East, but is highly exposed to its economic and logistical consequences, a situation that requires prudent resource management and close monitoring of supply chains.

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CONSIDERATIONS ON THE IMPACT OF THE ENERGY CRISIS ON REGIONAL COMPETITIVENESS

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Abstract: *Energy has become a strategic factor in global politics, a vital component for economic development and the progress of society as a whole. The term "energy security" is considered the key to global security. Since 2003, the European Security Strategy has mentioned "building security in our neighbourhood" as a strategic objective of the European Union. The stability of the states bordering the European Union is among the interests of the Union, for at least two major reasons. A first reason for the European Union's major interest in stability and security in its neighbourhood, especially in the eastern part, lies in the geo-economic value of this space, especially from the perspective of energy security. The Black Sea Basin includes states with relevance from an energy point of view, but also for the transit of hydrocarbons from Central Asia to Europe. Security developments in the Black Sea Basin have often been influenced by energy geopolitics, by the European Union's attempts to reduce its dependence on Russian hydrocarbons. The European security architecture is increasingly threatened by ongoing crises and conflicts in the immediate vicinity, to the east and south, capable of affecting, directly or indirectly, Romania's national security interests. Romania, a member of NATO and the European Union, assumes the obligation to maintain strategic balance in an area of interference of regional security complexes, but also to contribute to the consolidation of the Europeanization process, by gradually expanding the European area of freedom, prosperity, security and justice. Romania is interested in ensuring freedom of communication routes in the Black Sea for the development of trade, the resolution of frozen conflicts in the area, the protection of economic activities carried out in the Exclusive Economic Zone of Romania on the Black Sea, as well as the development of projects aimed at ensuring the diversification of access to resources, increasing interconnection capacity and competitiveness, including by implementing the objectives of the Energy Union.*

Keywords: *energy, competitiveness, security, European Union.*
JEL Classification: *F50, F52.*

1. Introduction

The concept of competitiveness is a complex notion; the theoretical origins of this concept can be traced in the economics of foreign trade and its role in national and international economic well-being, from classical mercantilist theory to the theory of competitive advantages to neoclassical criticisms of the international competitiveness of countries. Recent theories have developed the concept of regional competitiveness, bringing classical theories closer to the applied economics of regions (Voinescu, Moisoiu, 2015). Competitiveness is a concept with multiple meanings, which has led to the emergence of a significant number of definitions: we encounter the concept of competitiveness at the national level, but also at the firm level. Competitiveness takes into account all the elements that explain the success of a nation, from a global perspective. Competitiveness analyzes the way in which both nations and firms use all of their competencies to achieve prosperity and profit. In the European Union, regional competitiveness policy objectives have been adopted as the

main instrument for inducing economic growth, export capacity and performance on the global market.

Regional competitiveness is the capacity of a region to provide an attractive and sustainable environment for businesses and residents. In the European Union, regional competitiveness policy objectives have been adopted as the main instrument for inducing economic growth, export capacity and performance on the global market.

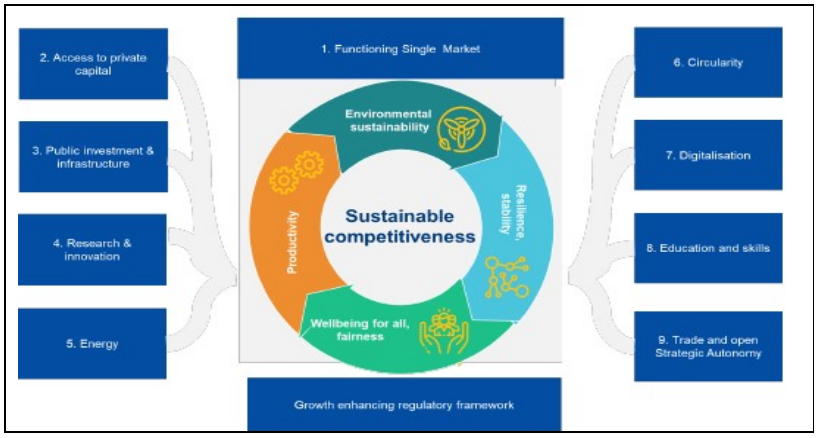
The main threats to Europe's industrial competitiveness are:

- The dynamics of the energy market for Europe.
- High energy costs.

European Union competitiveness – projections to 2030

To foster the competitiveness of the European Union in the future, the European Commission proposes an approach based on nine mutually reinforcing drivers. (European Commission, 2023)

Figure 1. Determinants of the competitiveness of the European Union towards 2030



Source: (European Commission, 2023)

Figure 1 highlights the main drivers of the European Union's long-term competitiveness.

The recent disruptions to energy flows through the Strait of Hormuz have raised major concerns about energy security, both among citizens and businesses in the European Union and beyond. Energy security means ensuring sufficient supply to meet needs, even in the most difficult times.

As early as 2023, according to the World Economic Forum (2023), the main risks for 2023 with the greatest potential impact on a global scale are: "energy supply crisis"; "cost of living crisis"; "rising inflation"; "food supply crisis" and "cyber attacks on critical infrastructure". The global "new normal" is, in fact, a return to basics – food, energy, security – problems that were thought to be on a path to being solved. Longer-term structural changes in geopolitical dynamics – with the diffusion of power across countries with different political and economic systems – coincide with a rapidly changing economic landscape, leading to lower economic growth, lower investment and cooperation, and a potential decline in human development after decades of progress. (WEF, 2023)

Energy has become a strategic factor in global politics, a vital component for economic development and the progress of society as a whole, generating a series of global concerns

since the immediate aftermath of World War I. Currently, the oil and gas component of energy represents the greatest challenge and concern not only at European level, but also at global level. This depends on many factors: reserves in the field, the countries that manage them, their policies, transit routes, the geopolitical situation, economic and diplomatic power. Lately, the term “energy security” has been increasingly used, being appreciated as the key to global security.(Vornic, 2010)

In a very dynamic and unpredictable global geopolitical and geo-economic context, the European Union launched the European Economic Security Strategy on 20 June 2023. The European Union currently needs a comprehensive strategic approach to economic security, so as to reduce risks and promote its technological advantage in critical sectors. The strategy also identifies the priorities of a European Union economic security strategy:

- Promoting the competitiveness of the European Union by increasing the resilience of the economy and supply chains;
- Protecting the European Union against jointly identified economic security risks, through better use of the instruments that the European Union already has, such as those on trade defence, foreign subsidies, 5G/6G security, foreign direct investment screening and export controls, as well as the new instrument to combat economic constraints;
- Creating partnerships with countries that share the European Union's concerns regarding economic security.(Iacob,2023)

2. Energy security of the European Union

According to Eurostat (Energy in Europe,2026), in 2024, the EU produced 43% of its own energy, while 57% was imported. 48% of the energy produced in the EU in 2024 came from renewable sources, and petroleum products have the largest share in the EU energy mix.

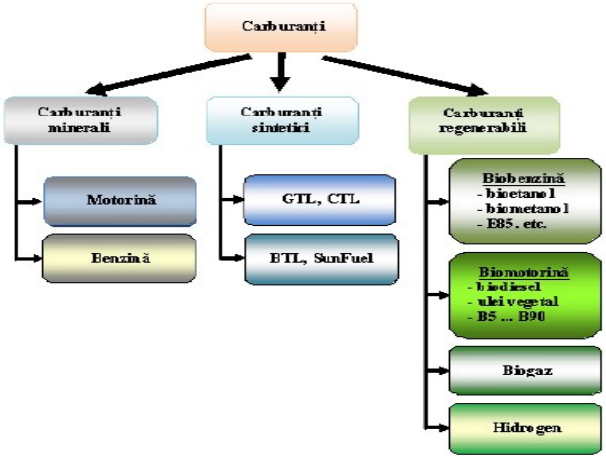
2.1 Energy security – general framework

Energy security is a multidimensional concept; if it was initially a concept attached to oil, it has gradually expanded to natural gas and electricity, as well as to the area of meanings, from physical supply to all phases related to the energy chain. Increased energy security means, first of all, a greater diversity of supply sources. For most specialists, energy security means being assured in terms of sources, control of routes and distribution and alternatives. In a broad sense, the concept is defined as "secure resources at a reasonable price", in other words it encompasses a much broader issue than the triangle security of supply - sustainability - competitiveness. Considered a major issue, energy security has at least two relevant aspects: the security of the supply channel and the security of associated critical infrastructures. Any definition of energy security includes the terms "risk" and "uncertainty", and supply disruptions raise the most pressing concern related to this topic. This note also includes the profile documents of the European Union, which provide definitions for energy security based on the risk of supply disruption, a risk that can be generated by natural disasters or terrorist threats. As an axiom, absolute energy security does not exist. It can be achieved at an acceptable level of risk, at an acceptable cost. As a synthetic definition, energy security can be considered as ensuring continuity in the supply of energy, in its various forms, while respecting restrictive conditions, over a given time horizon. Energy plays an important role in the national security of any country, from an economic perspective. Energy security is closely linked to vulnerability to disruptions in the supply of energy resources - oil, natural gas, coal and electricity. One of the major threats to energy security is the significant increase in the price of energy on the world market - as has happened in the numerous energy crises over

time - or through the imposition of price increases by oligopolistic or monopolistic suppliers, cartels or countries. In recent years, new threats to energy security have emerged in the form of increasing global competition for energy resources due to industrialization at an ever-increasing pace in countries such as India and China. The increasing competition for energy resources may also lead to the formation of new security blocs to allow for a fair distribution of oil and gas among the major powers. (Vornic, 2010)

In an increasingly globalized economy, a country's energy strategy is carried out in the context of developments and changes taking place worldwide. Total energy demand in 2030 will be about 50% higher than in 2003, and for oil it will be about 46% higher. Known proven oil reserves can support current consumption levels only until 2040, and natural gas reserves until 2070, while global coal reserves provide a period of over 200 years even with an increase in the level of exploitation. Forecasts indicate economic growth, which will imply an increased consumption of energy resources. The increase in energy demand, combined with geopolitical factors, especially the situation in the Middle East, determined, in the first decade of the 21st century, the increase in the price of crude oil, which also induced increases in natural gas prices. Another factor that determined the increase in the price of petroleum products worldwide was the lack of refining capacities, a problem that requires the identification of medium and long-term solutions. Added to all this was the tendency shown by some states to supplement stocks in order to cope with crisis situations. The above elements are the basis for the reorientation of the energy policies of countries that are net importers of energy, in the sense of increasing the attention paid to renewable energy resources and improving energy efficiency. At the same time, the opportunity to close nuclear power plants is being reassessed in a number of countries that have proposed to cease the production of electricity in such plants. The continuous increase in energy demand, combined with geopolitical factors, especially the situation in the Middle East, have determined the sharp increase in the price of crude oil. Added to this was the tendency shown by some states to supplement stocks in order to cope with potential crisis situations. (Vornic,2010)

Figure 2. Main types of fuels currently produced



Source: (Vornic,2010)

Ensuring an adequate level of energy security depends on the specific situations. In European countries, the debate on energy security focuses on the dependence on natural gas imports. Differences in the level of ensuring energy security also derive from the specificities

of the different energy subsectors, which are found throughout the energy chain - production, transport, storage, use. (Vornic, 2010)

The following major types of risks can affect the security of energy supply:

A. **Physical risks** that refer to the possibility of a physical, permanent interruption of supply, especially of oil. More than 3/5 of energy transport is carried out by sea and less than 2/5 through pipelines. Only oil tankers have made global, intercontinental transport of oil possible. In contrast, oil tankers are very easy targets for various types of political extremists. Due to the role they play in the global economy, the maritime system of oil trade can be called the vascular system of today's world. Disruptions and irregularities in the distribution cycle can have a major impact on oil prices, and can even lead to a global economic recession. The importance of the problem increases if we add the fact that the Far East (countries such as Japan, Taiwan, the Republic of Korea, China) is supplied with oil only through maritime trade. Other developed areas also have limited possibilities of replacing oil tankers with other means of transport. Oil trade routes lie along the coasts of many unstable states, where terrorists can organize their bases, where there are few narrow straits (called "mandatory crossing points"), which offer potential attackers favorable circumstances to organize attacks. The most important "mandatory crossing points", fixed due to the natural course of maritime oil trade routes, are: the Strait of Hormuz, the Bab el-Mandeb Strait, the Bosphorus, the Strait of Malacca and the Suez Canal.

B. **Economic risks** that refer to the vulnerability of the economic environment under the pressure exerted by fluctuations in energy prices, in particular the sharp increase in the price of crude oil, which represents the leading price of energy. Economic risk derives from the volatility of markets and crude oil prices. Theoretically, the sharp increase in prices leads to an increase in production costs, which induces inflationary pressure directly or indirectly in each economic sector which, in turn, determines a decline in consumption. This leads to a decrease in profits for most companies, to a reduction in production, to the postponement of investment decisions and, implicitly, to an increase in unemployment. On the other hand, cheap crude oil has been a great disadvantage for developed countries and the most "perverse" enemy of energy security. It has blocked the possibilities of resorting to alternative energy sources to oil, such as (more expensive) renewables, and of developing new oil fields, contributing to maintaining consumerist behaviors by encouraging waste and discouraging energy-saving practices. Finally, it has contributed to increasing consumer dependence on a small group of producing countries with the lowest costs, located in the Middle East.

C. **Geopolitical and geostrategic risks** arise because energy is a vital source of interest for both producing and consuming countries. Unequal access to resources, the special geopolitical interests of the great powers, are potential sources of conflict both between consuming countries and between them and producing countries. Political conflicts in the regions producing energy resources, including terrorist manifestations, pose a severe threat both to current oil supplies and to the prospects of the large investments needed to develop the resources to their full potential. Given that the demand for hydrocarbons of the EU and, in general, of developed countries tends to be satisfied to an increasing extent from the Persian Gulf, the Caspian Sea region and Russia, importing countries fear: political instability in the Caspian Sea and the Gulf Area; risk points/fever points in critical infrastructure (risks of supply disruption, terrorism); intensifying competition between consumer countries to ensure control over oil and natural gas resources, mainly between the USA, China and the EU. The fears associated with the security of these imports, although justified, do not justify taking

refuge in the concept of "self-supply", which would impose enormous costs for environmental protection and competitiveness. On the contrary, EU governments and energy companies will have to collaborate to ensure the continuity of supply at reasonable prices. For example, the Caspian basin represents an area of confluence, but also of confrontation between the interests of three major players: the USA, Western Europe, Russia, and the sine-qua-non condition for the exploitation of these reserves is the provision of transport infrastructure to Europe, either transiting Russia or via other routes. The terrorist actions of September 11, 2001 had seismic effects on energy geopolitics, especially on the geopolitics of oil. The Middle East suddenly became a less secure area, and the major economies realized that they were too dependent on it. As a result, they moved to actions to dissipate dependence throughout the globe. Thus, other areas also acquired strategic importance, new competitions were triggered, and the national interests of the states began to gain increased relevance compared to the interests of the alliances.

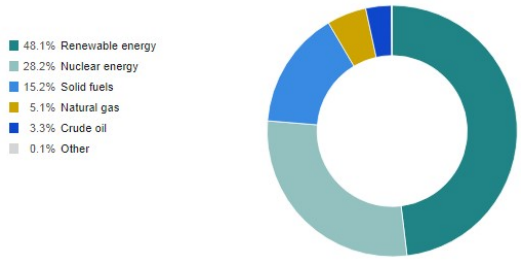
D. **Social risks.** The instability of the energy supply, whether associated with disorderly fluctuations in prices, or relations with producing countries, or geopolitical crises, can cause serious social disruptions but also changes in corporate behavior. Strikes and protests by certain social categories affected by the increase in oil prices, especially commercial carriers in Western European countries, are an illustrative example in the aforementioned sense. It should also be remembered that the first two oil crises put an end to a beneficial period in terms of the level of employment of the workforce. High energy prices imply the commitment of governments to find solutions to make an increase in energy prices bearable, especially for the most disadvantaged categories of the population, by virtue of the concept of social responsibility of energy projects.

E. **The risks associated with environmental protection** come from sources such as: accidents caused by the chain of energy operations, technical accidents, but above all, they are due to polluting emissions generated by the consumption of energy systems. Increasing energy security and addressing climate change are two of the major concerns and challenges of today's society. (Vornic,2010)

2.2 The European Union's energy mix

According to Eurostat (Energy in Europe,2026), in 2024, the EU produced 43% of its own energy, while 57% was imported. Approximately 48% of the energy produced in the EU in 2024 came from renewable sources, and petroleum products have the largest share in the EU's energy mix.

Figure 3. Energy production, by sources, 2024, (in %)



Source: (Energy in Europe,2026)

In 2024, the shares of different energy sources in the gross available energy varied considerably between EU countries:

- ✓ Petroleum products, in the available energy, were the highest in Cyprus (86%), Malta (85%) and Luxembourg (60%)
- ✓ Natural gas was a significant source of energy in Italy (36%), the Netherlands (31%), Hungary and Ireland (both with 29%)
- ✓ Renewable sources were the highest in Sweden (48%), Latvia (46%) and Denmark (43%)
- ✓ Nuclear energy accounted for 40% of the available energy in France, Slovakia (30%) and Sweden (26%)
- ✓ Solid fuels had the highest shares in Estonia (50%), Poland (34%) and the Czech Republic (26%).

➡ **Energy imports and import dependence**

In 2024, the main category of imported energy products was oil and petroleum products (including crude oil, which is the main component), accounting for 67% of EU energy imports, followed by natural gas (24%), solid fossil fuels (4%), electricity (3%) and renewable energy (2%).

➡ **Different models between EU countries**

In 2024, EU countries' energy imports had the largest shares of:

- oil and petroleum products in Cyprus (96%), Malta (86%), Sweden (85%) and Greece (84%)
- natural gas in Italy (37%), Denmark (33%), Germany and France (both 29%)
- solid fossil fuels in Slovakia (15%), Czech Republic and Austria (both 11%) and Germany (9%)
- electricity in Estonia (21%), Luxembourg (16%) and Slovenia (13%)
- renewable energy in Denmark (10%), Latvia (7%) and Luxembourg (5%). (Energy in Europe,2026)

➡ **EU's main suppliers in 2024: United States for oil and petroleum products, Norway for natural gas, Australia for solid fossil fuels**

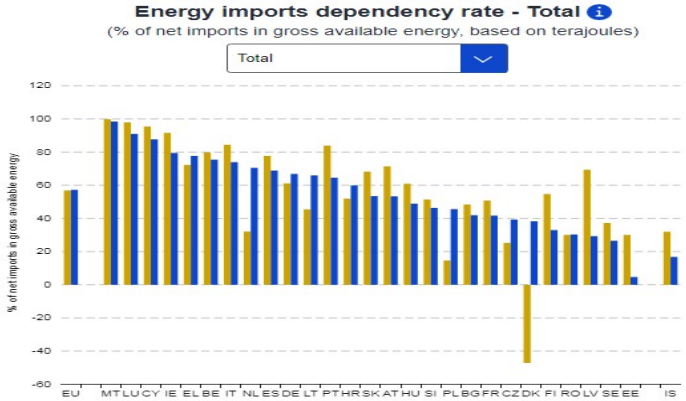
For its own consumption, the EU also needs energy imported from countries outside the EU. In 2024, the largest shares of EU imports for different products were:

➢ oil and petroleum products from the United States (16%), Norway (12%), Kazakhstan (9%), Saudi Arabia (8%), the United Kingdom and Libya (both 6%). These countries accounted for 57% of extra-EU imports of oil and petroleum products;

➢ natural gas from Norway (30%), the United States (17%), Algeria and Russia (both 14%). These countries accounted for 75% of extra-EU imports of natural gas;

➢ imports of solid fossil fuels (mainly coal) came from Australia (31%), followed by the United States (28%), Colombia (15%), Kazakhstan (8%) and South Africa (6%). These countries accounted for 88% of extra-EU imports of solid fossil fuels.

Figure 4. EU energy import dependency rate: 57% in 2024



Source: (Energy in Europe,2026)

2.3 European Energy Union Strategy

Adopted by the European Commission on 25 February 2015 and validated by the European Council in June 2015, the European Energy Union Strategy covers 5 dimensions:

- energy security;
- solidarity and trust;
- internal energy market;
- energy efficiency;
- decarbonisation of the economy and research;
- innovation and competitiveness.

The aim of the strategy is to provide the guidelines and actions necessary for the long-term transformation of the European energy system.

Romania is committed to the joint European effort to implement the actions related to the Energy Union. For Romania, measures to strengthen Europe's energy security, to achieve long-term objectives in the field of energy and climate change and to achieve an integrated and functional energy market remain priorities.

Romania seeks to participate/connect to new energy transport corridors, both in terms of ensuring a higher degree of security in energy supply, and through the importance of accessing European funding for the development of national energy infrastructure.

The main projects of interest promoted by Romania:

Natural gas

- BRUA (natural gas transport corridor on the Bulgaria-Romania-Hungary-Austria route);
- New developments of the NTS in order to take over gas from the Black Sea coast;
- Interconnection of the national energy system with that of neighboring states, a strategic project being the interconnection of the Republic of Moldova to the EU energy system through Romania; Romania-Serbia Interconnector;
- Projects for the development and establishment of new natural gas storage facilities.

Electricity

• Interconnection of the power systems of Romania and Bulgaria => to increase the exchange capacity between Romania and Bulgaria

• Interconnection of the power systems of Ukraine and the Republic of Moldova to the Continental European system. (European Commision,2026)

2.4 Measures to counter the energy crisis

As part of the Clean Industrial Pact, the Commission presented the Affordable Energy Action Plan (COM/2025/79) on 26 February 2025. Complementing this, in October 2025, Commissioner for Energy and Housing, Dan Jørgensen, called on his EU counterparts to take action in 7 priority areas to accelerate the reduction of energy prices for industry and households.

Affordable Energy Action Plan

The Affordable Energy Action Plan includes 8 actions, many of which have already been implemented in 2025. These actions are based on 4 pillars:

- reducing energy costs for all
- completing the Energy Union
- attracting and securing investments
- preparing for potential energy crises.

Measures implemented in the Action Plan

In the 2025 State of the Energy Union Report, the Commission summarised progress in implementing the Affordable Energy Action Plan:

Action 1 - Making electricity bills more affordable
Action 2 - Reducing the cost of electricity supply
Action 3 - Ensuring functioning gas markets
Action 4 - Delivering energy savings through energy efficiency
Action 5 - Completing the Energy Union
Action 6 - Tripartite agreements to ensure affordable energy for European industry
Action 7 - Ensuring security of supply for price stability
Action 8 - Preparing for the price crisis
Action 6 - Tripartite agreements to ensure affordable energy for European industry. (European Commision,2026)

To counter high energy prices and market uncertainty, tripartite agreements for affordable energy can bring together the public sector, energy producers and energy-consuming industries to create a favourable investment climate, facilitating a competitive EU industrial sector while ensuring the maintenance and creation of quality jobs. Through mutually reinforcing commitments, private and public actors can support a favourable investment framework and secure affordable energy supplies for European industries.

3. Energy prices – priority EU actions

Based on the Affordable Energy Action Plan, energy prices must be brought to a level that ensures Europe's competitiveness. The Commission has identified 7 priority actions to help the EU and EU countries achieve this goal, while taking into account regional and national factors:

1. Making full use of the consolidated State aid framework
2. Making the most of EU Cohesion Funds
3. Engaging promotional banks and working with the EIB to reduce risks in Power Purchase Agreements for industry and SMEs
4. Rapidly reforming national permitting regimes to accelerate the deployment of renewable energy, grids and storage

5. Prioritising interconnection and grid expansion at national level to limit congestion and enable businesses to connect
6. Gas, both pipeline and LNG, must come from more trusted allies
7. Reducing taxes and levies, with a strong focus on electro-intensive industries and vulnerable consumers, and providing tax credits for the electrification of industry (European Commision,2026).

4. Conclusions

Energy is an area of strategic importance because its provision at reasonable prices influences the economic competitiveness, domestic production capacity and political strength of a state. The security of energy supply affects the well-being of a state, and changes in energy prices affect the allocation of well-being at the national level. And, last but not least, the defense capacity of a state also depends on a good energy supply.

Energy security is a complex political, technical, economic, commercial and social concept. As an axiom, absolute energy security does not exist. It can be achieved at an acceptable level of risk, at an acceptable cost. As a synthetic definition, energy security can be considered as ensuring continuity in the supply of energy, in its various forms, while respecting restrictive conditions, over a given time horizon.

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DIGITAL PLATFORMS AND THE ECONOMIC PERFORMANCE OF TOURISM SMES: BETWEEN MARKETING VISIBILITY AND PLATFORM DEPENDENCE

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Abstract: *Digital platforms have become one of the most influential forces in contemporary tourism, especially for small and medium-sized enterprises. For many accommodation units, local agencies and tourism service providers, platforms are no longer simple promotional tools, but important economic intermediaries that influence visibility, bookings, reputation and access to demand. This paper examines the double role of digital platforms in the performance of tourism small and medium-sized enterprises. On the one hand, platforms increase market exposure, reduce entry barriers and support faster interaction with domestic and international tourists. On the other hand, they may create economic dependence through commissions, ranking systems, customer data control and limited direct contact between firms and tourists. The article uses a narrative literature review, supported by academic and institutional sources, to discuss the relationship between digital visibility, marketing performance and platform dependence. Its main contribution is the development of a balanced perspective: digital platforms can support the growth of tourism small and medium-sized enterprises only when they are integrated into a broader strategy that also includes direct communication, own digital channels and stronger brand autonomy.*

Keywords: *digital platforms, tourism small and medium-sized enterprises, marketing performance, economic dependence, digital transformation.*
JEL Classification: *L83, M31, O33.*

1. Introduction

In tourism, the first contact between a firm and a potential tourist rarely takes place at the reception desk, in a travel agency office or through a printed catalogue. In many cases, it begins on a screen, through a search result, a platform ranking, a review score, a photo gallery or a price comparison. Before the tourist arrives physically at the destination, the economic relationship has already started digitally. This makes visibility one of the most valuable assets for tourism firms, especially for small and medium sized enterprises (SMEs), which often compete not only through price or service quality, but also through how easily they can be found, trusted and selected online (Van Nuenen and Scarles, 2021; Zhang et al., 2025).

For tourism SMEs, digital platforms have changed the meaning of market access. A small guesthouse, a family hotel, a local agency or a niche experience provider can appear next to much larger competitors on the same digital shelf. This would have been difficult in a tourism economy dominated by traditional distribution networks, large tour operators and strong international brands. Platforms such as online booking websites, review systems and travel search engines reduce part of this distance by giving smaller firms a place in markets that were previously harder to reach. In this sense, digital platforms do not only promote tourism services. They reorganize the conditions under which small firms enter competition (Cenamor, Parida and Wincent, 2019; OECD, 2024).

The economic relevance of this shift can be observed in recent European data. Eurostat (2026) shows that, in 2025, tourists spent 951.6 million nights in short stay accommodation booked through online platforms in the European Union (EU), representing an increase of

11.4 percent compared with 2024. This volume is important because it suggests that platform based bookings are not a secondary channel anymore. They are part of the normal infrastructure of tourism consumption. Eurostat (2025) also treats short stay accommodation booked through platforms as a distinct statistical area, which confirms that digital intermediation has become relevant not only for marketing practice, but also for the measurement of tourism activity.

However, the growth of platforms creates a more complex situation than a simple story of digital progress. For a tourism SME, being present on a platform can mean more reservations, better exposure and faster access to tourists from other regions or countries. At the same time, this visibility is not fully owned by the firm. It depends on search filters, ranking criteria, reviews, commissions and platform rules. The firm can become more visible, but this visibility is partly rented from an intermediary. This is the central problem of the article: digital platforms help small tourism firms reach the market, but they may also make these firms dependent on the very systems that make them visible.

This tension is especially relevant because many tourism SMEs use digital platforms not as one channel among several, but as their main gateway to demand. When a large share of bookings comes from external intermediaries, the firm's economic performance may improve in the short term, while its strategic autonomy becomes weaker in the long term. More reservations can come together with higher commission costs. Better online exposure can come together with less control over customer data. Stronger reputation can come together with permanent pressure from reviews and ratings. Therefore, the question is not whether platforms are useful. They clearly are. The more important question is how much dependence is created when usefulness becomes necessity (Wang, Liu and Zhang, 2024; Verhoef et al., 2021).

This article proposes the idea of a visibility dependence paradox. The paradox refers to the fact that the same digital platform that helps a tourism SME become visible can also reduce its independence. The firm gains access to demand, but part of this access is controlled by another organization. It reaches more tourists, but the relationship with them may remain mediated. It benefits from digital trust mechanisms, but it also becomes exposed to public ratings and algorithmic ordering. This paradox is useful because it avoids two simplified interpretations. Digital platforms are not only a success story for small firms, but they are also not simply a threat. Their effect depends on how firms use them, what capabilities they develop and how much control they keep over their own market position (Teece, 2018; Succurro, 2026).

From this perspective, the performance of tourism SMEs should not be understood only through the number of bookings generated by platforms. Economic performance also includes the cost of obtaining those bookings, the stability of demand, the control over customer relationships, the ability to encourage direct reservations and the capacity to build a recognizable brand outside the platform. Marketing performance is therefore connected with economic performance. A firm may appear successful because it receives many reservations through a platform, but its real position is weaker if it cannot communicate directly with tourists, collect useful customer information or reduce its dependence on paid intermediation.

The aim of this paper is to analyse how digital platforms influence the marketing and economic performance of tourism SMEs. The article focuses on two connected dimensions. The first dimension concerns the benefits created by platforms, such as visibility, reputation, access to wider markets and booking conversion. The second dimension concerns the risks of

dependence, such as commission pressure, reduced control over data, weaker direct communication and vulnerability to platform rules. By putting these two dimensions together, the paper argues that tourism SMEs need a more strategic use of digital platforms, one that combines external visibility with internal digital capabilities (Wang, Liu and Zhang, 2024; Zhang et al., 2025; OECD, 2024).

The contribution of the paper is mainly conceptual. It brings together literature on digital transformation, tourism performance, digital platform participation and SME competitiveness in order to explain why platform presence should not be confused with digital strength. A tourism SME may be visible online without truly controlling its digital development. For this reason, the article argues that the most resilient firms are not necessarily those that use platforms the most, but those that know how to balance platform exposure with their own digital channels, direct communication, customer knowledge and brand identity (Cenamor, Parida and Wincent, 2019; Verhoef et al., 2021; Succurro, 2026).

The article is organized as follows. The first section introduces the relevance of digital platforms for tourism SMEs and explains the economic importance of the subject. The second section reviews the literature on digital transformation, tourism SMEs, marketing visibility and platform participation. The third section presents the research methodology, based on a narrative literature review. The fourth section discusses the main results, focusing on both the benefits and the risks generated by digital platforms. The final section presents the main arguments and highlights the need for tourism SMEs to transform platform visibility into a more balanced and autonomous digital strategy.

2. Literature Review

2.1 Digital transformation and tourism small and medium sized enterprises

In the case of tourism small and medium sized enterprises (SMEs), digital transformation often starts from a very practical problem: how can a small firm be found by tourists who no longer search for tourism services in the same way as before? For a large hotel group, digitalization may mean complex systems, data departments and integrated customer platforms. For a small guesthouse, a boutique hotel or a local agency, it may begin with something simpler but economically decisive: appearing where tourists already look. This makes digital transformation in tourism SMEs less abstract than in other sectors. It is not only about technology adoption, but about survival inside a market where demand increasingly passes through digital screens (Succurro, 2026; Verhoef et al., 2021).

A tourism SME can be online without being digitally strong. This distinction is important. A firm may have a website, a social media page and a profile on a booking platform, but still depend almost entirely on external systems to attract clients. In such a case, digital presence exists, but digital control remains weak. The firm is visible, yet it does not fully own the channels through which visibility is produced. This is one of the main differences between simple digital adoption and real digital transformation. The first means using tools. The second means changing how the firm creates value, communicates, learns from customers and protects its market position (Verhoef et al., 2021).

For small firms in tourism, this transformation is difficult because resources are limited and daily operations usually come before long term digital planning. A family accommodation unit or a small local operator may not have a person responsible only for marketing, data analysis or online reputation. Very often, the same people who manage reservations, guests, suppliers and complaints also manage the digital presence of the firm.

This creates a specific vulnerability: tourism SMEs are pushed to compete in a highly digital market, but they often do so with limited time, limited knowledge and limited financial capacity. The Organisation for Economic Co-operation and Development (OECD) also notes that small tourism firms face barriers related to skills, finance, infrastructure and the capacity to adapt to rapid technological change (OECD, 2024).

This is why platforms became so attractive. They offer small tourism firms something that would be difficult to build independently: traffic, credibility, booking infrastructure, review systems and access to consumers from different markets. For a small firm, joining a platform may seem more realistic than creating its own complete digital ecosystem. The platform becomes a shortcut to demand. However, this shortcut is not neutral. It solves the visibility problem by placing the firm inside another organization's commercial space. In other words, the firm obtains access, but access comes through rules, rankings and costs that it does not fully control (Cenamor, Parida and Wincent, 2019; Wang, Liu and Zhang, 2024).

The literature suggests that the real benefit of digital participation appears when firms do more than simply register on a platform. Wang, Liu and Zhang (2024) show that digital platform participation can improve performance when it supports organizational learning and marketing capability. This idea is especially useful for tourism SMEs because it shows that the platform itself is not the entire solution. What matters is what the firm learns from its digital activity: which photos attract attention, which services are praised, which complaints repeat, which prices work better and which types of tourists respond to the offer. From this point of view, a platform is not only a sales channel. It can also become a source of market intelligence.

Economic performance should therefore be understood in a broader way. For a tourism SME, the question is not only whether digital tools increase bookings, but whether they help the firm build a more stable position. A higher number of reservations may be useful, but it does not automatically mean stronger competitiveness if the firm pays high commissions, loses direct contact with tourists or cannot transform one time bookings into loyal customers. Succurro (2026) connects digital transformation in tourism SMEs with outcomes such as turnover and employment growth, but the managerial meaning of this connection depends on how digitalization is integrated into the firm's strategy. Digital growth that depends entirely on external platforms can remain fragile.

A more mature interpretation of digital transformation in tourism SMEs must therefore include both access and autonomy. Access refers to the firm's capacity to reach tourists through digital channels. Autonomy refers to the firm's capacity to keep some control over its brand, customer relationships, data and pricing decisions. Many discussions about digitalization focus mainly on access, because access is easier to observe. A firm becomes visible, receives bookings and appears more competitive. However, autonomy is just as important, because it determines whether this visibility can be converted into long term value. This is where digital transformation becomes a strategic issue, not only a marketing issue (Teece, 2018; Verhoef et al., 2021).

2.2 Digital platforms, marketing visibility and firm performance

Tourism is a market of promises sold before they are experienced. A tourist usually pays for a room, a destination or an experience before knowing exactly how it will feel. Because of this, digital signals have become extremely influential. Photos, descriptions, ratings, guest comments, response speed and platform position often replace direct

knowledge. For a small tourism firm, these signals can create trust before any personal interaction takes place. This is why marketing visibility in tourism is not just about being seen. It is about being seen in a context where the tourist feels confident enough to choose (Van Nuenen and Scarles, 2021).

Digital platforms are powerful because they combine attention, comparison and transaction in the same place. A traditional advertisement may inform the tourist, but a platform allows the tourist to compare prices, read reviews, check availability and book immediately. This changes the role of marketing. Promotion is no longer separated from purchase. The tourist does not move from information to decision through different channels in a slow and linear way. The decision can be made inside the same digital space where the firm is discovered. For tourism SMEs, this can be a major advantage because platforms reduce the distance between visibility and revenue (Eurostat, 2025; Eurostat, 2026).

Recent data confirms the economic size of this phenomenon. Eurostat (2026) reports that 951.6 million nights were spent in short stay accommodation booked through online platforms in the European Union (EU) in 2025. This figure matters because it shows that platform mediated tourism is not a niche behaviour limited to young or highly digital consumers. It has become a large scale market practice. For SMEs, this means that platform presence is no longer optional in many segments of accommodation and tourism services. Not being visible on digital platforms can mean being absent from a large part of contemporary demand.

Still, visibility on a platform is a different kind of visibility from visibility through an own website or a direct customer relationship. On a platform, the firm is visible together with many competitors, under a structure designed by the intermediary. The tourist sees the firm through filters, rankings, prices, review scores and photos arranged in a particular interface. This means that the firm is not only presenting itself. It is being presented by the platform. The difference is important because it shows that platform marketing is not fully controlled by the tourism SME. The firm contributes content and service quality, but the platform controls much of the environment in which these are interpreted.

This explains why platform participation can improve performance and create vulnerability at the same time. Wang, Liu and Zhang (2024) argue that participation in digital platforms can support the performance of bed and breakfast businesses, especially through learning and marketing capabilities. However, the same mechanism can also increase dependence if the firm becomes unable to generate demand outside the platform. A high rating may bring reservations, but it also makes the firm sensitive to every public evaluation. A better ranking may increase sales, but it also makes the firm dependent on criteria that can change. A platform profile may bring foreign tourists, but it may also weaken the habit of direct booking.

The issue is not that platforms are harmful. The problem is that their benefits can hide their costs. Commission fees are visible and easy to calculate, but other costs are less obvious. These include weaker brand recognition outside the platform, limited access to customer data, reduced direct communication and the risk of competing mainly through price and rating. A tourism SME may appear successful because it is fully booked through platforms, but its strategic position may still be weak if it cannot attract tourists independently. In this situation, the platform does not only sell the firm's services. It becomes the firm's main route to the market.

Cenamor, Parida and Wincent (2019) show that small and medium sized enterprises can compete through digital platforms when they develop platform related capabilities together with other strategic capabilities. This point is essential for tourism. A small firm should not treat the platform as a substitute for strategy. It should treat it as one element of a broader market approach. Platform visibility is useful when it is connected with a stronger website, better communication, improved service design, direct customer retention and clearer brand positioning. Without these complementary elements, the firm may grow in volume but remain dependent in structure.

The broader digital economy literature helps explain this situation. Teece (2018) argues that profiting from innovation in the digital economy depends not only on using technologies, but also on controlling complementary assets and business models. Applied to tourism SMEs, this means that the value of platform participation depends on what the firm controls outside the platform. If the firm controls only the service, while the platform controls visibility, data, ranking and customer access, then the distribution of value becomes uneven. The firm performs the hospitality work, but the intermediary controls a large part of the market interface.

For this reason, marketing performance and economic performance must be analysed together. A tourism SME may improve its marketing indicators, such as visibility, reviews and booking conversion, while also increasing its economic dependence. This dual movement is the key idea of the article. Digital platforms do not simply make small firms stronger or weaker. They create a new type of performance that must be managed carefully. The most competitive tourism SMEs are likely to be those that use platforms to gain visibility, but also transform that visibility into direct relationships, repeat demand and stronger brand autonomy (Zhang et al., 2025; Succurro, 2026).

3. Research Methodology

This paper is based on a review of the specialized literature and on institutional data provided by the Organisation for Economic Co-operation and Development (OECD) and Eurostat. The analysis uses academic articles focused on digital transformation, digital platforms, tourism small and medium sized enterprises (SMEs), marketing performance and economic performance.

The selected sources were mainly published between 2018 and 2026 and were identified through academic platforms such as ScienceDirect, SpringerLink and Sage Journals. The institutional sources were used to provide recent economic context regarding tourism digitalization and the growth of online platform based accommodation bookings in the European Union (EU).

The reviewed sources were organized around two main directions. The first direction refers to the benefits of digital platforms for tourism SMEs, especially online visibility, access to demand, reputation and booking conversion. The second direction refers to the risks of platform dependence, especially commissions, algorithmic ranking, reduced control over customer data and weaker direct communication with tourists. This structure supports the main argument of the article: digital platforms can improve the performance of tourism SMEs, but only when they are used as part of a broader and more autonomous digital strategy.

4. Results and Discussion

4.1 Digital platforms as visibility accelerators for tourism small and medium sized enterprises

The reviewed literature shows that digital platforms are important for tourism small and medium sized enterprises because they reduce one of the most difficult barriers in tourism: being noticed by potential clients. A small accommodation unit or a local travel service provider may not have the budget to build international recognition, but it can become visible on platforms where tourists are already searching. This changes the competitive position of small firms, because access to demand is no longer based only on physical location, traditional promotion or partnerships with large intermediaries (Cenamor, Parida and Wincent, 2019; OECD, 2024).

The first major result is that platforms transform visibility into a practical economic resource. In tourism, visibility is not only a communication advantage. It can directly influence bookings, occupancy, reputation and revenue. The data provided by Eurostat confirms the economic scale of this process. In 2025, online platforms generated almost one billion nights in short stay accommodation in the European Union, which shows that platform based demand has become part of the normal structure of tourism consumption (Eurostat, 2026). Therefore, for many tourism small and medium sized enterprises, platform presence is not just a marketing choice, but a condition for participating in a large part of contemporary tourism demand.

Digital platforms also support trust. Tourism services are bought before they are fully experienced, which means that tourists rely heavily on digital signs before making a decision. Reviews, ratings, response speed, photos and ranking position become part of the perceived quality of the offer. For small firms, this can be valuable because a good online reputation can compensate for the absence of a famous brand. A guesthouse, for example, can attract international tourists not because it is widely known, but because its platform profile creates enough confidence for the tourist to book (Van Nuenen and Scarles, 2021; Wang, Liu and Zhang, 2024).

Another result is that platforms can become learning environments. They do not only bring reservations, but also generate information. Reviews show what tourists appreciate or criticize. Search behaviour indicates what clients compare. Booking patterns reveal periods of higher or lower demand. This information can help managers adjust prices, improve service presentation, respond to complaints and adapt the offer. Wang, Liu and Zhang (2024) show that digital platform participation can support performance when it improves marketing capability and organizational learning.

However, the benefit is stronger when the firm uses platforms actively, not passively. A passive firm only waits for reservations. An active firm improves photos, updates descriptions, answers reviews, studies demand patterns, tests prices and tries to redirect satisfied clients toward direct communication in the future. In this sense, the platform is useful only when it becomes part of a wider managerial process. Digital transformation is therefore not the same as being listed online. It requires the capacity to transform platform visibility into better decisions, stronger reputation and more stable economic results (Succurro, 2026; Verhoef et al., 2021).

Table no. 1. Main benefits of digital platforms for tourism small and medium sized enterprises

Benefit	Explanation	Economic relevance
Online visibility	The firm appears where tourists already search for accommodation or tourism services.	Higher probability of being discovered by domestic and international tourists.
Access to demand	Platforms connect small firms with larger markets without requiring complex distribution systems.	Potential increase in bookings, occupancy and sales.
Digital reputation	Reviews and ratings help tourists evaluate the service before consumption.	Trust can be created even without a strong traditional brand.
Booking conversion	Tourists can search, compare and reserve in the same digital space.	The distance between promotion and purchase becomes shorter.
Market learning	Reviews, rankings and booking behaviour provide useful information.	Managers can adjust prices, services and communication more quickly.
Competitive presence	Small firms can appear near larger competitors on the same platform.	The firm can participate in markets that were previously harder to access.

Source: Author's synthesis based on Wang, Liu and Zhang (2024), Cenamor, Parida and Wincent (2019), OECD (2024) and Eurostat (2026).

4.2 Platform dependence as an economic vulnerability

The second major result is that the same platforms that increase visibility can also create dependence. This is the central tension of the article. Tourism small and medium sized enterprises may become more visible, but this visibility is often controlled by external intermediaries. A firm can receive many bookings through a platform, but the conditions of this visibility depend on ranking systems, commissions, reviews, filters and commercial rules that the firm does not fully control. Therefore, the platform does not only distribute demand. It also shapes the way demand reaches the firm.

This creates a specific economic vulnerability. If a large share of reservations comes from one or two platforms, the firm's performance becomes sensitive to changes made outside the firm. A modification in ranking logic, a higher commission, a negative review or a change in platform policy can affect bookings quickly. In traditional marketing, a firm could control more directly its communication channels. In platform based tourism, the firm often operates inside an environment designed by another organization. This weakens strategic autonomy, even when short term sales improve (Teece, 2018; Verhoef et al., 2021).

Commission pressure is one of the most visible forms of dependence. Platforms can increase demand, but they also capture part of the value created by the tourism firm. This means that growth through platforms may not have the same profitability as growth through direct bookings. A small accommodation unit may have high occupancy, but if a significant part of its reservations comes through commission based intermediaries, the final economic benefit can be lower than it appears. For this reason, performance should not be measured only by the number of bookings, but also by the cost of obtaining those bookings.

Another risk is the weakening of the direct relationship with tourists. When the booking, communication and review process are mainly mediated by platforms, the firm may have limited control over customer data and future communication. This makes it harder to build loyalty, encourage repeat visits or develop personalized offers outside the platform. In the long term, this can reduce the firm's capacity to create its own customer base. The tourism small and medium sized enterprise remains active in the market, but the relationship with demand is partly owned by the intermediary.

Algorithmic visibility is also a major issue. On a platform, being present does not automatically mean being noticed. The position of a firm depends on criteria that may include price, reviews, response time, availability, paid visibility and other platform specific indicators. A firm can improve its service quality and still lose visibility if it does not match the logic of the platform. This creates a form of competition that is not fully transparent. Tourism firms compete not only with each other, but also for a favourable position inside the digital architecture of the platform (Van Nuenen and Scarles, 2021; Zhang et al., 2025).

Beyond these visible risks, platform dependence also changes the way tourism small and medium sized enterprises understand their own performance. A firm may believe that it is becoming stronger because reservations increase, but this growth can be fragile if it depends almost entirely on a platform environment. In this situation, the platform does not only bring clients; it also defines how the firm is discovered, compared, evaluated and sometimes even priced. This is why dependence should not be understood only as a financial issue related to commissions. It is also a strategic issue related to control. The more a tourism SME depends on external platforms for visibility, customer contact and reputation, the less it can shape its own market position independently. Therefore, the main risks of platform dependence can be grouped around several dimensions, as shown in table no. 2.

Table no. 2. Main risks of platform dependence for tourism small and medium sized enterprises

Risk	Description	Economic effect	Possible managerial response
Commission dependence	The firm pays a fee for each reservation generated through the platform.	Revenue may increase, but profitability can be reduced if most bookings come through intermediaries.	Increase the share of direct bookings through own website, loyal clients and post stay communication.
Algorithmic visibility	The firm's position depends on platform ranking criteria, such as reviews, prices, availability and response time.	Demand can become unstable because visibility may change without full control from the firm.	Monitor platform performance, but avoid relying on one channel only.
Weak direct relationship	The tourist interacts mainly with the platform before, during or after the booking process.	The firm may lose opportunities to build loyalty and repeat demand.	Encourage direct contact after the stay through newsletters, feedback forms and loyalty incentives.

Risk	Description	Economic effect	Possible managerial response
Limited customer data	The platform controls important information about users, search behaviour and booking patterns.	The firm has less capacity to understand its own clients and personalize future offers.	Build internal customer databases where legally and ethically possible.
Reputation pressure	Reviews and ratings strongly influence how tourists evaluate the firm before purchase.	A small number of negative reviews can affect demand, prices and perceived quality.	Respond professionally to reviews and use complaints as service improvement signals.
Price comparison pressure	Platforms place many similar offers next to each other, making price differences very visible.	Firms may be pushed to compete through lower prices instead of brand value or service quality.	Differentiate the offer through experience, service design and added value, not only price.
Reduced strategic autonomy	The firm depends on external rules, commissions, visibility mechanisms and platform policies.	Business decisions become influenced by the interests and rules of the intermediary.	Combine platform use with own brand, social media, direct sales channels and stronger digital capabilities.
Brand dilution	The tourist may remember the platform more than the individual tourism firm.	The firm can receive bookings without building a strong independent market identity.	Strengthen brand identity through own website, visual style, storytelling and direct communication.

Source**:** Author's synthesis based on Teece (2018), Verhoef et al. (2021), Wang, Liu and Zhang (2024) and Zhang et al. (2025).

Table no. 3. Recent economic indicators of platform based tourism in the European Union

Indicator	Value	Interpretation
Nights booked through online platforms in the European Union, 2025	951.6 million nights	Platform based accommodation has become a large part of tourism demand, not a marginal online channel.
Growth compared with 2024	11.4%	The use of platforms continued to expand from one year to another.
Growth compared with 2023	32.4%	The increase shows the rapid consolidation of online platform based tourism consumption.
Nights booked in the fourth quarter of 2025	172.3 million nights	Platform demand remained significant even outside the main summer season.
Growth in the fourth quarter of	10.9%	The annual growth trend was also visible at

Indicator	Value	Interpretation
2025 compared with the fourth quarter of 2024		quarterly level.

Source: Author's synthesis based on Eurostat (2026).

The data presented in table no. 3 helps move the discussion from a purely managerial level to an economic one. Platform dependence matters because the market itself is increasingly organized through online intermediaries. When almost one billion nights are booked through digital platforms in the European Union in a single year, platforms are no longer only places where firms advertise their services. They become part of the infrastructure through which tourism demand is distributed, measured and transformed into revenue (Eurostat, 2026). For tourism small and medium sized enterprises, this means that visibility on platforms is directly connected with market access, occupancy and economic performance (OECD, 2024; Succurro, 2026).

At the same time, these figures also make the risk of dependence more visible. A growing platform based market can create important opportunities for small firms, but it can also increase the pressure to remain present, competitive and well ranked inside the platform environment. The problem is not that platforms are used. In the current tourism economy, this is almost unavoidable. The problem appears when a firm depends on platforms so strongly that commissions, ranking rules, reviews and access to customer data begin to shape its entire commercial position (Wang, Liu and Zhang, 2024; Zhang et al., 2025).

This is where the visibility dependence paradox becomes useful. Digital platforms open the market for tourism small and medium sized enterprises, but they also mediate this market. They bring tourists closer, but not always directly. They increase exposure, but the firm does not fully own that exposure. They can improve performance, but they can also capture part of the value, information and customer relationship generated by the firm. Therefore, platform visibility should be understood as a powerful resource, but also as a resource that must be managed carefully (Teece, 2018; Verhoef et al., 2021).

The practical implication is that tourism small and medium sized enterprises should not reject digital platforms, because this would be unrealistic. Instead, they should avoid using them as the only route to demand. A more balanced approach would combine platform presence with direct booking tools, an updated website, social media communication, post stay contact, customer databases, loyalty incentives and a clearer brand identity. The purpose is not to replace platforms, but to transform the visibility obtained through them into stronger direct relationships and more autonomous marketing capabilities (Cenamor, Parida and Wincent, 2019; Wang, Liu and Zhang, 2024).

Therefore, the main result of the article is that digital platforms improve performance only when they are used strategically. They are useful when they increase visibility, support learning and help firms reach tourists that would otherwise be difficult to access. They become risky when the firm loses control over costs, data, communication and long term market positioning. For tourism small and medium sized enterprises, the real challenge is not choosing between platforms and independence, but building enough internal digital capability to benefit from platforms without becoming fully dependent on them (Succurro, 2026; OECD, 2024).

5. Final Remarks

This article analysed the role of digital platforms in the marketing and economic performance of tourism small and medium sized enterprises. The main argument is that platforms should not be understood only as promotional tools. They are also economic intermediaries that influence visibility, bookings, reputation, customer access and the distribution of value in tourism markets. For small firms, this role is especially important because platforms can offer access to demand that would otherwise be difficult to reach through traditional marketing channels.

The analysis showed that digital platforms create a double effect. On the one hand, they help tourism small and medium sized enterprises become more visible, reach wider markets, receive online reviews and transform tourist interest into reservations. On the other hand, they may create dependence through commissions, ranking systems, limited customer data, review pressure and weaker direct communication with tourists. This is why the article proposed the idea of the visibility dependence paradox: the same platform that increases the firm's visibility can also reduce its strategic autonomy.

From a managerial point of view, the solution is not to avoid platforms. In the current tourism economy, such a strategy would be unrealistic, especially considering the strong growth of platform based bookings in the European Union. The more relevant solution is to use platforms as an entry point, not as the only route to the market. Tourism small and medium sized enterprises should combine platform presence with their own websites, direct booking systems, social media communication, customer databases, loyalty actions and stronger brand identity. In this way, platform visibility can be transformed into a more stable and autonomous market position.

The article also highlights that digital transformation is not equal to simple platform presence. A firm can be listed online without having a real digital strategy. Sustainable performance appears when firms are able to learn from digital interactions, understand customer behaviour, manage online reputation and reduce excessive dependence on external intermediaries. Therefore, digital platforms improve performance mainly when they are used strategically and supported by internal digital capabilities (Wang, Liu and Zhang, 2024; Succurro, 2026; OECD, 2024).

Future research could develop this topic through empirical studies focused on tourism small and medium sized enterprises from specific destinations or countries. For example, future studies could compare firms that depend mainly on platforms with firms that combine platforms and direct booking channels. Another useful direction would be to analyse how commission levels, review scores, ranking position and direct booking shares influence profitability. Qualitative research based on interviews with hotel managers, guesthouse owners or local tourism agencies could also provide a deeper understanding of how small firms experience platform dependence in daily business practice.

Overall, the article concludes that digital platforms are neither a complete solution nor a simple threat for tourism small and medium sized enterprises. Their value depends on how they are used. When platforms are treated as one element of a broader digital strategy, they can support visibility, learning and economic performance. When they become the only source of demand, they may weaken autonomy and increase vulnerability. The real challenge for tourism small and medium sized enterprises is therefore to benefit from platform access while gradually building their own digital strength.

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SUSTAINABILITY AND INNOVATION AS VECTORS OF ECONOMIC PERFORMANCE IN THE WINE SECTOR IN THE REPUBLIC OF MOLDOVA

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Abstract: *The wine sector is a strategic pillar of the Moldovan economy, exerting a multidimensional impact on export earnings, employment and sustainable rural development. In the current context, defined by heightened climate volatility and competition on the EU market, sustainability and innovation are no longer simple competitive options, but are becoming essential structural imperatives for strengthening the economic resilience of the sector. The study aims to analyze the impact of these dimensions on the sector's performance in the period 2014–2023, highlighting the role of subsidy mechanisms and external financing, including programs supported by the European Investment Bank, in facilitating the transition to a value-added model. The methodology used is of a mixed type and integrates documentary analysis of public policies, a systemic approach and the processing of statistical data provided by relevant institutions, such as the Ministry of Agriculture and Food Industry, the Agency for Intervention and Payments for Agriculture and the reports of the International Organization of Vine and Wine. The research results reveal an increase in average productivity by 2.67%, simultaneously with a significant consolidation of the Premium wine segment, which came to represent approximately 6% of total national merchandise exports. This dynamic confirms that investments directed towards post-harvest infrastructure and the rigorous adoption of quality standards have increased the sector's ability to adapt to external shocks. The study supports the need to implement a "Twin Transition" strategy based on digitalization and sustainability. This double transition is essential for aligning with Green Deal standards and maintaining competitiveness on international markets.*

Keywords: *Wine sector, innovation, sustainability, economic performance, subsidies, competitiveness.*
JEL classification: *Q13, Q18, G11.*

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1. Introducere

The vitivinicultural sector is a strategic branch of the national economy of the Republic of Moldova, exerting a direct influence on the Gross Domestic Product (GDP) and the maintenance of social balance in rural areas. This sector serves as Moldova's calling card, defining its identity and competitiveness on the global market. Over the last decade, following the implementation of the Association Agreement with the European Union (Association Agreement with the Republic of Moldova, 2014), the wine industry has undergone a radical transformation, shifting from a model based on quantity and extensive land cultivation to one focused on quality and high added value. This paradigm shift represented a maturation process that enabled the sector to adapt to the rigorous demands of global markets.

The importance of the vitivinicultural sector in the Republic of Moldova is characterized by key fundamental indicators:

- **Contribution to Gross Domestic Product:** Viticulture and winemaking play a major role in generating national value added. The wine sector generates approximately 3% of the GDP and accounts for around 7–8% of the total exports of the Republic of Moldova (BNS, 2024). Unlike other agricultural branches, viticulture delivers high added value by processing

raw materials into finished goods (wines, divins), thereby stimulating related industries such as glassware, logistics, and tourism.

- **Export Performance and Strategic Reorientation:** Following the signing of the Association Agreement (2014), exports to the EU have grown steadily, currently representing over 50% of the total volume of bottled wines. Analyses indicate a clear transition from bulk wine exports (high volume, low profit) to bottled wine (lower volume, higher profitability), consolidating the Republic of Moldova's position as the most awarded wine producer in Eastern Europe (BNS, 2024).
- **Social Impact and Employment:** The wine sector provides employment opportunities both in rural areas and within processing industries, helping mitigate outward migration and ensuring the continuity of local economic activities.
- **Modernization of Wine Grape Vineyards:** The Republic of Moldova has one of the highest vineyard densities in the world relative to its total land area, encompassing about 120,000 hectares. Although the total area remains large, a restructuring process is underway: removing hybrid varieties and replacing them with European and indigenous grape varieties such as Fetească Albă, Fetească Regală, and Rară Neagră, which yield better returns. These native varieties serve as Moldova's passport to foreign markets, offering distinct authenticity (ONVV, 2024).
- **Rural Development and Agritourism:** The modernization of vineyards and the rise of boutique wineries have boosted rural infrastructure and enogastronomic tourism, turning villages into attractive destinations for investments and visitors.

Taken together, these indicators reveal a sector undergoing profound structural maturation. Although vulnerable to geopolitical and climate shocks, the industry demonstrates strong resilience driven by quality, moving away from its historical dependence on traditional Eastern markets toward competitive integration into premium global networks. In the face of contemporary global challenges such as climate change, market volatility, and rising consumer demand for "green" products, sustainability and innovation are no longer just strategic alternatives, but vital drivers of economic resilience. The "Twin Transition," which leverages the synergy between digitization and sustainability, is becoming the new benchmark for competitiveness. This research aims to analyze how the adoption of modern technologies and sustainable practices influences the economic performance indicators of the Moldovan wine sector, providing an overview of the financing mechanisms and structural barriers that shape the success of this transition during the 2014–2024 period.

2. Data sources and methods

The methodological objective of this research consists in evaluating the impact of innovation and sustainability on the economic performance of the wine sector in the Republic of Korea / Republic of Moldova. For a comprehensive analysis, a mixed methodology was adopted; thus, the research was based on the processing of statistical data for the 2014–2023 period. The data sources utilized are: the database of the National Bureau of Statistics (NBS) for indicators such as vineyard areas, total grape production, and yield per hectare; the UN Comtrade database for monitoring exports of wine (code 2204) and table grapes (code 080610); and the reports of the Agency for Intervention and Payments in Agriculture (AIPA) to analyze subsidies directed toward post-harvest modernization and winery technology upgrades. Additionally, reports from the National Office of Vine and Wine (ONVV) were used to determine average export prices and the penetration rate into premium markets, while

reports from the European Investment Bank (EIB) and USAID served to assess the impact of external assistance. For data interpretation, the following methods were applied: comparative analysis, to highlight price and performance discrepancies between traditional markets (CIS) and high-value ones (EU, Asia, North America); and quantitative method (statistical analysis), calculating the Compound Annual Growth Rate (CAGR) to evaluate the long-term dynamics of the indicators, using the formula:

$$CAGR = \left(\frac{V_{final}}{V_{initial}}\right)^{\frac{1}{n}} - 1$$

where V_{final} is the value in 2023, $V_{initial}$ is the value in 2014, and n represents the number of years.

diagnostic analysis: identifying critical points and the sector's resilience capacity. The analysis focuses on the post-Association Agreement period (2014–2024). The data for the year 2024 are partial, based on quarterly estimates and operational reports from the ONVV, and are utilized to foreshadow current market trends within the context of the EU pre-accession process.

3. Results and discussion

3.1. Dimensions of economic performance and innovation in sustainable agriculture

Economic performance in sustainable agriculture marks a fundamental transition from short-term profit maximization to a business model anchored in stability, efficiency, and resilience. This implies an optimal management of natural capital, ensuring a balance between productivity, ecosystem conservation, and social responsibility. According to the Food and Agriculture Organization of the United Nations (FAO), economic success depends on the capacity to produce "more with less," optimizing flows without degrading the resource base (FAO, 2014). Complementarily, the Organisation for Economic Co-operation and Development (OECD) emphasizes that performance evaluation must integrate efficiency indicators for input utilization, such as water, fertilizers, and energy. Consequently, economic performance is considered the direct result of technological precision. Thus, modern economic performance transcends the productivist paradigm, becoming an indicator of the equilibrium between operational efficiency, ecosystem protection, and social equity, thereby ensuring food security and commercial success for future generations (Agricultural Policy Monitoring and Evaluation, 2024).

The transition toward this production model represents a genuine paradigm shift in agricultural management, wherein innovation and modern technologies become the bridge connecting economic efficiency and ecological responsibility. Precision agriculture redefines the way agricultural holdings are managed, providing farmers with the opportunity to make data-driven decisions. Through the use of GPS systems, soil sensors, drones, and digital monitoring platforms, agricultural processes are optimized in real time. This technological advancement allows for the maximization of yield per hectare and profitability, while simultaneously reducing the consumption of inputs such as seeds, water, fertilizers, or fuel. In this context, competitiveness is no longer defined solely by productivity, but also by the enterprises' capacity to respond to global challenges, such as food security for a continually growing population and adaptation to climatic and demographic shifts (Agro BASF, 2024; Iațișin, Ciobanu & Timuș, 2023).

The modernization of the wine sector through precision agriculture configures an integrated, digitalized, and efficient operational model, in which agricultural processes are monitored and managed based on data collected in real time. The actions undertaken within the wine sector are executed in a timely manner and with maximum precision, being supported by sensors, satellite imagery, weather stations, and data analysis systems. This approach enables viticulturists to optimize resources, increase productivity, and maintain a balance between economic performance and environmental protection, as illustrated in Figure 1.

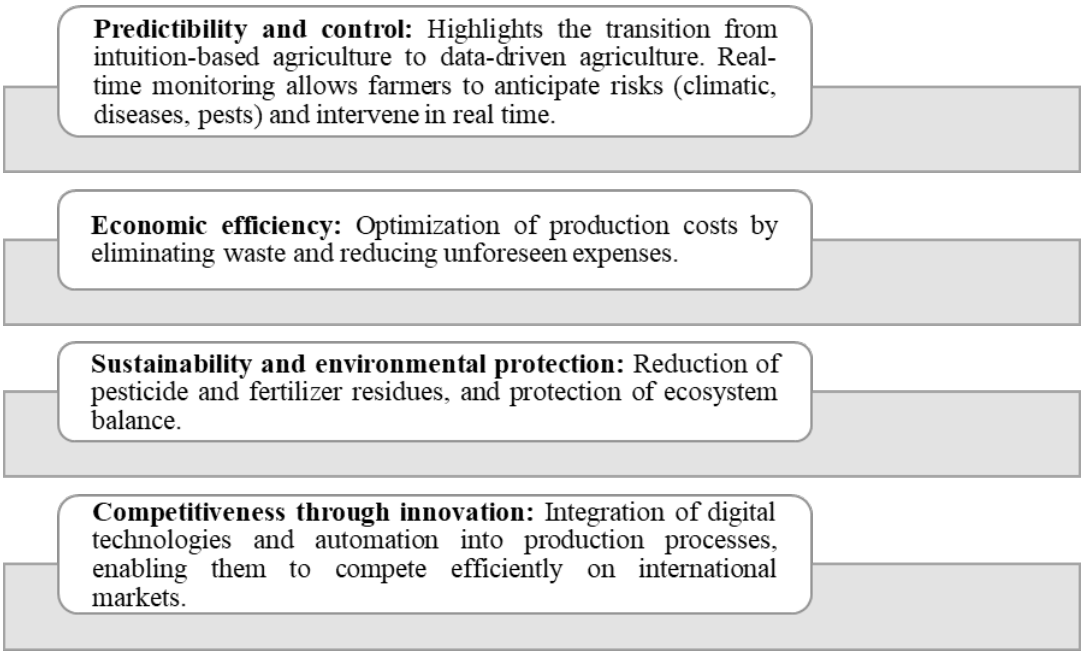

Figure 1. Model of the strategic advantages of advanced technology implementation

Source: Developed by the author, based on (Iatisin T., 2022, Timuș A., Iațișin T., 2024)

To achieve global market competitiveness, the wine sector must integrate innovation and digitalization. Consequently, the modernization of the viticultural sector becomes an essential driver for sustainable growth and the consolidation of its competitive position worldwide.

The implementation of integrated agricultural management systems demonstrates the transition from conventional farm management to Data-Driven Agriculture. Yield analysis indicates that optimized fertilization, executed via sensors and computational algorithms, can generate considerable economic benefits. Specifically, increasing nitrogen use efficiency and reducing the losses associated with non-uniform fertilizer application lead to an estimated value-added of approximately 185 €/ha. This outcome confirms that precision technologies contribute not only to enhancing productivity but also to improving the profitability of agricultural activities. The digital ecosystem (see Figure 2) highlights the interconnection between modern technologies used in agriculture, such as weather stations, soil sensors, and GPS systems. All collected data are integrated into an analytical and monitoring platform capable of providing actionable insights regarding crop development and environmental conditions.

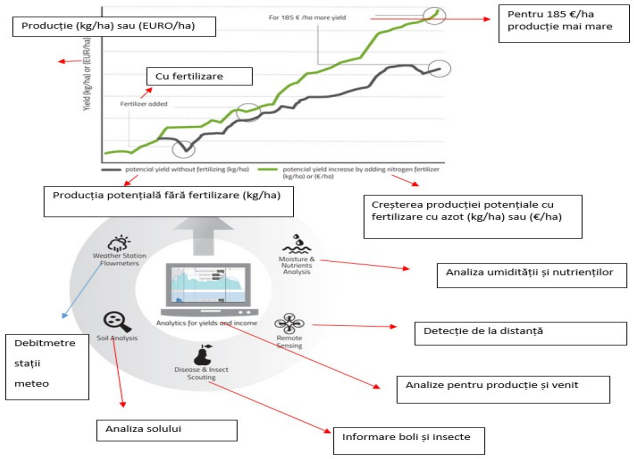

Figure 2. The precision agriculture ecosystem and the impact of input optimization on economic performance. (Adapted from digital agricultural management models).

Source: (Datalab Agro, 2024).

The integration of modern technologies into the management of the wine sector is no longer a mere option, but a strategic necessity. The predictability of production processes, generated by complex data analysis, provides guarantees for sustainability and competitiveness, transforming innovation into the primary vector of economic performance within the viticultural sector (Datalab Agro, 2024).

3.2 Diagnostic analysis of the wine sector

For the diagnostic analysis of the wine sector in the Republic of Moldova, the evolution of the main economic indicators during the 2014–2023 period was examined, including production dynamics and export trends. These indicators allow for the assessment of the effectiveness of support policies and the sector's capacity to respond to the demands of the international market (Table 1).

Table 1. Evolution of indicators assessing economic growth in the wine sector in the Republic of Moldova (in all types of households)

The indicator	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	CAGR, %
Share of vineyards in production, as a percentage of total vineyards, %	95,2	95	95,4	93,1	95,4	94,1	94,1	88,9	89	88,8	-0,77
Productivity of vineyards in production, q/ha	43,7	45,6	46,9	54	57	54,8	39,2	45,4	49,1	55,4	2,67
Total grape harvest obtained from vineyards in production, mii/tone	593,9	599,3	615,7	675	730	659	462	491	531	571	-0,44
Exports of table grapes, thousand tons (according to the code 080610)	50,4	47,5	51,4	80,2	48,2	62,7	41,3	57,8	61,7	69,9	3,69
Volume of grape wine exports, million	102	113	133	141	139	152	134	116	97	108	0,63

liters, (according to the code 2204)											
Revenue from alcoholic beverage exports, million USD dollars	**111,9**	**97,7**	**107,9**	**128,4**	**137,9**	**139,6**	**134,3**	**141,3**	**126,7**	**137,5**	**2,29**

Source: Calculated and compiled by the author based on data from the National Bureau of Statistics (NBS) and reports from the National Office of Vine and Wine (ONVV) and the Customs Service of the Republic of Moldova (2014–2023).

The diagnostic analysis of the wine sector in the Republic of Moldova for the 2014–2023 period highlights a trajectory of structural maturation, marking the transition from a quantity-based production model to one defined by value added and technological resilience. Although vineyard areas underwent a process of optimization and uprooting of unproductive plantations—reflected by the decrease in the share of productive vineyards from 95.2% to 88.8%—the viticultural sector achieved a qualitative leap in productivity. During the analyzed period, the yield increased from 43.7 q/ha in 2014 to 55 q/ha in 2023 (CAGR +2.67%). This evolution indicates the success of investments in modern technologies and certified planting material, demonstrating the sector's capacity to achieve superior yields on smaller land areas.

In the context of geopolitical shocks and regional economic transformations, the wine sector demonstrated adaptability, as well as a successful reorientation of external trade flows. The national economy has displayed remarkable resilience. The EU became the country's primary trading partner, with Romania consolidating its strategic role as the main market for Moldovan exports (NBS, 2024). The evolution of commercial relations with EU member states reflects not only the diversification of foreign markets but also the gradual integration of the Republic of Moldova into the European economic circuit. During the analyzed period, export revenues recorded steady growth, with a compound annual growth rate of CAGR +2.29%. This dynamic highlight the capacity of Moldovan exporters to leverage higher value-added markets and to adapt to new trade requirements and European quality standards.

Concurrently, the wine sector was affected by several crises, which acted as catalysts for innovation and modernization processes. The 2020 climate crisis, which reduced grape production to 39.2 q/ha, accelerated the need for investments in smart irrigation systems and digital technologies for vineyard monitoring (Figure 2). Subsequently, the 2022 regional and energy crisis caused by the war in Ukraine disrupted logistical chains and transport costs. Nevertheless, export revenues continued to rise, reaching 137 million USD, which confirms the resilience and adaptive capacity of the sector. The table grapes sector also recorded a positive trend during this period, with a compound annual growth rate of CAGR 3.69% for exports. The increase in exported volumes from 50.4 thousand tons in 2014 to 69.9 thousand tons in 2023 demonstrates enhanced competitiveness and growing external demand for this fresh product. In this context, the adoption of the "Twin Transition" model (Blum, S., 2022) confirms that digitalization and sustainability are no longer secondary strategic options, but essential standards for the competitiveness of the wine sector on the global market. Integrating digital technologies, utilizing smart solutions, and shifting toward sustainable practices are becoming decisive factors for increasing value added, streamlining processes, and consolidating the position of the Republic of Moldova in international wine trade.

3.3 Economic analysis: Strategic reorientation and competitiveness of the wine sector

For the wine sector, the year 2014 represented a turning point regarding the external competitiveness of the Republic of Moldova. The signing of the Association Agreement with the EU and the implementation of the Deep and Comprehensive Free Trade Area (DCFTA) acted as a catalyst for a radical reorientation of the export model. Prior to 2014, wine exports were highly dependent on CIS markets (particularly the Russian Federation), which absorbed approximately 60% of total export volumes. This dependence rendered the wine sector vulnerable to trade restrictions and geopolitical instability. Following the agreement with the EU, wine producers initiated a profound process of redirecting exports toward more stable and competitive markets. Consequently, the EU market gradually became the primary destination, absorbing over 55% of the export value of bottled wines (tariff code 2204 for wines) (Figure 2) (Customs Service of the Republic of Moldova, 2024; UN Comtrade, 2024). This shift involved not only the redirection of trade flows but also the adaptation of the entire sector to stricter European standards regarding quality, food safety, labeling, and product competitiveness. The integration process of the wine sector into the European market stimulated its modernization, prompting producers to invest in modern technologies and quality standards. Concurrently, this integration contributed to strengthening the international image of Moldovan wine, enhancing its visibility in global markets. As a result, the viticultural sector has become more resilient to shocks and more competitive on the global stage.

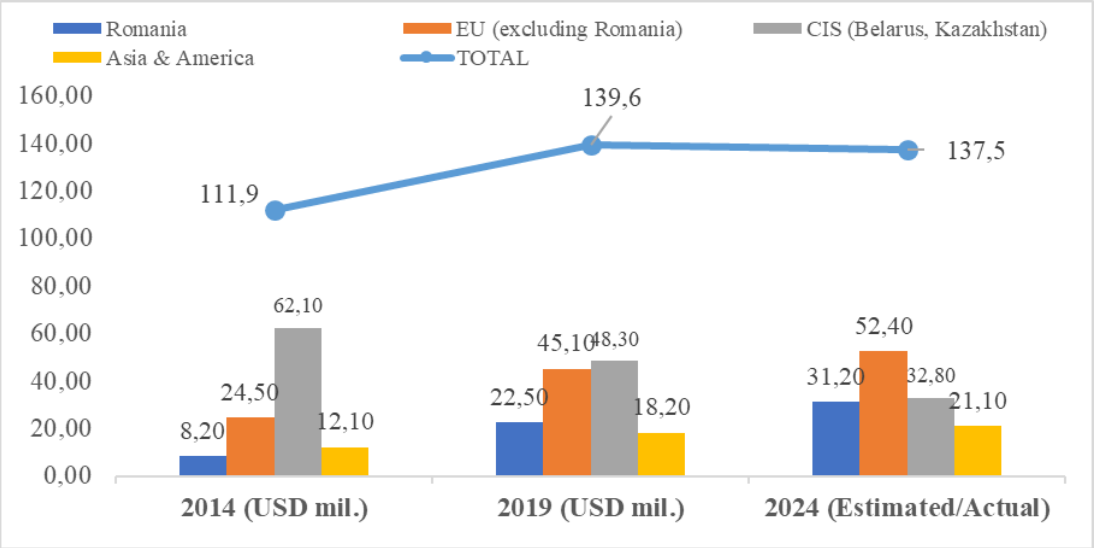

Figura 2. Reconfiguration of geographic export flows for alcoholic beverages (wine Code 2204) across main outlets (2014–2024)

Source: Customs Service of the Republic of Moldova, 2024; National Office of Vine and Wine (ONVV): "Wine of Moldova" annual reports on market developments and average export prices.

The geographic and value distribution of alcoholic beverage exports during the analyzed 2014–2024 period registers a reversal of market shares between the CIS and the European Union.

In 2014, wine exports were dominated by CIS markets (primarily Belarus and Kazakhstan), which accounted for approximately 62.1 million USD, representing the largest share of total exports. Conversely, exports to the EU (excluding Romania) amounted to about 24.5 million USD. The total export value of alcoholic beverages stood at 111.9 million USD (Colesnicova et al., 2024).

By 2019, alcoholic beverage exports followed an upward trend, reaching a value of 139.6 million USD. Exports to the EU increased considerably, amounting to 45.1 million USD, with Romania consolidating its position as the primary trading partner. Although CIS markets continued to hold a significant share, dependence on them began to decrease gradually. Consequently, by 2024, the European Union became the primary trading partner, offsetting declines in traditional markets through higher average prices per liter. Additionally, during the analyzed period, a strategic expansion was achieved in high-purchasing-power markets such as Japan, South Korea, the USA, and Canada, where the average price per liter is higher than in traditional markets (see Table 2).

Table 2. Comparative analysis of the average export price per liter of wine, by selected destinations (USD/Liter estimates)

Export Destination	Average price 2014 (USD/L)	Average price 2024* (USD/L)	Increase (%)	Market Segment
Japan	2,10	3,85	+83%	Premium / Super-Premium
South Korea	1,95	3,60	+85%	Premium / Varieties
USA	2,40	4,10	+71%	Premium / Wine of Moldova
Canada	2,25	3,95	+75%	Premium / Boutique
UE (Media)	1,45	2,35	+62%	Mid-to-High / Retail & HoReCa
Romania	1,60	2,80	+75%	Premium Brands / Retail
Traditional Markets (CIS)	0,95	1,25	+32%	Low-cost / Econom

** Note: For the year 2024, data are estimates based on operational reports from the National Office of Vine and Wine (ONVV) and market trends from the first three quarters of 2024.*

Source: Author's own calculations based on data from the National Office of Vine and Wine (ONVV) and the Customs Service regarding the value and volume of exports (2014-2024).

The analysis of the average export price during the investigated period (2014-2024) reveals a significant increase. While the average price in the CIS markets grew moderately, reaching up to 1.25 USD/liter, it doubled in the Asian and North American markets. Consequently, the USA recorded the highest average price, approximately 4.10 USD/liter in 2024, positioning Moldovan wines within the Premium segment. Similar trends were

observed in Japan, South Korea, and Canada, where consumers are willing to pay a premium for quality products with a distinct identity and origin.

This transformation reflects a shift in the sector's competitiveness model. While the emphasis was previously placed on low prices, competitiveness is currently driven by quality, authenticity, and added value. The growing share of wines with Protected Designation of Origin (PDO) and Protected Geographical Indication (PGI) has enabled the wine sector to move beyond the export model focused on cheap raw materials. Indigenous varieties, such as Fetească Neagră and Rară Neagră, have become pivotal elements in the international promotion of Moldovan wines. The accolades received at prestigious competitions, such as Mundus Vini and Decanter (ONVV, 2024), have consolidated the image of the "Wine of Moldova" country brand and contributed to increasing the value of exported products.

In the context of current European requirements, the modernization of the wine sector extends beyond simple re-engineering; it is heavily influenced by the concept of the "Twin Transition," which entails the integration of digitalization and sustainability. Implementing modern technologies within the wine sector transforms traditional vineyard management into a model based on data and predictive analytics, thereby optimizing resources and ensuring product traceability an essential aspect for Premium markets. Concurrently, sustainability is becoming a strategic factor, as eco-friendly practices and climate change adaptation enhance the image of Moldovan wines and boost their competitiveness in foreign markets (Timuș A., Iațișin T., 2024; Blum, S., 2022).

3.3 Economic analysis: The impact of funds and technology transfer

The acceleration of technology transfer and the increased competitiveness of the wine sector were primarily driven by support from European funds and foreign assistance programs (Table 3). Consequently, during the investigated period (2014–2024), the EU financed the modernization of the sector through programs such as ENPARD and EU4Business. According to official data, within the framework of the ENPARD program (2014–2020), over 64 million euros were allocated for agriculture and rural development, with a significant portion directed toward modernizing the wine sector (European Neighbourhood Policy, n.d., 2013). These funds enabled investments in modern winemaking equipment, temperature control technologies, and traceability systems. Furthermore, projects implemented by USAID, such as the "Agriculture Competitiveness Project," supported over 100 wine enterprises in adopting modern technologies and international quality standards. According to USAID reports (2020), these interventions contributed to increasing productivity and improving the export capacities of wine companies. Additionally, a major role was played by the European Bank for Reconstruction and Development (EBRD), which, in partnership with other financial institutions, provided credit lines and grants for investments worth over 25 million euros in Moldova's agrifood sector, including viticulture (EBRD, 2022). These investments facilitated the implementation of modern processing and bottling technologies (Timuș A., Iațișin T., 2024). Data from the National Office of Vine and Wine (ONVV) show that the share of bottled wines in total exports increased from approximately 30% in 2014 to over 60% in 2023, indicating a clear orientation toward products with higher added value. At the same time, the average export price rose significantly in Western markets, in some cases exceeding a 70% growth, which reflects the success of investments in quality and branding (ONVV, 2023). Beyond investments in modernizing the wine sector, external assistance played a pivotal role in know-how transfer. Training programs, consultancy, and the exchange

of best practices enabled local producers to align with international standards, thereby facilitating access to demanding markets such as Germany, the United Kingdom, or China.

Table 3. The impact of external assistance programs on technology transfer in the wine sector (2014–2024), EUR million

Program / Funding Institution	Period	Allocated amount, EUR million (estimate)	Type of action	Technology transfer impact
UE- ENPARD	2014-2020	64,0	Grants for agriculture and rural development.	Modernization of equipment, quality control systems, and traceability.
EIB - "Livada Moldovei" Project	2016-2024	120,0*	Credit lines and tax incentives.	Restructuring of vineyards, investments in laboratories and post-harvest infrastructure.
USAID (PCR/RCRA)	2016-2024	25,0	Grants and technical assistance.	Nation branding (Wine of Moldova), market access to Asia, and digitalization of marketing.
EBRD and Partners	2014-2024	25,0	Credit lines (EBRD credit lines).	Production line modernization, bottling, and energy efficiency.
National Fund for Agricultural and Rural Development (AIPA)	At present	tens of millions EUR/year	EU co-financed national subsidies.	Replanting of vineyards, mechanization, and agricultural technologies.

Note: "Livada Moldovei" funding covers the entire horticultural sector, with viticulture serving as the primary beneficiary.

Source: Author's elaboration based on MAIA (2014-2024), EU Delegation, and USAID reports; Timuș A., Iațișin T., 2024.

Thus, the research findings indicate that external financing for the viticultural sector is structured along three main dimensions:

- Technological capital (hard) – modern equipment, processing lines, and controlled fermentation technologies;
- Human capital (soft) – training, consultancy, and international know-how;
- Market capital (branding) – external promotion and quality certifications.

Therefore, European funds and external assistance have acted as a catalyst for technology transfer within the wine sector, driving infrastructure modernization, enhancing product quality, and diversifying export markets. Empirical data confirm that these interventions have sustained the transition toward a value-added economic model, thereby

consolidating the international standing of Moldovan wines. The correlation between investment and the growth of export value demonstrates that technology + branding = sustainable competitive advantage in the viticultural industry.

4. Conclusion

The research highlights that the wine sector of the Republic of Moldova underwent a process of transformation and consolidation during the analyzed period of 2014–2024. Throughout this timeframe, the wine industry successfully reduced its dependence on CIS markets and strengthened its presence in high value-added markets, such as the European Union, the USA, and Japan. This strategic reorientation contributed to increased export revenues and enhanced the external competitiveness of Moldovan wines.

The sectoral analysis demonstrates that technological modernization played an essential role in driving efficiency. Although vineyard areas underwent an optimization process—with unproductive plantations being eliminated—productivity recorded a positive trend. The increase in yield per hectare reflects the investments made in modern technologies, high-performance management systems, and quality planting material.

During this period, the wine sector demonstrated a high capacity to adapt to economic and geopolitical changes. Reorienting exports toward European and international markets reduced vulnerability to traditional markets and enabled the consolidation of the Republic of Moldova's image as a quality wine producer. The promotion strategy under the "Wine of Moldova" national brand contributed to increasing the value of exported products and positioning them within the premium segment.

Furthermore, another important aspect is the integration of the "Twin Transition" concept, which is based on digitalization and sustainability. The implementation of modern technologies and sustainable agricultural practices enabled resource consumption optimization, cost reduction, and more efficient climate risk management. At the same time, the focus on sustainability has become a significant competitive advantage in foreign markets, where quality and environmental protection standards are increasingly stringent.

Nevertheless, the sector continues to face certain vulnerabilities, particularly those related to climate change and rural labor shortages. These challenges underscore the necessity of continued investment in digitalization, modernization, and climate adaptation to ensure the sustainable development of the industry.

In conclusion, the wine sector represents one of the most dynamic and modernized branches of the Republic of Moldova's economy. Its capacity to integrate innovation, modern technologies, and sustainability principles demonstrates not only the maturation of the industry but also its potential to serve as a development model for the entire agricultural sector in the process of European integration.

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THE IMPACT OF MULTIPLE CRISIS ON ECONOMIES IN THE BORDER REGIONS OF THE EUROPEAN UNION

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Abstract: *A reality in the current environment is the overlapping of crises in Europe (COVID-19, energy crisis, war in Ukraine). The eastern border regions of the European Union are spaces of direct contact with areas of instability and have a strategic role in security, mobility and trade. The importance of the eastern external border is given by migratory and security pressures and economic and institutional discontinuities. Romania is located at the intersection of geoeconomic axes that are being consolidated: the axis of the seas (Caspian Sea - Black Sea - Mediterranean Sea) and the axis of rivers and canals (Rhine - Main - Danube), connecting the North Sea with the Black Sea. From the point of view of population, but also of civil and military potential, Romania is at the intersection of the enlarged circle of Central Europe – within which it ranks second, after Poland – with the enlarged circle of the Balkans, in which our country ranks third, after Turkey and Greece (in terms of surface area and population it ranks second, after Turkey). In the context of changes in Europe, Romania is becoming increasingly linked to the Danube-Pontic Balkan space. In this paper, we aim to carry out an analysis of the impact of multiple crises on border regions, compare the response of the states that make up the eastern border of the European Union and identify the factors that explain the differences in resilience. In this sense, we will approach border regions as specific economic spaces, multiple crises (polycrisis) and the specifics of the eastern border of the European Union.*

Keywords: *crises, border regions, security, migration, European Union.*
JEL Classification: *F50, F52.*

1. Introduction

A reality in the current context is the overlapping of crises in Europe (COVID-19, energy crisis, war in Ukraine). The eastern border regions of the European Union are spaces of direct contact with areas of instability and have a strategic role in security, mobility and trade. The importance of the eastern external border is given by migratory and security pressures and economic and institutional discontinuities.

In this paper, we aim to carry out an analysis of the impact of multiple crises on border regions, to compare the response of the states that make up the eastern border of the European Union and to identify the factors that explain the differences in resilience. In this sense, we will approach the border regions as specific economic spaces, multiple crises (polycrises) and the specificity of the eastern border of the European Union.

Romania is located at the intersection of geoeconomic axes that are in the process of consolidation: the axis of the seas (Caspian Sea - Black Sea - Mediterranean Sea) and the axis of rivers and canals (Rhine - Main - Danube), which connects the North Sea to the Black Sea. In terms of population, but also of civil and military potential, Romania is located at the intersection of the extended circle of Central Europe - within which it ranks second, after Poland - with the extended circle of the Balkans, in which our country ranks third, after Turkey and Greece (in terms of surface area and population it ranks second, after Turkey).

In the context of changes in Europe, Romania is increasingly linked to the Danube-Pontic Balkan space.

The European Union is facing a "polycrisis" - a complex and interconnected set of simultaneous crises, including the war in Ukraine, climate change, energy changes, economic fragility and societal fragmentation. These interconnected challenges create cascading effects that threaten European stability, forcing the EU towards faster geopolitical adaptation and long-term systemic political transformations, instead of short-term solutions.

2. Polycrises – concept and typology

2.1 The concept and typology of polycrises

Research on crises and their role in European integration is extensive. International relations and comparative politics scholars often define crises as “tipping points,” i.e., moments of acute pressure or upheaval that lead to policy or regime changes (Capoccia & Kelemen, 2007; Fioretos, 2011). Scholars have consistently addressed crises as factors of (dis)integration, studying how their varying characteristics can have a differential impact on the dynamics of European Union policy-making (e.g., Haas, 1964; Schmitter, 1970; Jones et al., 2016; Schimmelfennig, 2018, 2023; Ferrara & Kriesi, 2022; Nicoli, 2020). In parallel, constructivist studies have analyzed how crisis discourse is used by different actors to justify policy decisions or mobilize political forces (Lawrence, 2014; Snaith & Rosamond, 2015; Hepp et al., 2016; Niemann & Zaun, 2018; Rhinard, 2019). These contributions differ substantially in their definition of crises, but regardless of each person’s position in this defining debate, we argue that polycrises have specific characteristics and features in themselves. (Nicoli, Zeitlin, 2024)

Characterized by cross-border effects, multiple causalities, and complex system properties, polycrises present unique obstacles to traditional governance and policy responses. We define a polycrises as the simultaneous occurrence or temporal overlap of crises that:

- affect agents participating in a system of shared governance;
- are attributed to distinct sources;
- have an impact on different policy areas; and
- have reciprocal consequences for each other, resulting in positive effects or negative interdependencies. (Nicoli,Zeitlin,2024)

A polycrisis is a complex network of interconnected crises, sometimes with cascading effects, that transcend traditional policy boundaries. First coined by two complexity theorists twenty-five years ago, the term “polycrisis” has gained popularity in the post-COVID19 era. The global pandemic has highlighted the increasingly multidirectional transmission of complex crises – with human, political, social, economic, environmental and security dimensions – between countries in the North and those in the South. Seen from this perspective, a polycrisis is a state of interconnected crises that unfold simultaneously and influence others. This interconnectedness creates a system that cannot be reduced to singular causes, addressed in isolation or as a geographically limited phenomenon. Climate change, migration, economic instability, geopolitical conflict and technological disruption are some of the key areas where polycrisis dynamics are evident. Drawing on complex systems thinking, recent work in the field of international relations has contributed to defining polity as characterized by cross-border effects, multiple causality and complex system properties. Cross-border effects refer to the ability of polity to transcend specific domains and impact on diverse aspects of society. Multiple causality means that its chain of events can trigger

unexpected consequences. As for its complex system properties, these refer to its self-sustaining nature, caused by a complex network of causal relationships and feedback loops. (Schreiber et al.,2025)

Events in recent years can provide useful illustrations; for example, how climate change can exacerbate food insecurity, which in turn can lead to social unrest, population movements and political unrest, as demonstrated by the Syrian Civil War and the Arab Spring. These cascading effects illustrate the cross-border effects of polycrisis. In turn, the impact of Russia's war of aggression against Ukraine on development budgets in other countries is an example of the multiple causality of polycrisis. Finally, polycrisis has complex systemic properties, as seen in the way in which the global financial crisis of the late 2000s and the food crisis of 2010 rapidly turned into interconnected sovereign debt crises, social unrest and political tensions that reinforced each other, leading to a downward spiral that is difficult to control. (Schreiber et al.,2025)

The concept of polycrisis has become global - for example, Janzwood and Homer-Dixon (2022) define a global polycrisis as "any combination of three or more systemic risks with the potential to cause a cascading collapse of the Earth's natural and social systems, irreversibly and catastrophically degrading the prospects for humanity". Tooze (2022) himself considers the central features of polycrisis to be (1) the inability to understand our current situation as the result of a single specific causal factor (e.g. capitalism); and (2) the extraordinary scale of local development that makes us likely to pass through critical turning points. (Nicoli,Zeitlin,2024)

The term "polycrisis" is often used in conjunction with the term "Anthropocene", highlighting the human factors of our crisis-prone era. Indeed, the "Anthropocene" describes our current era as one characterized by the profound impact of human activity on the planet. Historian and author Adam Tooze, for example, emphasizes that anthropogenic factors such as industrialization, deforestation, and fossil fuel use have accelerated environmental degradation, contributing to the complex web of global challenges known as the polycrisis. By placing human activity at the center of our analysis, we can see how the polycrisis is linked to three central human-made challenges: effective global cooperation, resilient economic models, and strong public trust in institutions. These three challenges are critical to mitigating its adverse effects and building a sustainable future. (Schreiber et al.,2025)

2.2 Polycrisis – an analysis in the case of the European Union

Since 2016, the European Union has been widely seen as being in a state of 'polycrisis', in which simultaneous, mutually reinforcing challenges threaten the cohesion and legitimacy of the Union. Such polycrises can fracture Europe's political space, creating cross-cutting 'polyclivities' that polarise Member States and their citizens asymmetrically, thereby limiting the European Union's capacity to reach effective compromises on key policy issues. In doing so, they exacerbate the risk of the EU falling into a multi-level 'political trap', in which the negative politicisation of European issues prevents national leaders from agreeing on ambitious solutions in intergovernmental negotiations. (Nicoli,Zeitlin,2024)

The concept of a global polycrisis, defined in the way that climate change is at the epicenter, is quite different from the polycrisis manifested in the European Union, having more elements in common with that of a "permacrisis", in which "slow-acting" crises, such as climate change, reinforce the effect of "fast-acting" crises, such as Covid-19 and the war in Ukraine.

Such polycrises can fracture Europe's political space, creating cross-cutting "polyclivations" that polarize member states and their citizens asymmetrically, thus limiting the EU's capacity to reach effective compromises on key issues. Europe's first polycrisis was triggered by the overlapping impact of the euro/sovereign debt crisis (2009–2016) and the refugee/migration crisis (2015–2016), each of which mobilized certain constituencies and opened up deep divisions between member states. The second polycrisis - deeper and broader - The Covid-19 pandemic, first, and the Russian invasion of Ukraine, initially led to a simultaneous collapse of the European health, economic and security prospects. The EU was hit, in less than three years, by the worst recession, the worst health crisis, the worst energy crisis and the worst security crisis since the end of the Second World War. In an era of dominant and constraining dissensions, the cross-politicization of these issues could have paralyzed the Union, following the scenario of a multi-level political trap. However, the responses of the European Union and its member states, both to the Covid-19 pandemic and to the invasion of Ukraine, suggest that other outcomes are indeed possible. (Nicoli, Zeitlin, 2024)

Key aspects of the European Union's polycrisis:

 Interconnectedness: Crises are no longer isolated; they amplify each other, with environmental, political and economic crises feeding into each other.

 Key pillars: Major crises include the Russian invasion of Ukraine, the "slow rebalancing" of the economy, climate change and growing societal fragmentation.

 EU response: The EU is trying to move from reactive crisis management to proactive, long-term systemic change, such as promoting greener circular economic models and reducing dependence on foreign energy and materials.

 Governance change: The EU is using "strategic foresight" through tools such as the EU Policy Lab's Polycrisis exploration tool to anticipate risks and manage risks that are now considered persistent.

 Security and defence: While the war in Ukraine has stimulated faster decision-making, it has also highlighted disparities between Member States, leading to a "hybrid adaptation" of the Union's security framework, often with the support of NATO.

 The EU is adapting by developing a "transformative resilience" that seeks to reform internal systems to better withstand future shocks.

Polycrisis, characterised by multiple, interconnected crises, severely challenges traditional response mechanisms. However, while polycrisis transcends the boundaries of traditional policies, it does not extend indefinitely; its non-linearity does not exclude the existence of causal links; and its emergent nature does not necessarily translate into an ever-worsening spiral. This understanding, together with the recognition of the inherent dimensions of a crisis, allows us to identify a clear path forward: the pursuit of "polysolutions", i.e. comprehensive strategies designed to enhance resilience and adaptability. (Schreiber et al., 2025)

Multi-crises create both challenges and opportunities for the European Union and the European integration process, beyond those normally resulting from individual crisis episodes. On the one hand, interconnected coalitions and cross-vetoes can block EU-wide solutions to interdependent problems, while a deadlock in one policy area can spill over into others, creating a broader systemic crisis for the Union. On the other hand, however, solutions in one crisis policy area can facilitate solutions in another, either simultaneously (in the form of "grand bargains") or sequentially. (Nicoli,Zeitlin,2024)

Brexit can be seen as a "hinge" between the first polycrisis (the euro/sovereign debt crisis and the refugee/migration crisis), when the EU seemed to be in constant danger of falling into a political trap, and the second polycrisis (Covid and Ukraine), when the Union collectively responded to what were perceived as exogenous, symmetric and existential threats by taking unprecedented steps towards deeper integration. The EU's responses to both the Covid and Ukraine crises, as a number of contributions to this collection suggest, can also be seen as a progressive learning process, drawing on the positive lessons of the Union's successful response to Brexit, as well as the negative lessons of the first polycrisis. Brexit also facilitated the EU's collective response to subsequent crises, by removing a key veto-wielding player who opposed further integration measures, whether on security and defence or on joint borrowing and the use of the Union budget to support member states' post-pandemic recovery. Beyond the specific policy lessons from previous crises, this progressive learning process, Laffan suggests, led to the consolidation of a series of EU political norms of unity, solidarity and collective responsibility to act, which in turn helped the Union avoid a political trap in the second polycrisis. Such emerging political norms, as Laffan points out, condition collective action, making collaborative EU-level responses to subsequent crises more likely, without determining the outcome, which will depend on the strategic capacity of key actors working through the Union's dense and evolving institutional ecology. More generally, the temporal succession of EU polycrises can be seen as a sequential process, in which successful responses to one crisis strengthen the Union's capacity and commitment to resolve the next one, as can be seen in the trajectory from Brexit to Covid, to Ukraine and to the energy crisis. Avoiding a political trap in one crisis increases the probability – but not necessarily the certainty – of avoiding it in the next one, thus transforming the intersectoral consequences created by a polycrises from a negative force to a positive one. (Nicoli,Zeitlin,2024)

2.3 European solutions to urgent problems

A Borders: After initially imposing unilateral restrictions on cross-border movements, Member States adjusted their control measures to the pressure of the pandemic (measured by monthly Covid mortality rates), did not politicise border closures along party lines despite their high public importance, and followed EU recommendations despite their non-binding nature and the Union's limited competences in this area.

Health: Here too, after initial hesitations, the Commission quickly convened a Coronavirus Response Team and a Covid-19 Advisory Group and initiated unprecedented centralised joint procurement of vaccines, which despite initial supply problems proved largely effective in meeting Member States' needs. In the long term, these developments laid the foundations for a modernised "European Health Union", creating a new Health Emergency Preparedness and Response Authority (HERA) at European Union level to coordinate medical countermeasures in public health emergencies, while strengthening the competences and capacities of the European Medicines Agency (EMA) and the European Centre for Disease Prevention and Control (ECDC).

Economic recovery in the pandemic context: Following the introduction of the European Central Bank's (ECB) Pandemic Emergency Purchase Programme (PEPP), which helped to limit financial instability by purchasing private and public securities, the Commission and the Council acted quickly to first adopt the innovative SURE initiative to limit unemployment risks by supporting short-time work schemes, and then, following heated debates in the European Council, to agree on the massive NextGenerationEU (NGEU)

package of grants and loans to Member States for national recovery and resilience plans, financed by joint European Union borrowing, which immediately contributed to reducing sovereign bond spreads, while providing medium-term financing for investments in social cohesion and the green and digital transitions in return for domestic reform commitments.

Security and defence: in this area, the European Union's response to the Russian invasion of Ukraine has been even faster, more concerted and more innovative than in the case of the Covid-19 pandemic. Notable measures include far-reaching sanctions against Russia, renewed and extended 13 times; the re-use of the European Peace Facility (EPF) as an extra-budgetary instrument to provide Ukraine with lethal weapons and military resources; the creation of an EU Military Assistance Mission in Ukraine (EUMAM), overseen by the EU's Political and Security Committee, with the Military Planning and Conduct Capability (MPCC) as its operational headquarters; the joint procurement of ammunition by Ukraine under the auspices of the European Defence Agency (EDA) through the Ammunition Production Support Act (ASAP); the adoption of the European Defence Industry through Joint Procurement Act (EDIRPA) to financially stimulate the joint procurement of weapons by Member States in a broader sense; the Commission's proposal for a European Defence Industrial Strategy (EDIS); and enhanced cooperation between the EU and NATO, focused on ensuring complementarities. At Member State level, Denmark's abandonment of its option to opt out of the CSDP and Finland and Sweden's decision to join NATO reflect an equally unprecedented radical shift in domestic public opinion and foreign policies. Even more significant in the long term may be the decision to open a path for Ukraine's accession to the Union, which, like many of the other security and defence milestones listed above, had been dragging on the European Union's political agenda before the Russian invasion.

Energy: In this case, key elements of the European Union’s unexpectedly effective response to the energy crisis triggered by the Russian invasion of Ukraine include the adoption of the REPowerEU programme attached to the RRF to support member states in reducing their dependence on Russian oil and gas while accelerating the green transition, followed by the adoption of a “market correction mechanism” (MSM) to cap gas prices. Many of these innovations, such as collective borrowing to finance non-repayable grants to member states through the RRF, joint vaccine procurement, the broad scope of sanctions against Russia, and the use of the EPF to purchase lethal weapons for Ukraine, “would have been unimaginable just a few months before they were agreed” (Laffan). Some of these measures were explicitly temporary, notably the RRF and SURE, although they are nevertheless likely to have a significant impact on future EU policy, for example through the proposed extension of performance-based funding to the Cohesion Policy Funds. Others are explicitly intended to be more permanent, notably the creation of a European Health Union and the extension of joint arms procurement, although both still require considerable further elaboration. While none of these crisis-related innovations represents a comprehensive European solution to the problems in the relevant policy areas, neither can they be considered lowest common denominator agreements, which would be destined to prove their inadequacy in the face of the next crisis: they can thus be seen as examples of ‘previous success’ rather than ‘previous failure’. The European Union has clearly proven more resilient to the combined effect of the Covid-19 pandemic and the Russian invasion of Ukraine than might have been expected from the first polycrisis created by the overlapping impact of the euro and the refugee/migration crisis. So far, crucial to the dynamics of this second polycrisis has been the ability of EU and national leaders to frame the challenges involved as having an impact on

the whole of Europe and then to muster the political support necessary to pursue decisive political action. Such a collective framing of the pandemic and the war in Ukraine as symmetrical and existential threats to the European Union and its member states, thereby reducing the level of polarization in the highly salient debates on crisis response, has led to a successful, if perhaps temporary, dynamic of positive or favorable politicization. Brexit generated a practice of common framing of issues, along with a set of emerging political norms of unity, solidarity and collective responsibility to act, which the Commission and the European Council were able to draw on to achieve an effective political response to the Covid-19 crisis and the Russian invasion of Ukraine.

Other threats to the consensus on the EU's collective response ("collective power Europe") could come from future crises that truly fragment the political space both between and within countries. The most recent polycrisis has, in fact, demonstrated that the European way of "creating de facto solidarity" without formal state construction can be effective even in the face of fundamental challenges to the continent's well-being and security. The key to this success, as the contributions to this collection show, is the collective will of European leaders to be united, to exploit the institutional avenues offered by the EU's distinctive governance structure, and to avoid falling into a political trap. (Nicoli,Zeitlin,2024)

Romania's border regions, especially those in the east and south-east, face a series of complex "polycrisis" risks in 2026, generated by the proximity to the conflict in Ukraine and the instability in the wider Black Sea region.

The main aspects of this situation are:

Security and Geopolitical Risks: The conflict in Ukraine continues to destabilize security in the Black Sea region. This implies an intense military presence and direct security risks on Romania's eastern border.

Economic Instability: Romania faces economic risks, including a high budget deficit, exchange rate pressures (rising euro) and high interest rates, accentuated by internal political uncertainties. Analyses indicate that 2026 is a complicated year for Eastern Europe, with risks of a deep economic crisis.

Border Risks (Illicit Trafficking): Border regions are vulnerable to illicit trafficking of goods, which undermines the economy and fuels organized crime.

Political and Social Crises: Internal political tensions and high geopolitical risks create an unstable environment, warning of major difficulties in managing resources and attracting European funds (PNRR).

These combined elements – security, economy, crime and political instability – define the "polycrisis" context that Romania's border areas are facing this year.

Since 2014, the European Union has implemented an Integrated Political Crisis Response Mechanism (IPCR) that supports rapid and coordinated decision-making at the EU political level for major and complex crises, including acts of terrorism. Through this mechanism, the Council presidency coordinates the political response to crises, bringing together EU institutions, affected Member States and other key actors. (European Council, 2014)

3. Conclusions

To the extent that crises are perceived by domestic audiences as fundamentally symmetrical and highly important or even existential, they can fuel positive rather than negative politicization. Framing a crisis as a collective problem requiring a collective

response is therefore a crucial component of the EU's ability to escape a political trap. Shared understandings of a crisis as "symmetrical" and "existential", affecting all member states in a highly significant way, regardless of their differences, can thus serve as a basis for positive or "facilitative" politicization at both the national and European levels. In the case of the Russian invasion of Ukraine in 2022, there was a stronger consensus from the outset between EU and national leaders on the existential nature of the crisis and the need for a collective response. Crucial to the EU's ability to avoid falling into a political trap in the second polycrisis was the willingness and ability of EU and national leaders to reach consensus not only on a common framework of the problem, but also on a common framework of action, in terms of developing specific policy solutions, from joint vaccine procurement and collective borrowing for the NGEU package to far-reaching sanctions against Russia, the use of the European Peace Facility for the acquisition of lethal weapons and the decision to open a path for Ukraine to join the European Union. Beyond their immediate practical impact, these innovative policy measures helped to mitigate the impact of the crises by signaling the Union's collective will to act during the euro crisis. The temporal succession of EU polycrises can be seen as a sequential process, in which successful responses to one crisis strengthen the Union's capacity and commitment to resolve the next one, as can be seen in the trajectory from Brexit to Covid, to Ukraine and to the energy crisis. Avoiding a political trap in one crisis thus increases the probability - but not the certainty - of avoiding it in the next one, thus transforming the cross-sectoral consequences created by one polycrisis from a negative force into a positive one for further integration. The EU's ability to avoid falling into a political trap in the second polycrisis can thus be understood as a sequential process in which successful responses to one crisis strengthen the Union's capacity and commitment to resolve the next one, thus transforming the cross-sectoral spillover effects created by one polycrisis from a negative force into a positive one for deeper integration. To effectively manage the polycrisis, it is necessary to explore alternative economic models and financial mechanisms. Thus, instead of limiting themselves to amplifying crises, economic systems should be transformed to provide effective solutions. Short-term reactive measures are insufficient to address the interconnected and long-term nature of these challenges.

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APPLICABILITY OF THEORIES OF COMPETITIVE ADVANTAGE FOR ENTERPRISES FROM GAGAUZ REGION

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Abstract. *In the context of increasing global competition, companies in the Gagauzia Autonomous Region of the Republic of Moldova are faced with the need to identify sustainable sources of competitive advantage, given that the impact of innovation, recognized as a key factor of regional development and sustainable competitiveness, on regional competitiveness is manifested through a number of indirect channels, such as infrastructure, human capital and institutional interactions. However, methodological challenges, lack of consistency and strategic fragmentation remain pressing, and the application of modern methods for assessing the impact of innovation on the competitive advantage of the region presents a complex methodological challenge due to the multidimensionality of indicators, the time lag between implementation and impact, the institutional characteristics of the regions and the specificity of the approaches used. The article presents an analysis of the region's positioning in the innovation coordinate system and the applicability of innovation activity assessment systems and modern theories of enterprise competitive advantage.*

Keywords: *theories, competitive advantage, enterprises, global competition, Gagauzia.*
JEL Classification: *Q1, R1, H254.*

1. Introduction

In the last two decades have been made various attempts to mechanically adapt and borrow Western European innovation strategies by Central and Eastern European countries, without proper localization. Eastern European countries, and especially Moldova and its autonomous region of Gagauzia, are characterized by active but still unstable attempts to form clusters, often with the participation of international donors and without sustainable internal synergy mechanisms.

In the academic literature, theories of regional competitive advantage and regional competitive advantage often overlap, but their focus and origins differ. Theories of regional competitive advantage focus on adapting general theories such as RBV, DCT, relational perspective, institutional theory and triple helix to the regional level and are applied to a focused analysis of regions as independent agents. Meanwhile, theories of regional competitive advantage, such as cluster theory, regional innovation systems (RIS), built advantage, smart specialization and agglomeration theories, are applied to a focused analysis of regions as independent agents and initially focus on regions as systems, examining the type of competitive advantage specific to regions as entities and explaining regional sources and mechanisms of competitiveness. For example, a comparative study of clustering and smart specialization strategies in Romania, Bulgaria and Moldova (Roman et al., 2022) highlights the dependence of many clusters on external financing (mainly EU funds). The authors conclude that while Romania has experienced successful localized practices (e.g. the IT cluster in Cluj-Napoca), clustering initiatives in Moldova are more often formal in nature and lack consistent signs of self-organization, competition and specialization.

Publications by moldovan researchers show that the Republic of Moldova offers fragmentary examples (the wine cluster, Tekwill, cluster initiatives in the forest fruit industry (Pomoșoarele Moldovei), the clothing industry (Din inima) and the tourism sector (Pomul vieții)), but, overall, suffers from a lack of a mature market and cluster institutions, while a real innovative synergy and a sustainable cluster structure, as well as still unstable attempts to

form clusters, are created with the participation of international donors or exclusively through external support. Thus, I. Certan and E. Malcova analyze the potential for implementing innovative clusters in Moldova, identifying priority sectors (media, ICT, agri-food production) and emphasize the need to transition from an agricultural model to a clustering strategy based on scientific and technological foundations. A. Levitskaia, analyzing the current cluster formation policy in Gagauzia, emphasizes the unique institutional and territorial characteristics of Gagauzia and the importance of educational and innovative proximity between actors. T. Buyse et al. demonstrate a methodological framework for cluster identification using specialist assessments and cluster maturity indicators, based on qualitative mapping of clusters in the regions of Moldova (Center, South, Gagauzia) and a peer-reviewed expert evaluation methodology, based on an assessment of concentration, RDI, internationalization and cooperation. E. Benea Popușoi analyzes a real textile cluster as an environment for competitive cooperation, models of cooperation between firms, joint projects, export practices, problems of competitive interaction and deficiencies of cluster management, as well as the cluster's capacity for competitive cooperation within small enterprises. UNDP Blog 2024 presents real data from cases in Gagauzia: the case of the "Heart of the Nistru" tourism cluster (Coșnița, Gagauzia), where in the period 2021-2024 the number of tourist attractions increased by over 50, and the turnover increased from 5 million to 30 million lei; the furniture cluster in Ungheni (southern Moldova) as a successful example of SME diversification; nine clusters supported by UNDP, certified according to the ESCA Bronze Label, are described. Babin A. et al. studying the need for dual use of cluster infrastructures, their role in digital transformation, SME internationalization and increasing resilience in times of crisis (COVID-19, the war in Ukraine), and considering universities as key elements for accessing global value chains and increasing competitiveness, highlights the role of clusters in increasing the resilience of businesses in the Republic of Moldova and international integration in times of crisis. Ilie's (2021) study focuses on the agro-industrial sector in southern Moldova, including Gagauzia.

The author raises the issue of the lack of horizontal linkages between agricultural research institutes, SMEs and universities, which hinders the development of innovation systems. Although the region has experienced isolated successful agricultural modernization projects (for example, within the framework of UNDP and IFAD programs), these are implemented in a fragmented manner and do not lead to a sustainable institutionalization of innovation.

2. Problem description

Several studies from Central and Eastern European countries raise the issue of the uneven development of Regional Innovation Systems in countries with economies in transition (Lengyel and Leydesdorff, 2011). In 2022, the United Nations Economic Commission for Europe (UNECE) published the Innovation for Sustainable Development Review of Moldova, which examines the concept of RIS as a central element of sustainable development. The document provides an in-depth analysis of regional disparities and identifies systemic limitations of RIS in Moldova. It highlights extremely low levels of investment in research and development (less than 0.3% of GDP), the lack of technology transfer mechanisms and weak regional participation in innovation programs, the situation being particularly critical in the southern regions of the country, including Gagauzia, where sustainable scientific-industrial linkages are lacking (UNECE, 2022).

Additional methodological support for the assessment of the SIR in Moldova is provided by a series of JRC studies led by Hollanders (2017–2021), which included mapping the regional innovation potential. According to the analysis, Gagauzia has a low density of knowledge-based industries (less than 20), while significantly lagging behind Chisinau (over 60 industries). At the same time, the region's indicators are comparable to those of other central regions of the country, which allows Gagauzia to be considered an "innovative and promising" but "institutionally fragmented" region. Thus, the analysis demonstrates that innovation systems develop unevenly and face a number of institutional barriers: lack of coordination between stakeholders, weak regional research and development, and insufficient support for technology transfer. Gagauzia, as an example of a peripheral region, suffers from a lack of both infrastructure and human resources to develop a full-fledged regional innovation system. However, due to localized growth points, participation in international initiatives (Horizon Europe, Interreg, EIT) and donor support, the region can be considered a promising area for pilot implementation of RIS elements.

3. Review of the specialized literature

Recent publications confirm that the theoretical construct of a regional innovation system is adapted and modeled in various countries, including those in Eastern Europe. However, Moldova and the autonomous region of Gagauzia remain in the early stages of RIS development: infrastructure is underdeveloped, interactions between universities, companies and government agencies are limited, and innovation potential is concentrated around the capital. Analyses of JRC (Hollanders) and UNECE datasets demonstrate the existence of potential, but its underutilization.

In Moldova, academic publications that directly address the application of the Built Advantage theory, which provides an analytical framework for active modeling of regional competitive advantages, including platform interactions between various types of knowledge and actors, are few. In Europe and Poland, examples of its application are formalized, while in Moldova and Gagauzia, it is implemented through pilot clusters and donor platforms, although it is not officially designated as such. In order to integrate built advantage into local regional policies, it is important to develop platforms (e.g., technology parks, educational centers), inter-sectoral spillovers, and institutional coordination. Thus, C. Morcan (2024) in the work "Moldova's Clusters: Key Drivers for Innovation and EU Integration", on the Cluster Collaboration platform, emphasizes that the exchange of experience between Moldovan and European clusters (cluster exchange) is an important strategy for building regional advantage, and this is an example of a strategy characteristic of platform policy. The Cluster Mapping Report for the Republic of Moldova (EC SERV Report) presents ministerial and specialist analyses on cluster mapping, assessing the potential of the platform-based approach and building a regional advantage through inter-cluster and cross-sector links.

The 2024 European Commission report notes that Moldova is only at the initial stage of developing and implementing the Smart Specialization Concept (S3), which is an approach to regional innovation policy based on prioritizing sectors in which each region has the greatest growth potential, assuming that regions should identify and prioritize their strongest or most promising innovation, entrepreneurship and research activities, and emphasizes the need to implement a corresponding strategy and action plan. Thus, in the study conducted by H. Hollanders et al. (2024) S3 priority areas were identified for four regions: North, Center, South and Gagauzia, for which agriculture and food processing are common areas of

economic activity. Gagauzia also noted the potential in the field of textiles, biomedicine and electrical equipment. In the presentation of A. Topala (2020), Gagauzia's industrial clusters within the S3 framework were listed, in particular textiles, pharmaceuticals, wood processing, agro-processed products and others, and indicated the potential for creating clusters in these areas. E. Ilie (2021) notes that the implementation of S3 in Moldova is often demonstrated formally, resulting in the declarative nature of S3 activity in the context of a complete or partial absence of real mechanisms of interaction between the government and the business environment. This is especially characteristic of Gagauzia. The research of the JRC platform confirms that Gagauzia is among the regions with potential for S3, but in practice it requires specific institutional support, including coordination at the local level, i.e. local platforms, intersectoral coalitions and support. In addition, key recommendations for improving S3 capacity in Moldova and the Gagauz region include the need to develop a roadmap for S3 implementation based on the identified priorities (RIS mapping), strengthening the institutional capacity of the region (government, business environment and universities), adapting the Elite entrepreneurial discovery method by involving local actors, ensuring financing and establishing sustainable local S3 governance mechanisms.

To date, no publications have been found in the academic literature directly dedicated to the application of the Learning Regions theory in Moldova or Gagauzia. However, a number of authors have examined related aspects, especially in the fields of education, regional development and intersectoral collaboration. For example, Ebru Eren (2021) provides an analysis of educational policy in Gagauzia, highlighting the multilingual reality of the region, the role of identity and the need for adaptive approaches to education. H. Küçükler and A. Curdoglo (2021) examine changes in the language of instruction, highlighting the importance of multilingual education for social inclusion and sustainable development in the region. In addition, there is some evidence of educational initiatives that promote the development of learning regions through infrastructure and platform solutions. The EduLIFE Hub project, implemented by UNFPA and Orange Moldova, has created an innovative educational space for young people, as an example of action learning and intersectoral collaboration. The UNDP digital transformation project for 46 schools in Gagauzia is focused on strengthening the sustainability and quality of education, as a step towards a regional learning center. The EU4Moldova: Focal Regions (2024) initiative aims to train teachers in the regions in the application of AI and STEAM approaches, which is a step towards creating a modern educational environment that facilitates knowledge transfer. The Moldova Education Reform Project (2024)/MERP (2024) initiative aims to renovate schools, equip them with STEM laboratories and use smart boards and interactive equipment, all of which will transform educational institutions into regional learning centers. Thus, although there are few direct studies on Learning Regions in Moldova in the scientific literature, existing research, initiatives and educational projects in the field of education and coworking reflect elements of the concept, in particular the active implementation of innovative teaching methods, a platform for knowledge exchange and the gradual consolidation of the regional educational environment and can be considered empirical attempts to form elements of Learning Regions.

Although direct academic research on the application of the theory of institutional complementarity in Moldova and the Gagauzia region is lacking, there is indirect evidence in the analyses of the regional innovation system, and their regional implications are important and require rethinking. According to the JRC (Hollanders et al., 2021), Gagauzia has

approximately 20 industries with innovation potential comparable to that of the central regions, indicating institutional premises for complementarity at the regional level. However, according to Ilie (2021), only 13% of innovative firms collaborate with universities or research institutes, indicating weak horizontal institutions - and, consequently, low complementarity. Thus, at the regional level, institutional complementarity manifests itself through: coordinating horizontal links between universities, companies and government; vertical links between regional and national institutions; creating platforms for the exchange of experience (e.g. Interreg); and initiating institutional networking as the main source of innovative potential. For Gagauzia and Moldova, an important task is to strengthen these links through educational, research and clustering initiatives, taking into account the principles of inter-level networking and coordination.

One of the most influential approaches, which has had a significant impact on strategic management and competitive analysis, is the Resource-Based View (RBV) theory (Barney, 1991, Wernerfelt, 1984), which focuses on a firm's resources as sources of sustainable competitive advantage and organizational capability. European research adapts the RBV to innovative contexts, emphasizing the role of intellectual capital and organizational competencies, demonstrating how research and development, knowledge, and organizational processes enhance competitiveness.

Dynamic Capabilities Theory (DCT) (Teece, Pisano and Shuen, 1997) provides an extension of the resource-based view (RBV),

The Relational View Theory (Dyer & Singh, 1998) postulates that sustainable competitive advantage can be formed not only within a firm, but also through relationships with external partners (suppliers, customers and allies) as a result of interorganizational networks and alliances in which rents are created through interactions. Eastern European countries are increasingly applying bottom-up logics, focused on long-term partnerships, specialized sectors and sustainable economic transformation through relational assets. Countries new to innovation policy are successfully adapting the R&D approach through EIT, Horizon and Interreg. A key challenge remains the capacity of regions to maintain sustainable partnerships and develop local innovation ecosystems. Moldova is actively developing relational links through the Tekwill and EU4Innovation/StartupCityCahul programs - projects are carried out with the participation of universities, businesses and the general public, including in the regions (Cahul, Balti). The specifics of the relational approach in the Gagauz region include triple and quadruple partnerships (university→local business→donors→public), as well as knowledge localization (creation of training courses, IT schools with the support of Tekwill and ATIC) and regional internationalization through the participation of the region in cross-border projects through Interreg Black Sea and CBC-UA-MD.

The concept of Institutional Complementarity proposed by Hall, P. A., & Soskice, D. (2001), which emphasizes synergies between institutions, intellectual property and human capital, is applicable to European SMEs, especially in peripheral regions. European researchers demonstrate how the combination of open resources (CBV) can provide a competitive advantage even without unique assets (Bruno Amable (2000, 2016), Hall & Gingerich (2009), Deeg (2005).

The Composition Based View (CBV) theory proposed by Luo & Child (2015), which explains the growth of firms without unique resources that create competitive advantages by creatively combining open resources and integrating external components (knowledge,

technology, services), as well as the Triple Helix theory of Etzkowitz & Leydesdorff (2000), which emphasizes the integration, co-evolution and co-creation of new knowledge and technologies in innovation policy practice, have served as the basis for more comprehensive models.

The Quadruple Helix and Quintuple Helix theories developed by Carayannis & Campbell (2010, 2012) develop the Triple Helix model by adding new dimensions: civil society and the natural environment, involving not only universities, businesses and government in innovation processes, but also NGOs, media and environmental factors. The theory was elaborated and further developed in the work of Nicolescu and Popa (2017) in their study on the role of universities in shaping regional ESG sustainability.

Our study used innovation assessment systems (EUROSTAT/Community Innovation Survey (CIS), OECD-Oslo Manual (2018), OECD - MSTI/STI Indicators, European Innovation Scoreboard (EIS), Regional Innovation Scoreboard (RIS), JRC - Methodological Support for Neighboring Countries (Moldova), UNECE - Innovation for Sustainable Development Review (Молдова), a set of analytical and methodological documents of the Innovation for Sustainable Development Review initiative (I4SDR, 2022), Roadmap on Innovation and Technology Transfer for Moldova (2022), capacity-building research, and Interim Sub-regional Innovation Policy Outlook (IIPO, 2023), which provided a comparative analysis of development dynamics and identified opportunities to take into account the specifics of territorial units, including Gagauzia. This document expanded the context of strategic planning, allowing the integration of international best practices into local models and the adjustment of priorities taking into account the resource, institutional and socio-cultural characteristics of the region. Thus, the combination of these documents and tools formed a comprehensive cycle of innovative development management - from analytical to diagnostic to practical implementation and adaptation of strategies, which is especially important for Gagauzia in the context of the need for accelerated economic diversification and increased competitiveness within the framework of the SDG 2030.

4. Methodology and data sources

The analysis of innovation activity in Gagauzia was carried out using key indicators - the number of innovative enterprises, their activity profile and their share in the total business environment of the region.

Share of innovative enterprises in the region. According to official statistics* from the statistical survey on innovation activity for the period 2017–2022 (National Statistics, NBS) and the European Innovation Scoreboard 2025, the "Innovative Enterprises" component for 2022 of the EU Commission for the period 2021–2022, approximately 17.4% of enterprises in Gagauzia are innovative, below the national average of 18.2%. In Chisinau, this figure is 18.8%, in the north - 19%, and in the south - 22.3%. In 2019–2020, the share of innovative enterprises was 12.6%, and in 2017–2018 the highest share was recorded - 18%, which may reflect the effort of the first years of active implementation of innovation. In Moldova, the value of the indicator has been constantly decreasing from 18% in 2017-2018, 12.6% in 2019-2020, 11.4% in 2021-2022 and 10.6% in 2022-2024. Regarding the number and distribution of enterprises, according to the report of the General Department for Economic Development of the Executive Committee of the Gagauz Autonomy (GDER, 2023), there are 7141 registered enterprises in Gagauzia, of which 2828 are legal entities, 3564 are individual entrepreneurs, and SMEs constitute 99% of the total number in the region.

Although sectoral data are not fully disaggregated for Gagauzia, data on the sectoral distribution of innovative enterprises (according to the Statistical Classification of Economic Activities in the European Community CAEN Rev.2) and the dynamics of the number and structure of innovative enterprises demonstrate some general trends according to which: (1) manufacturing represents the largest sector of innovative activity – approximately 46.2% of the total number of innovative firms in Moldova, where 89.8% of the total number of innovative enterprises are small and medium-sized enterprises; (2) there is a tendency towards a decrease in the total number of innovative enterprises, which indicates structural limitations in the national innovation system, mainly related to limited access of enterprises to financing and weak integration between science and business; (3) in the distribution of innovative firms by size of employees, small enterprises (10-49 employees) predominate, which indicates the dominance of small firms in the innovation sector, typical of economies with limited industrial potential and highly fragmented markets; (4) the ratio of innovation activity in industry and services remains relatively equal, although regional differences are significant. In Gagauzia and the southern regions, manufacturing enterprises show higher innovation activity (up to 78% of innovative enterprises), while in Chisinau, the service sector is the leader (about 62%), reflecting regional specializations, especially agro-processing and winemaking in the south, and IT and financial and business services in the capital; (5) regional differences are also evident in the size structure of enterprises, thus, in Gagauzia, small enterprises dominate among innovative firms (63-68%), indicating a lack of diversified production and limited resources for large-scale innovative investments, which contrasts with the center and the capital, where the share of medium and large enterprises is higher due to the concentration of industrial complexes and IT companies.

5. Results

The regional profile of innovation activity demonstrates duality. On the one hand, innovation relies heavily on small businesses with limited scalability, and on the other hand, small businesses are important drivers of the adaptation of new technologies in niche segments. For Gagauzia, this requires institutional support for small and medium-sized businesses, including grant and credit mechanisms, as well as the development of cooperative formats (clusters, technology parks) that could compensate for the lack of large innovative players. Volumes and structure of innovation costs by types of innovation activities are presented in table 1.

Table 1. Volumes of innovation expenditures among the regions of the Republic of Moldova, million lei

Regions	Total	including by regions				
		Research and internal development		Acquisition of machinery, equipment and software	Acquisition of external knowledge	Other innovati on activities
2022-2024	1190	120	40	780	110	140
2022						
Total	759,0	93,7	80,7	409,7	18,3	156,7
Chisinau	565,5	33,5	79,9	291,0	16,5	144,7
North	44,9	19,8	0,2	24,0	0,8	0,1

Center	117,9	40,1	0,4	65,4	1,0	11,0
South	14,2	0,2	0,1	13,7	0,1	0,2
UTA Gagauzia	16,6	0,2	0,0	15,6	0,0	0,8
2019-2020						
Total	867,4	168,4	35,7	633,7	10,1	19,5
Chisinau	609,0	119,8	24,9	446,6	6,3	11,4
North	95,6	24,1	10,0	56,6	0,8	4,1
Center	132,4	21,0	0,7	103,8	2,9	4,0
South	24,7	3,5	0,1	21,0	0,1	0,0
UTA Gagauzia	5,7	-	-	5,7	-	-
2017-2018						
Total	828,6	185,5	21,3	540,8	8,1	72,9
Chisinau	346,3	58,1	18,9	202,7	7,2	59,4
North	306,4	58,8	2,1	244,8	0,2	0,5
Center	107,5	41,1	0,3	62,9	0,5	2,7
South	47,6	27,0	-	20,4	0,2	-
UTA Gagauzia	20,8	0,5	-	10,0	-	10,3

Source: elaborated by the author based on NBS data

The data presented in Table no. 1 reveal significant differences in the structure and volume of innovation expenditures between the regions of Moldova for the period 2017–2022, including ATU Gagauzia. Thus, total expenditures for innovation activities in the country decreased from 867.4 million lei in 2020 to 759.0 million in 2022, reflecting a general decline in investment activity in innovation. In 2017–2018, the Gagauzia region allocated 20.8 million lei for innovation, a significant share of which was allocated to the purchase of equipment (10.0 million) and "other innovative activities" (10.3 million). In 2020, there was a sharp decrease to 5.7 million lei, without investments in research and development or external development, probably due to a weak scientific and technological base and limited resources. In 2022, the volume of investments increased to 16.6 million lei, but the structure remained extremely unbalanced: almost 94% of the funds were spent on the purchase of equipment and software, indicating a technological catch-up rather than internal development. At the same time, the data reveal some structural differences between regions, for example, internal research and development is actively developing in Chisinau and the center, but is almost non-existent in Gagauzia and the south. Gagauzia had extremely low expenditures in 2020, but in 2022 they increased from 5.7 to 16.6 million lei, mainly due to the modernization of equipment, which may indicate local modernization programs. Expenditures on the acquisition of external knowledge (licenses, patents) remain extremely low in all regions, indicating weak integration into international technological chains. External research and development is minimal throughout the country, except for certain periods in Chisinau and the north. The acquisition of machinery, equipment and software is the main expenditure in most regions, reflecting the focus of enterprises on technological innovation. The acquisition of external knowledge (purchase of patents, licenses and know-how) has a very small share, especially in Gagauzia, limiting the rapid adoption of modern technologies.

Thus, the specific structure and volume of innovation spending in the regions of the country allow drawing certain conclusions regarding the need to stimulate the growth of innovation spending in regions outside the capital through targeted grants, tax incentives and

support for technology transfer, which is also valid for regional policy in Gagauzia. Specifically, a regional innovation strategy should include the development of domestic research and development, at least at the level of small-scale applied research in the agricultural, winemaking and renewable energy sectors. Participation in technology transfer programs and cooperation with universities in the Republic of Moldova and abroad should also be intensified. In addition, the high share of equipment spending should be accompanied by parallel skills development, so that investments in technology are transformed into productivity growth and the production of innovative products. Thus, for Gagauzia it is important to continue the program of modernization of its production base, complementing it with measures to develop its own R&D skills and attract external knowledge, while for the southern region as a whole it is important to develop clusters around agri-food and energy technologies, taking into account the following trends:

• Decrease in domestic R&D spending. In almost all regions, including Ceadir-Lunga and Comrat, domestic R&D decreased between 2017–2018 and 2022. The decrease was particularly significant in Chisinau (from 58.1 million to 33.5 million lei) and the North (from 58.8 to 19.8 million lei). This may reflect a decrease in investment activity, a lack of personnel and a reallocation of resources towards the acquisition of ready-to-use technologies.

• A sharp increase in external R&D in 2022. After moderate levels in 2017–2020, a sharp increase in external R&D was observed in 2022 (from 35.7 to 80.7 million lei nationally). Chisinau had the largest contribution (79.9 million lei). However, in Gagauzia, this indicator remained at zero, indicating weak interaction with external research organizations and low integration into international projects.

• Procurement of equipment and software is a key priority. Throughout the entire period, the largest expenditure on innovation was the purchase of machinery, equipment and software. In 2020, a peak was recorded (633.7 million lei nationwide), but by 2022, spending had decreased to 409.7 million. Gagauzia, however, demonstrated an increase (from 5.7 million in 2020 to 15.6 million in 2022), which may indicate technological modernization of individual enterprises in the region.

• A sharp contrast between regions. Chisinau consistently holds the vast majority of innovation spending (over 70% in each category), while the share of Gagauzia, the South and the North regions remains minimal. This confirms the centralization of innovation activity in the capital.

The implications for Gagauzia include the following: (i) low levels of internal and external research and development require the creation of incentive programs and support for scientific partnerships; (ii) increased investments in equipment should be complemented by staff training and the introduction of new business models so that technology is used efficiently; (iii) regional programs for external research and development should be developed, including technology transfer through cooperation with universities and foreign partners.

Analysis of the innovation investment index by region for the period 2017–2022, according to the data in Figure 1, revealed significant territorial disparities. Chisinau remains the leader in the analyzed period, due to the concentration of national research and development centers, a significant share of companies with internal research and access to external sources of innovation financing. Despite a moderate decline in the index after its peak in 2020, the capital maintains its dominant position due to the developed infrastructure supporting startups and the influx of qualified personnel. The North region in 2017–2018

demonstrated high innovation activity, but after 2018 a decline was observed, probably due to the decrease in industrial production and weakening cooperation with external partners. The Central region is characterized by a relative stability of the index values, which may be due to a robust but limited segment of agri-food processing and a low level of diversification of innovation sectors. The South, and especially the Gagauzia Autonomous Region, have significantly lower scores. In 2020, Gagauzia recorded a sharp decline in innovation activity (nearly zero in several areas, such as domestic and foreign research and development), reflecting the region's high dependence on external factors, including COVID-19 and the decline in foreign demand for agricultural products. The recovery in 2022 remains partial and is mainly due to investments in equipment and software upgrades, rather than long-term research and development.

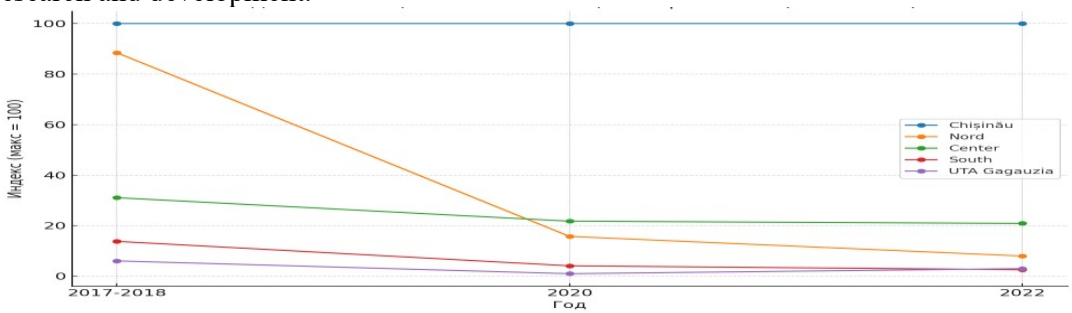

Figure 1. Dynamics of the innovation investment index in the Gagauzia Autonomous Region and other regions of the Republic of Moldova

Source: developed by the author

In the period 2023–2024, Gagauzia was not classified as an innovation-active region according to international or national classifications. This is confirmed by the European classification (JRC EC/RIS3 Mapping Moldova), according to which Gagauzia corresponds to regions with low or moderate innovation activity. In the report of the European Commission, JRC (2021), Gagauzia is not included in the list of priority or innovation-active areas. Table no. 2 presents the distribution of enterprises in Gagauzia by type of innovation: product, process and organizational/marketing.

Table 2. Distribution of enterprises in ATU Gagauzia by type of innovation, 2022

Type of innovation	Number of enterprises	Share, %	
		ATU Găgăuzia	Moldova
Total enterprises	7 141		
Active innovative enterprises	1 243	17.4 of total enterprises	18,2–22,3
SMEs in innovative firms		89.8 of total innovative firms	
Technological innovations		< 6	8–11
(product + process)	415	5.8 (national average ~8) of total enterprises	
Product innovations	357	5.0 of total enterprises	
Process innovations	707	9.9 of total enterprises	
Organizational/marketi	59	14.3 of total innovative product	>20

ng		enterprises	
New products for the market	296	71.4 of total innovative product enterprises	

Source: elaborated by the author based on NBS and JRC EC data (2023)

According to the Smart Specialization Strategy (S3/RIS3) Moldova, innovation potential has been identified in areas such as Chisinau, Balti and northern Moldova, but Gagauzia is referred to as a "low innovation region" with limited growth drivers. The reasons why Gagauzia is not classified as an innovation hub include: (i) limited R&D structures and the absence of strong universities with applied laboratories; (ii) low funding for innovation, including from state programs or the Horizon Europe program; (iii) focus on traditional industries: winemaking, textiles, agricultural raw materials – with a low level of digitalization and technology; (iv) weak integration into global innovation chains.

Table 3. Share of enterprises by type of innovation and region, 2023, %

Region	Active innovative enterprises	Technological innovation (product/process)	Organizational and marketing innovations	Market novelty
Gagauzia	17.4 (low level)	5,8	9,9	14,3
Chisinau	18.8 (medium level)	10,2	12,4	21,2
North	19 (medium level)	8,5	11,3	18,4
South	22.3 (high level)	9,8	13,6	22,5
Center	20.1 (medium level)	9	12	20

Source: elaborated by the author based on NBS and JRC EC data (2023)

According to the data in table no. 3, Gagauzia shows a stable but moderate growth in the share of innovative enterprises (from 12.5% in 2017 to 17.4% in 2023). Organizational and marketing innovations are the most common (about 10%). The share of technological innovation remains low compared to other regions of Moldova, due to a weak technological base, low levels of research and development and limited market diversification. However, Gagauzia has demonstrated a gradual increase in participation in innovation initiatives, such as GAMCON, UNDP and ADA projects, hackathons and agro-innovation initiatives involving students from the University of Comrat. Thus, the low level of innovation activity in Gagauzia is characterized by the following indicators: less than 18% of firms are involved in innovation, with technological innovation (product/process) being half that of the more developed regions of the country; new products are particularly rare, reflecting the low level of external technological disruption; small and medium-sized enterprises dominate among innovative enterprises, but their activity is mainly local and focused on improving internal processes and marketing.

Thus, the data of our study show that the innovation profile of Gagauzia remains focused on capital-intensive and low-knowledge, strongly biased towards material investments (equipment), with a very weak development of its own research and development, technology transfer and knowledge acquisition. The emphasis is on equipment modernization, rather than internal research and technology transfer. Equipment acquisition remains the main driver of innovation, while investments in internal research and

development remain extremely low. The insufficient development of external channels of technology transfer (external research and development, knowledge acquisition) limits the region's ability to achieve technological progress. A positive sign is the increase in spending in Gagauzia in 2022, which may indicate the beginning of the formation of a local innovation infrastructure; however, this trend requires specific support. In this regard, Gagauzia, like the entire southern region, requires specific support through grant and voucher programs, the development of technology transfer centers, and the active involvement of the diaspora in investment projects. This contrasts with Chisinau, where it makes sense to strengthen the role of the city as an engine of technology transfer to the regions; the North, where it is necessary to restore cooperation chains with industrial and agri-food processing enterprises and strengthen ties with scientific institutions; and the Center, where it is necessary to expand the range of innovative industries through the digitalization of the agricultural sector.

The Economic Monitor of the German Economic Group (GET) shows that Gagauzia is a significant economic entity within Moldova, even if its economic indicators are the lowest in the country. A comparative analysis of key indicators of innovation and entrepreneurial activity between Gagauzia (UTAG), the Republic of Moldova and the European Union would help to identify the specifics of regional development and to assess the prospects for integration into the European innovation space. For this purpose, we have supplemented the table developed by GET (table no. 4) with the estimated data for the Gagauzia region.

Table 4. Structural differences in innovation performance

Indicators	Gagauzia*	MD	EU
Performance and structure of the economy			
Herfindahl-Hirschman Index of non-EU imports of high-tech goods (2022-2024)	0,34	0,22	0,20
Herfindahl-Hirschman Index of Imports by Country	0,2914		
Herfindahl-Hirschman Index of Imports by Country	0,3322		
HHI Index for Imports by Product Group	0,1293		
HHI index for exports by product groups	0,1805		
GDP per capita (2022-2024 average)	(2022) €2 900	N/A	100
Average annual GDP growth (2022-2024 average)	est. –0,5% ()	N/A	0,8
Employment share manufacturing (2022-2024 average)	est.16% (agro-food sector)	N/A	15,6
Employment share high and medium high-tech (2022-2024 average)	14% (est.)		38,1
Employment share services (2021-2024 average)	est. ≈ 68%*	~35,5%	40,2
Employment share knowledge-intensive services (2022-2024 average)	8–12% (est.)	~19%	28,5
Turnover share SMEs (2018-2020 average)	40–45% (est.)	45	12,6
Turnover share large enterprises (2018-2020 average)	45% (est.)	45	49,6
Foreign-controlled enterprises – share of value added (2018-2020 average)	10–14% (est.)	18	13,3
Business and entrepreneurship			
FDI net inflows (2021-2023 average)	3,03% (est.)	3	1

Buyer sophistication (2015-17 average)	2,7–2,9 (est.)	2,9	3,6
Enterprise openness (2018-2020 average)	13,97%	14,7%	9,5%
Total Entrepreneurial activity (2022-2024 average)	est. 5–6%	7	7,1
Digital Intensity Index (2024)	average score 4.3 ± 0.5 из 12; est. 15 (below national)	N/A	34,2
Young high growth enterprises (2022)	0,5–1,0% (est.)	0,8–1,2	0.8
Innovation profiles			
In-house product innovators with market novelties (2020)	9,5	12,2	11,7
In-house product innovators without market novelties (2020)	12	12,8	13,7
In-house business process innovators (2020)	15	16,5	17,6
Innovators that do not develop innovations themselves (2020)	7,0	6,5	6,1
Innovation active non-innovators (2020)	4,5	4,1	4,2
Non-innovators with potential to innovate (2020)	19,5	17,2	17,8
Non-innovators without disposition to innovate (2020)	32,5	30,7	30,6
HEU funding intensity per researcher (2022-2024 average)	450–750	N/A	6194
Governance and policy frameworks			
Rule of law (2021-23 average)	est. –0,3 (same as MD)	-0,3	1
Corruption Perceptions Index (2022-24 average)	est. 32 (below MD ~33)	N/A	63,3
Basic-school entrepreneurial education and training (2022-24 average)	-	N/A	2,4
Innovation procurement as a share of total public procurement (2024)	-	N/A	9,2
Environment			
Circular material use rate (2021-23 average)	-	N/A	11,5
Greenhouse gas emissions intensity of energy consumption (2018-20 average)	-	N/A	82,8
Eco-Innovation Index (2024)	-	N/A	127,5
Demography			
Population size (2022-24 average, in millions)	0,12 mln (2024 census 110 k)	2,5	447,7
Average annual population growth (2022-24 average)	–2,8%	-2,8	0,4
Population density (2022-24 average)	est. 60 per km	N/A	109,1

Source: Developed by the author based on data from the European Innovation Scoreboard 2025, Moldova Country Profile

* Calculated by the author. The National Bureau of Statistics of Moldova provides monthly and annual data on international trade for the entire Republic of Moldova. These reports reflect the total volume of exports and imports, as well as general trends, but do not provide a breakdown by regions, such as Gagauzia.

This extensive table reflects the structural differences between the Gagauzia region and the environments of the Republic of Moldova and the EU, allowing the assessment of the institutional and economic premises for the innovative development of the region in a comparative context. The table also captures the differences in four key areas: economic efficiency and structure, business and entrepreneurship, innovation profiles, governance and policies, as well as environmental and demographic parameters.

The data of our study indicates that the economy of Gagauzia region is characterized by a low level of diversification, a limited capacity for innovation and digitalization, as well as insufficient integration into European economic and research chains, but nevertheless there is a latent innovative potential. The arguments for this conclusion serve the indicators of innovators with novelties: 9.5% (below the MD and EU) and non-innovators without disposition: 32.5% (very high). Compared to the European Union average and, in many cases, even the national average, the region presents significant gaps in terms of productivity, employment structure and the quality of the institutional environment. These vulnerabilities are amplified by demographic decline and high dependence on concentrated imports, which indicates the need for strategic interventions aimed at economic diversification, human capital development and strengthening the innovation ecosystem through the complex application of theories of competitive advantage at regional level but adapted for analysis at the enterprise level.

6. Conclusions

The analysis confirms that the applicability of competitive advantage theories to enterprises in the Gagauzia region from Moldova depends on their adaptation to a specific regional context that is marked by limited innovation infrastructure, weak research and development capacity, low technology transfer, and strong dependence on material investments, particularly equipment modernization. While the region demonstrates certain latent advantages, including the dominance of SMEs, sectoral specialization in agri-food, winemaking and textiles and participation in donor-supported initiatives, these resources have not yet been transformed into a sustainable innovation ecosystem. The findings show that theories such as the resource-based view, dynamic capabilities, relational view, institutional complementarity, smart specialization and the helix models are relevant for explaining the current constraints and future opportunities of Gagauz enterprises, but their practical value depends on strengthening cooperation between business, universities, public authorities and external partners. Therefore, the formation of competitive advantage in Gagauzia region requires a shift from fragmented modernization toward coordinated regional innovation policy, investment in human capital, applied research, digitalization, technology transfer and cluster-based cooperation, enabling enterprises to move from technological catch-up to sustainable and knowledge-based competitiveness.

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PERFORMANCE EVALUATION OF LOGISTICS MANAGEMENT

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Abstract: *Logistics is a crucial component of any enterprise's operations—one that is difficult to overlook today, given the overarching goal of maximizing profit while minimizing costs. This paper outlines methods for measuring logistics management performance and the challenges associated with this process. The primary issues in measuring logistics performance stem from a lack of alignment between organizational strategy and performance measurement systems, an emphasis on financial indicators, and the use of numerous, isolated, and incompatible measurement tools. The expansion of global logistics networks has necessitated the evaluation of logistics performance at the national level and the development of tools that enable cross-country comparisons.*

Key-words: *logistics, logistics management, logistics management performance.*
JEL-Classification: *L91, M11.*

1. Introduction

Logistics is a crucial, value-generating link that seeks to harmonize all constituent processes—ranging from the real-time sourcing of raw materials and their transformation into finished products within customer-mandated timeframes to the final delivery to the client at optimized costs.

The purpose of establishing a logistics performance measurement system is to accurately assess outcomes (whether positive or negative), identify and meet customer requirements, pinpoint issues regarding procedural implementation or the need for procedural adaptation and improvement, evaluate the utility and soundness of decision-making processes, and identify challenges in implementing managerial decisions.

In logistics, performance measurement relies on qualitative and quantitative indicators designed to quantify both the efficiency and effectiveness of operations. Both process-based and strategy-based indicators are essential at various levels; they complement one another, facilitating the achievement of objectives across the organization.

2. On the concept of logistics

The term "logistics" is rooted in the military domain. Logistics was considered that branch of the art of war concerned with the movement and supply of armies (Pânzariu and Scipanov, 2016, pp. 61–69).

Subsequently, the need to address the challenges armies faced during wartime regarding the transport of materials from one location to another led to the creation and use of logistics system models (Gănescu, 2017, pp. 7–8). The concept of logistics was first introduced in a work on military theory by Antoine Henri Jomini (Popescu-Cruceru and Udrescu, 2013, p. 21). In his 1838 work *Précis de l'art de la guerre* (Summary of the Art of War), the author identified the six military branches that constitute the art of war at the command level: strategy, grand tactics, logistics, the art of engineering, minor tactics, and politics.

In Jomini's view, logistics was the concern of high-ranking commanders; Napoleon himself served as his own logistics specialist, strictly calculating march distances and the effort required to transport materials for the execution of missions.

Specialized literature highlights the following stages in the evolution of logistics in the USA (Gănescu, 2017, p. 9):

- Coordination of operations (initially, the primary concern focused on coordinating transport, warehousing, storage, and order processing operations, with the aim of ensuring customer service at a cost-efficient level);
- Reorganization of personnel involved in these activities (aimed at increasing the efficiency of physical distribution management and materials management);
- Integrated logistics (the integrated logistics system brings together the chain of links that enable products to be provided at the right time and place, in the requested quantity and form);
- Strategic logistics (inter-organizational alliances that allow a company to combine its assets and performance with services offered by other logistics operators).

According to author Liviu Ilieș (Bălan, 2001, p. 22), the evolution of logistics involved passing through the following phases:

- Distribution logistics (until the 1970s, specialists viewed physical distribution management as a tool of sales policy, aimed at coordinating and optimizing transport and delivery efficiency to end customers in order to secure a competitive advantage);
- Supply and production logistics, viewed as materials management (after 1970, the focus shifted to ensuring cost-efficiency in the procurement of raw materials and production supplies, production scheduling, and inventory management, with the aim of purchasing raw materials at minimum prices and aligning production with sales);
- Integrated logistics (after the 1990s, logistics emerged as a fundamental strategic lever for securing a competitive market advantage, based on an analysis of the total cost of logistics activities).

To better understand the concept of logistics, a number of interpretations are presented below.

In 1962, the NCPDM defined logistics in terms of the activities performed by logistics personnel, as follows: "the industrial or commercial employee involved in the broad spectrum of activities required to ensure the efficient movement of finished products from the point where they leave the manufacturing process until they reach the consumer. This also encompasses the movement of raw materials from suppliers to the point of entry into manufacturing. Specifically, these activities include: freight transport, warehousing, goods handling, packaging, inventory control, plant and warehouse site selection, order processing, market forecasting, and customer services."

The definition presented above expands the scope of logistics to include additional tasks, such as market forecasting, customer services, and the selection of plant and warehouse locations.

Another definition of logistics characterizes it as "the technique of controlling and managing the flows of materials and products from the source of supply to the point of consumption" (Ciobanica, 2017). Compared to previous ones, this definition clearly encompasses supply flows and the management aspect of logistics.

The interest shown by professional organizations in the study of logistics did not stop there; in 1972, the Council of Logistics Management (CLM) provided a new definition of the concept, describing logistics as "a term describing the integration of two or more activities for the purpose of planning, implementing, and controlling an efficient flow of raw materials, semi-finished goods, and finished products from their point of origin to the point of

consumption. These activities may include customer service, demand forecasting, distribution communications, inventory control, material handling, order processing, after-sales service, spare parts support, plant and warehouse location selection, procurement, packaging, handling of returned goods (through negotiation, reuse, reconditioning, disposal, etc.), transport organization, and the actual transportation of goods, including warehouse handling and storage."

This perspective, reflected in the definition, takes into account management-related aspects, including planning and control.

Logistics is a process consisting of the planning, implementation, and control of the efficient flow and storage of raw materials, work-in-progress, finished goods, and related information from the point of origin to the point of consumption, with the aim of meeting customer requirements.

In specialized economic literature, logistics is defined as a collection of activities related to the procurement, movement, storage, and delivery of parts and goods within a logistics chain. Logistics encompasses the functions of transportation, distribution, warehousing, and materials and inventory management. It is linked to manufacturing and marketing.

The term "logistics" has been addressed in specialized literature by various authors, including James L. Heskett, who stated in 1977 that the logistics process encompasses the set of activities involved in product flow and resource coordination, achieving a specific service level at the lowest cost.

Furthermore, ASLOG (Association Française pour la Logistique) considers logistics to be a function aimed at making a product available—at the lowest cost and required quality—at the specific place and time where demand exists. Logistics encompasses product movement as well as the location of plants and warehouses, procurement, inventory management, handling and order preparation, and transportation and delivery routing.

According to the definition provided by the UN/ECE and the ECMT (European Conference of Ministers of Transport), logistics is the process of designing and managing the supply chain in the broadest sense. This chain may encompass the supply of raw materials needed for production, material management at the production site, delivery to warehouses and distribution centers, and the sorting, handling, packaging, and final distribution to the point of consumption.

In English-language literature, logistics is defined as "designating the time required to position resources." Thus, two forms of logistics emerge: one that seeks to optimize material flow through a network of transport connections and storage nodes, and another that focuses on coordinating a specific set of resources to carry out an activity. Logistics encompasses activities aimed at harmonizing time and space with goods and people through their appropriate grouping.

Thus, logistics is defined as the integrated planning, organization, and control of all flows of goods and materials—along with their associated information flows—extending from suppliers, through value-creation stages, to product delivery to customers, and including recycling and waste disposal.

Based on the definition regarding the field of goods logistics, we can state that the logistician's mission is to deliver goods and services to the right place, at the right time, and under the required conditions, while ensuring the greatest possible contribution to the company's profit (Ciobanica, 2017).

According to James Heskett, logistics encompasses the set of activities involved in product flow and the coordination of resources and market outlets to achieve a specific service level at the lowest cost (The Council of Logistics Management, 1991).
In my view, logistics is a crucial link in any enterprise's operations—one that is difficult to ignore today, given the objective of maximizing profit while minimizing costs. Logistics is a key value-generating link that seeks to harmonize all component processes: from the real-time procurement of raw materials and their processing into finished products—meeting customer-set deadlines—to the final delivery to the customer at highly optimized costs.

3. Logistics management performance evaluation

Measuring performance in logistics is currently becoming a priority; its aims include identifying results, defining customer needs, fostering an understanding of processes, pinpointing internal issues requiring improvement, and ensuring that decisions are based on facts rather than assumptions, emotions, beliefs, or intuition (Ganescu, 2017, p. 17).

The purpose of establishing a logistics performance measurement system is to accurately determine positive or negative outcomes, identify and meet customer requirements, detect issues regarding the implementation of procedures—or the need to adapt and improve them—assess the utility and soundness of the decision-making process, and identify problems in the implementation of managerial decisions.

In logistics, performance measurement is carried out using qualitative and quantitative indicators designed to quantify both the efficiency and effectiveness of actions. Both process-based and strategy-based indicators are necessary at various levels and complement one another, facilitating the achievement of objectives at the respective organizational level. For instance, financial performance tools are important for strategic decision-making, whereas non-financial performance tools are useful for controlling and evaluating manufacturing and distribution operations. In practice, a combination of financial and non-financial performance tools proves most beneficial.

In the specialized literature, greater attention has been paid to individual measurement than to a performance measurement system. Thus, Kearney posited that "logistics management performance measurement must focus on the quality of logistics services, adopt a forward-looking perspective, and emphasize the importance of the consumer" (Kearney, 1991).

Based on a review of the specialized literature, authors Chris Caplice and Yossi Sheffi (1995, pp. 61–67) identified six criteria for evaluating logistics performance. Accordingly, a high-performing logistics system must be:

- Comprehensive (highlighting the impact of policies on every relevant stakeholder; for instance, an evaluation system containing only financial indicators might not be comprehensive, as it overlooks the consumer's perspective);
- Cause-oriented (highlighting the causes of phenomena—the elements driving performance—rather than just final outcomes; using cause-oriented metrics enhances the visibility of long-term objectives);
- Vertically integrated (enabling every decision-maker to understand and implement the organization's overall strategy, and linking indicators at each level to the corresponding reward system);

- Horizontally integrated (encompassing all activities, functions, and departments involved in the logistics system, thereby fostering the integration of operations across the entire logistics chain);
- Comparable with other internal performance dimensions (the logistics activity measurement system is defined in alignment with other internal evaluation systems, so as to drive performance);
- Useful (it becomes easy for decision-makers to understand and use, and serves as a guide for the actions to be taken).

Driven by the need to create appropriate reward systems, innovative and high-performing logistics firms strive to deliver value to consumers. The most commonly used options for evaluating logistics value are (Lambert and Burdurogiu, 2000, pp. 1-17):

a) Customer satisfaction arises when companies successfully fulfill their obligations across all components of the marketing mix—product, price, promotion, and distribution;

b) Customer-added value is reflected in the consumer's desire to obtain quality products at good prices;

c) Total cost analysis entails minimizing total logistics costs—including transportation, warehousing, inventory holding, order processing, information flows, purchasing, and production—while achieving a specific level of customer service, without regard for the impact on revenue;

d) Segment profitability analysis considers the impact of logistics on both costs and revenue at every level: consumers, trade categories, geographic areas, sales territories, and products;

e) The strategic profit model demonstrates how asset management influences asset returns through inventory reduction, increased sales, and the rapid market introduction of new products;

f) Shareholder value is secured when a business meets or exceeds a cost of capital that accurately reflects the risk assumed by the investor.

An effective logistics system must ensure customer satisfaction through flawless order fulfillment and enable the achievement of performance indicators; it must prevent lost sales by ensuring products are constantly available in stock, improve the organization's liquidity and avoid financial losses by maintaining optimal inventory levels, and drive business profitability by controlling and reducing logistics costs.

Performance measurement systems include: traditional systems (focused on results), those based on business excellence self-assessment, and the Balanced Scorecard (used to formulate organizational strategy, mission, and objectives, as well as to define appropriate performance tools and measurement indicators). Another perspective categorizes logistics performance measurement systems as either traditional or emerging in the Table 1 (Butilca, 2012).

Table 1. A comparison of the two systems highlights the long-term superiority of emerging systems

Traditional performance measurement systems	Emerging performance measurement systems
Based on the traditional accounting system	Based on organizational strategy
Based on cost/efficiency	Based on values
Focused on results and financial performance	Aligned strategy, objectives, and performance measurement tools
Profit-oriented	Customer-oriented
Short-term oriented	Long-term oriented
Predominance of individual and functional tools	Predominance of team-based and cross-functional tools
Comparison against standards	Monitoring improvements
Evaluation as the goal	Evaluation and engagement as the goal
Hinders continuous improvement	Supports continuous improvement

Source: Butilca, D.A., 2012. *Performanța in Supply Chain Management*, Cluj-Napoca. [pdf] Available at: <doctorat.ubbcluj.ro/sustinerea.../Butilca_Delia_%20Ro.pdf> [Accessed 12 February 2026].

Numerous emerging performance measurement systems highlight the interest in the continuous improvement of logistics operations. Notable examples include the Balanced Scorecard (BSC), the Results and Determinants Matrix (R&DM), the Strategic Measurement and Reporting Technique (SMART), the Cambridge Performance Measurement Questionnaire (CPMP), integrated performance measurement systems, and dynamic performance measurement systems.

The development of global logistics networks necessitated the evaluation of logistics performance at the national level and the establishment of tools to enable cross-country comparisons. Consequently, in 2007, World Bank experts created the first country ranking based on the Logistics Performance Index (LPI), derived from a survey of 800 international freight forwarders and carriers. The index evaluates logistics performance and provides, for the first time, an analysis of disparities between countries and regions within this economic sector. Calculated between 2007 and 2023, the Logistics Performance Index is based on six criteria: customs clearance efficiency (simplicity and predictability of customs procedures), quality of trade and transport infrastructure (ports, roads, information technology), international shipments (ease of arranging competitively priced international transport), competence and quality of logistics services, tracking and tracing (ability to locate shipments), and timeliness (frequency with which shipments reach the customer).

4. Conclusions

The main issues arising in the measurement of logistics performance stem from: the lack of links between organizational strategy and the performance measurement system, the priority given to financial indicators, and the use of numerous, isolated, and incompatible measurement tools (Holmberg, 2000, pp. 847–868).

In the context of supply chain management, aspects such as ethics, diversity, the environment, human capital competencies in logistics (Croitoru et al., 2026), human rights,

fair trade, health and safety, and corporate philanthropy have been studied in relation to the logistics function.

Organizations often voluntarily focus on ensuring responsible supply chain management, recognizing the long-term benefits for their businesses.

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