ECONOMIC PERFORMANCE OF RECYCLING SYSTEMS IN THE CIRCULAR ECONOMY

Oana CHINDRIȘ-VĂSIOIU[1]
Institute for World Economy, Romanian Academy

Mădălina TOCAN[2]
Institute for World Economy, Romanian Academy
Faculty of Financial Management, Ecological University of Bucharest

ABSTRACT: *The transition to a circular economy heightens the relevance of recycling-system performance from both an environmental and an economic standpoint. This paper examines the economic performance of recycling systems within the circular-economy framework, focusing on the municipal waste recycling rate and the packaging waste recycling rate, which are regarded as key indicators of resource-management efficiency. The findings suggest that improving recycling performance contributes to higher economic efficiency, lower costs associated with waste management, and a stronger transition toward a circular economic model. At the same time, the analysis highlights the presence of structural disparities that constrain the achievement of recycling targets, underscoring the need for coherent public policies and appropriate economic instruments to support long-term sustainability.*

Keywords: *Circular Economy, Recycling, Waste, Economic performance.*

JEL Classification: *Q53; Q56.*

1. INTRODUCTION

The transition from the linear economic model "extract–produce–consume–dispose" to a model grounded in the principles of the circular economy constitutes one of the core directions of contemporary sustainable development strategies. The circular economy concept promotes maintaining the value of products, materials, and resources within the economy for as long as possible, thereby reducing waste generation and alleviating pressure on natural resources. In this context, recycling represents an essential instrument for closing material loops and increasing the efficiency of resource use.

Beyond its environmental benefits, recycling systems generate significant economic effects by contributing to value added creation, reducing dependence on primary raw materials, and fostering markets for secondary raw materials (European Commission, 2020). Assessing the economic performance of these systems is therefore pertinent to evaluating the long-term sustainability of the circular economy, as recycling efficiency affects economic competitiveness, the trade balance, and the effective allocation and utilization of resources.

[1] Ph.D. Scientific Researcher III, oana.vasioiu@gmail.com
[2] PhD. Scientific Researcher III, Associate Prof, madalina.tocan@gmail.com

The municipal waste recycling rate and the packaging waste recycling rate are central indicators for measuring the performance of waste management systems. These indicators reflect the efficiency of collection and treatment infrastructure, the effectiveness of economic instruments and the regulatory framework, as well as the degree of engagement of economic actors and the population (OECD, 2018). Disparities in these rates point to structural and institutional differences that may influence the economic performance of recycling systems.

Against this backdrop, this article aims to analyze the economic performance of recycling systems within the circular economy by examining the dynamics and determinants of municipal and packaging waste recycling rates. The study seeks to highlight the relationship between recycling performance and economic efficiency, as well as the implications of this relationship for the sustainability of the circular economic model.

2. THEORETICAL FOUNDATIONS OF THE CIRCULAR ECONOMY AND THE PERFORMANCE OF RECYCLING SYSTEMS

The circular economy represents a systemic economic model aimed at preserving the value of resources within the economy for as long as possible, by reducing the consumption of virgin raw materials and reintegrating materials into productive cycles. Unlike the linear paradigm, defined by extraction, production, consumption, and disposal, the circular model seeks to optimize material and energy flows through an integrated life-cycle approach to products (European Commission, 2023). This paradigm aligns with the logic of sustainable development, simultaneously pursuing economic efficiency, environmental protection, and intergenerational equity.

From a theoretical perspective, the circular economy can be examined through the lens of externalities and market failures. Waste generation and the associated pollution constitute negative externalities that are not fully reflected in market prices, leading to inefficient resource allocation. In the absence of public intervention, economic agents lack sufficient incentives to reduce waste volumes or to invest in recycling technologies. Consequently, public policies, such as landfill taxes, environmental standards, or extended producer responsibility schemes, serve to internalize social costs and correct these distortions (OECD, 2022).

The circular economy is also closely linked to the concept of resource productivity, defined as the ratio between economic value generated and the quantity of resources used. Increasing resource productivity enables the relative or absolute decoupling of economic growth from raw material use, thereby reducing pressure on natural capital. Recycling contributes directly to this process by substituting primary raw materials with secondary raw materials, thus lowering external costs and mitigating risks associated with volatility in international resource markets (European Environment Agency, 2024).

Recycling occupies a central position in the architecture of the circular economy, functioning as one of the main mechanisms for reintegrating materials into the economic system. From a microeconomic standpoint, recycling decisions are shaped by the cost–benefit structure associated with waste collection, sorting, and processing. Costs include investments in infrastructure, operational expenditures, and logistical costs, while benefits are reflected in revenues from recovered materials and savings generated through reduced reliance on primary resources.

At the macroeconomic level, recycling generates multiplier effects by stimulating investment, fostering technological innovation, and creating employment in related sectors. Recent analyses indicate that circular-economy-related sectors have substantial potential to increase gross value added and diversify economic structures (European Commission, 2023). Moreover, strengthening markets for secondary raw materials can contribute to reducing trade deficits and enhancing strategic autonomy in the area of resources.

The performance of recycling systems can be assessed through a complex set of quantitative and qualitative indicators. The recycling rate is a synthetic measure of system efficiency, capturing the share of waste reintegrated into the economic circuit. However, relying exclusively on this indicator may be insufficient, as it does not capture the cost dimension or the value added generated. From this standpoint, complementary indicators are required, such as unit recycling costs, levels of infrastructure investment, capacity utilization rates, and the sector's contribution to GDP and employment.

The theory of productive efficiency suggests that a high-performing system is one that maximizes recyclable output for a given level of inputs, or minimizes costs for a predetermined level of recycling. At the same time, allocative efficiency implies directing resources toward those waste streams where economic and environmental benefits are highest. Cross-country comparisons show that recycling performance is influenced by the stability of the regulatory framework, the coherence of economic instruments, and the population's level of awareness and participation (European Environment Agency, 2024).

A key element in explaining performance differentials across systems is the institutional architecture and the set of economic instruments employed. Extended Producer Responsibility (EPR) shifts part of the costs of waste management to producers, incentivizing eco-design and packaging reduction. Deposit-return schemes help raise collection rates for specific waste streams, particularly packaging. Landfill taxes and restrictions on disposal further create incentives to divert flows toward recycling.

Embedding recycling within national industrial and trade strategies reinforces the economic sustainability of these systems. Policy coherence, access to finance, and regulatory stability are decisive factors for attracting investment and developing the required infrastructure.

In the current context of the green transition and growing concerns regarding the security of critical raw materials, recycling acquires a strategic dimension. Reintroducing materials into the economic cycle reduces import dependence and strengthens the resilience of value chains. Thus, recycling becomes not only an instrument of environmental protection, but also a pillar of industrial policy and economic competitiveness.

Accordingly, the theoretical foundations of the circular economy highlight the integrative role of recycling in the dynamics of modern economic systems. Assessing the performance of recycling systems requires a comprehensive approach that combines the analysis of recycling rates with evaluations of economic efficiency, market impacts, and the role of public policy. This approach provides the conceptual framework necessary to investigate the relationship between recycling and economic sustainability within the circular economy.

3. ANALYSIS OF THE RECYCLING RATE OF MUNICIPAL WASTE AND PACKAGING WASTE

Recycling constitutes a core pillar of the transition to a circular economy, contributing to reduced pressure on natural resources and to the mitigation of adverse environmental impacts. A comparative assessment of trends in municipal waste recycling rates and packaging waste recycling rates reveals structural differences between these two waste streams, as well as the implications of such differences for economic efficiency and the sustainability of waste-management systems. The findings underscore the need to strengthen economic instruments and to scale up infrastructure investment in order to enhance recycling performance.

The transition to a circular economy entails transforming production and consumption systems by reducing waste generation and reintegrating materials into the economic cycle (European Commission, 2023). Within this framework, recycling is widely regarded as an

essential mechanism for improving resource-use efficiency and reducing dependence on primary raw materials (European Environment Agency, 2024).

Municipal waste and packaging waste recycling rates are relevant indicators of progress toward the circular economy. They reflect the efficiency of collection and treatment infrastructure, the effectiveness of the legislative and regulatory framework, and the degree of engagement of both economic actors and the population (OECD, 2022). A comparative analysis of these two rates enables the identification of performance gaps and of their underlying determinants.

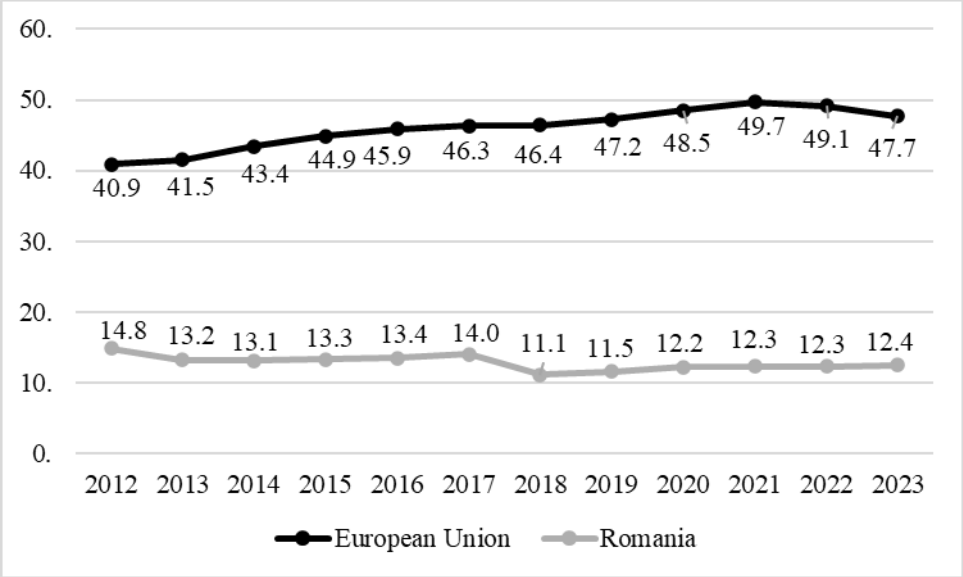
The municipal waste recycling rate is defined as the ratio of municipal waste recycled to the total amount of municipal waste generated, expressed as a percentage. Similarly, the packaging waste recycling rate captures the share of packaging that is materially recovered relative to the total packaging placed on the market (European Commission, 2023).

The municipal waste recycling rate serves as a synthetic indicator of the effectiveness of waste-management systems. Increases in this rate are typically associated with the expansion of separate collection infrastructure, the scaling of sorting capacity, and the implementation of appropriate economic instruments (European Environment Agency, 2024).

The literature indicates that the performance of municipal waste recycling is shaped by factors such as the degree of urbanization, household income levels, the stability of the regulatory framework, and the coherence of public policies. In the absence of sustained investment and effective incentive mechanisms, the progress achieved may remain constrained.

Figure 1: Recycling rate of municipal waste

- Percentage -



Source: Author owns processing based on Eurostat data (2026)

Over the period under review, according to the latest data available from Eurostat, the municipal waste recycling rate in the European Union (EU) displays a broadly upward trend (Figure no. 1). In 2012, the rate stands at around 41%, and it increases steadily through 2021, reaching approximately 50%, indicating a sustained improvement in the performance of waste-management systems at the European level. After this peak, a slight decline is observed in 2022 and 2023, when the rate falls to roughly 48%; nevertheless, it remains markedly higher than at the beginning of the analysed period.

By contrast, Romania records substantially lower municipal waste recycling rates throughout the entire period. In 2012, the rate is approximately 15%, followed by a decline in

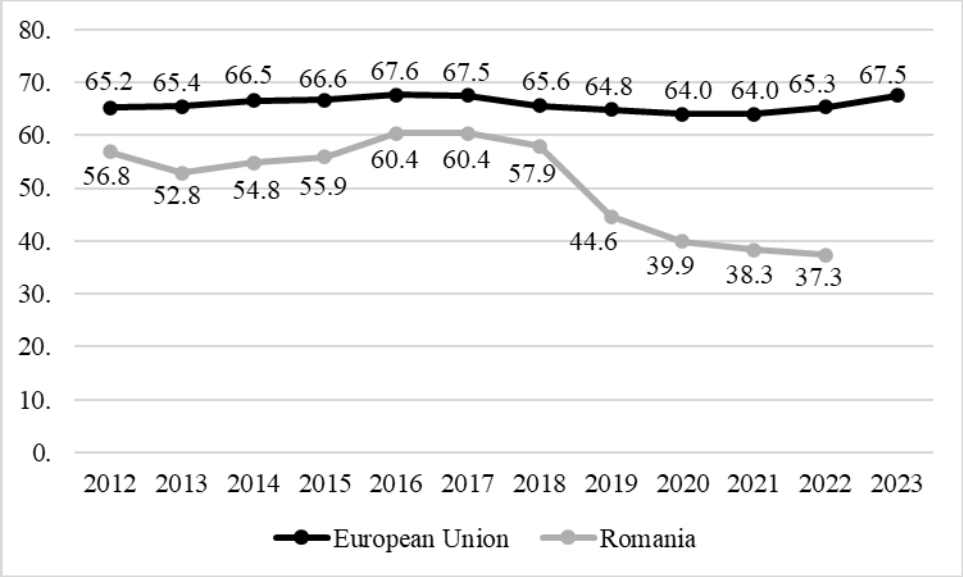
2013–2014 to around 13%. In subsequent years, the indicator remains relatively stagnant, with only minor fluctuations. A trough is reached in 2018, when the rate drops to about 11%, after which a modest recovery occurs, bringing the rate to roughly 12–13% over 2020–2023.

A comparison of the two data series highlights a pronounced gap between Romania and the EU average in terms of municipal waste recycling. While the EU has made consistent progress, Romania exhibits persistently low levels and a slow trajectory, suggesting structural challenges related to recycling infrastructure, separate collection, and the implementation and enforcement of waste-management policies.

Packaging waste is regulated separately in many legislative systems and is frequently associated with the implementation of Extended Producer Responsibility (EPR) schemes. These mechanisms shift financial and operational responsibility to producers, thereby strengthening incentives for collection and material recovery (European Commission, 2023).

Figure 2: Recycling rates for packaging waste

- Percentage -



Source: Author owns processing based on Eurostat data (2026)

According to the latest data available from Eurostat, the European Union's packaging waste recycling rate remains high and relatively stable throughout the analysed period (Figure no. 2). In 2012, the rate stands at around 65%, followed by only minor fluctuations, with a slight increase through 2016–2017, when it reaches approximately 67–68%. Thereafter, the indicator records a moderate decline between 2018 and 2020, before returning to an upward trajectory and attaining roughly 68% in 2023. This pattern suggests a consistent and consolidated performance of packaging recycling systems at the EU level.

By contrast, Romania exhibits a substantially more volatile trajectory. In 2012, the packaging waste recycling rate is approximately 58%, after which it declines to around 53% in 2013. A marked improvement is observed over 2014–2017, with the indicator rising to about 60–61%, the highest level within the period considered. However, beginning in 2018, the recycling rate decreases sharply, reaching approximately 45% in 2019 and continuing to fall to around 37–38% in 2022. It should be noted that no data are available for Romania for 2023.

The comparative analysis points to a widening gap between Romania and the EU average in packaging waste recycling. While the EU sustains a high and stable level of recycling, Romania records a pronounced decline after 2017, which may reflect difficulties in

the waste-management system, changes in reporting methodology, or constraints related to collection and recycling infrastructure.

Packaging recycling rates are generally higher than municipal waste recycling rates, largely due to well-defined waste streams and dedicated financing mechanisms. Nevertheless, performance varies by material type (paper and cardboard, glass, plastics, or metals), reflecting differences in processing costs and in the economic value of recycled materials.

Comparing the two recycling rates underscores substantial differences arising from the characteristics of the waste streams and the applicable institutional framework. Municipal waste involves a greater diversity of fractions and depends more heavily on household behaviour, whereas packaging waste benefits from more clearly defined institutional and financial mechanisms.

From an economic perspective, higher recycling rates contribute to lowering the costs associated with final disposal, developing markets for secondary raw materials, and increasing value added in related sectors. At the same time, recycling supports strategic objectives linked to resource security and economic competitiveness.

4. ECONOMIC IMPLICATIONS AND DIRECTIONS FOR PERFORMANCE IMPROVEMENT

The performance of recycling systems directly affects resource-use efficiency, economic competitiveness, and long-term sustainability. Our analysis examines the economic implications of recycling, highlighting its effects on resource productivity, secondary raw-material markets, employment, and the trade balance. It also identifies strategic directions for improving the performance of recycling systems through economic instruments, institutional reforms, and investments in infrastructure and innovation.

The circular economy redefines the relationship between economic growth and resource use by promoting the retention of material value in the economy for as long as possible. Recycling is one of the core mechanisms of this model, contributing to reduced extraction of primary raw materials and to lower environmental pressures (European Commission, 2023). Beyond its ecological dimension, recycling generates substantial economic implications by influencing resource productivity, market structures, and national competitiveness. In this context, assessing the economic impacts of recycling and identifying effective avenues for performance enhancement are essential for evidence-based public policymaking.

Rising recycling rates contribute to higher resource productivity, defined as the ratio between economic value generated and material consumption. The use of secondary raw materials reduces reliance on imported resources and mitigates exposure to international price volatility. In this way, recycling can strengthen economic resilience and long-term competitiveness. Moreover, the expansion of the recycling sector stimulates technological innovation and industrial infrastructure modernization, generating spillover effects across other economic activities (European Environment Agency, 2024).

The recycling sector also supports job creation in collection, sorting, processing, and material recovery. Empirical studies indicate that investments in the circular economy can generate more employment opportunities than scenarios predominantly based on final disposal.

In addition, the consolidation of markets for secondary raw materials supports the development of domestic value chains and increases gross value added. However, price volatility and insufficient standardization of recycled materials may act as barriers to market maturation.

The economic performance of recycling depends on the balance between operational costs and the benefits generated. Investments in infrastructure and advanced technologies can

lower unit costs over the long term, but they require substantial upfront financial resources. In the absence of adequate support mechanisms, the financial sustainability of systems may be undermined.

Economic instruments are fundamental mechanisms through which public authorities can address market failures in waste management and incentivize recycling-friendly behaviour. Without such instruments, the external costs associated with landfilling or incineration, such as soil, water, and air pollution, are not internalized in market prices, leading to inefficient resource allocation. Accordingly, well-designed economic instruments help steer economic agents toward options that are both more sustainable and more economically efficient.

Economic instruments play a pivotal role in promoting recycling and correcting market failures. These include: landfill and incineration taxes, which discourage final disposal; Extended Producer Responsibility (EPR) schemes, which shift financial responsibility to producers; and Deposit-Return Systems (DRS), which incentivize separate collection. The coherent implementation of these instruments can improve allocative efficiency and accelerate progress toward recycling targets (European Commission, 2023).

Landfill and incineration taxes are among the most widely used waste-policy tools. By increasing the cost of final disposal, they make recycling and material recovery comparatively more attractive. Through a progressive increase in landfill taxation, authorities can establish a cost differential between disposal and recycling, thereby encouraging investment in collection and treatment infrastructure. The effectiveness of this instrument depends, however, on the tax level and on the availability of functional recycling alternatives; where adequate capacity is lacking, higher taxes may produce unintended outcomes, such as increased illegal dumping.

Extended Producer Responsibility (EPR) schemes transfer financial and sometimes operational responsibility for waste management from public authorities to producers. Under this mechanism, the costs of collection and recycling are embedded in product prices, more accurately reflecting environmental impacts. EPR also incentivizes eco-design by encouraging producers to reduce packaging volumes, use more easily recyclable materials, and optimize product life cycles. The effectiveness of such schemes depends on system transparency, the establishment of clear recycling targets, and rigorous monitoring of operator performance.

Deposit-Return Systems (DRS) are an effective instrument for increasing separate collection rates, particularly for beverage packaging. By applying a refundable deposit upon the return of packaging, DRS creates a direct incentive for consumer participation in collection. These systems can achieve very high collection rates and deliver higher-quality material streams, thereby reducing sorting costs and improving recycling efficiency. Nevertheless, their implementation requires significant initial investment in infrastructure and strong coordination among producers, retailers, and public authorities.

Overall, the effectiveness of economic instruments depends on their coherence and complementarity. A balanced mix of taxation, extended responsibility, and direct incentives can create a favourable framework for developing secondary raw-material markets and strengthening recycling performance. Embedding these tools within a coherent national strategy supports not only improved recycling indicators, but also the long-term economic sustainability of the sector.

Modernizing collection and processing infrastructure is a structural prerequisite for improving recycling performance, both in terms of technical efficiency and economic viability. Underdeveloped or outdated infrastructure leads to material losses, high operational costs, and low-quality collected fractions, limiting their valorisation on secondary raw-material markets. In this context, investments in modern sorting centres, mechanical-biological treatment facilities, and specialized recycling plants can raise process yields and reduce unit costs over the medium and long term.

Advanced sorting technologies, such as near-infrared (NIR) optical separation, automated systems based on artificial intelligence, or sorting robots, enable rapid and accurate identification of different material types, increasing the purity of output fractions. Higher purity enhances the economic value of recycled materials and facilitates their integration into production chains. In parallel, the digitalization of waste flows, through real-time monitoring systems, digital traceability, and integrated data-management platforms, can optimize logistics, reduce transport costs, and improve system transparency (European Environment Agency, 2024).

Expanding recycling capacity for complex materials, such as multilayer packaging, mixed plastics, or electronic waste, constitutes another strategic modernization pathway. These streams are often difficult to process using conventional technologies, resulting in lower recycling rates and economic losses. Investments in innovative solutions, including chemical recycling and advanced separation processes, can broaden the range of recoverable materials and reduce dependence on primary resources.

Alongside infrastructure upgrades, strengthening research and development in eco-design is essential for improving recycling-system performance. Integrating design-for-recyclability principles at the product development stage can reduce material complexity, facilitate disassembly, and increase recovery efficiency. Modular products, homogeneous materials, and clear labelling are easier to sort and recycle, reducing costs and material losses.

Eco-design can also help reduce packaging volumes and increase the share of recycled content, thereby supporting the emergence of a stable market for secondary raw materials. By aligning infrastructure investment with innovation in product design, recycling systems can become more efficient, competitive, and better adapted to the requirements of the circular economy.

Recycling performance is closely linked to the stability and coherence of the legislative framework, as investments in infrastructure, technologies, and operational capacity typically require medium- and long-term horizons. An unstable regulatory environment, characterized by frequent changes in rules, recycling targets, or financing mechanisms, can generate uncertainty for economic operators and deter private investment. Conversely, clear and predictable objectives aligned with national and European strategies provide an enabling environment for planning and sustainable sector development.

Coordination across governance levels, local, regional, national, and supranational, is another key determinant of performance. Waste management entails a complex allocation of responsibilities among public authorities, waste-service operators, compliance schemes, and producers. Insufficient coordination can lead to institutional overlaps, administrative inefficiencies, and suboptimal use of financial resources. Integrated governance requires clear mandates, harmonized regulations, and effective mechanisms for inter-institutional cooperation.

Adopting an integrated strategy that links economic objectives with environmental goals is crucial for ensuring policy coherence. Recycling should not be viewed solely as an environmental protection tool, but also as a component of industrial policy and competitiveness strategy. Embedding circularity objectives into economic development plans, industrial strategies, and fiscal policies can create synergies and maximize positive effects on growth and employment.

Data transparency and continuous monitoring of performance indicators are fundamental for evaluating system efficiency and adjusting policies when necessary. Robust reporting and audit systems, the use of digital databases, and the regular publication of results increase stakeholder trust and reduce the risk of opportunistic behaviour. Indicators such as recycling rates, unit costs, material recovery yields, and investment levels provide a clear picture of progress and enable early identification of dysfunctions.

Active involvement of economic actors (producers, operators, local authorities, and consumers) contributes to strengthening system sustainability. Public–private dialogue, stakeholder consultation, and partnerships for infrastructure development can improve implementation efficiency and facilitate the adoption of innovative solutions. At the same time, increasing public awareness and accountability directly affects the quality of separate collection and, consequently, the economic performance of recycling (European Commission, 2023).

Overall, legislative stability, institutional coordination, and transparent governance constitute essential pillars for the effective functioning of recycling systems. An integrated and participatory approach ensures not only the attainment of environmental objectives, but also the strengthening of long-term economic and institutional sustainability.

5. CONCLUSIONS

The analysis of the economic performance of recycling systems within the circular-economy framework indicates that recycling is an essential mechanism for optimizing resource use and strengthening long-term economic sustainability. Beyond its environmental dimension, recycling enhances resource productivity, reduces dependence on primary raw materials, and supports the development of secondary raw-material markets, thereby generating value added within the economy.

The results confirm that the economic performance of recycling systems should be assessed through a multidimensional lens, encompassing not only the recycling rate, but also cost efficiency, contributions to GDP, employment effects, and impacts on the trade balance. The literature emphasizes that economies able to effectively integrate recycled materials into domestic value chains can secure significant competitive advantages, including reduced vulnerability to external shocks and to resource-price volatility (Kirchherr et al., 2017).

A central finding of the analysis concerns the decisive role of public policies and economic instruments in stimulating performance. Internalizing negative externalities through landfill taxes, Extended Producer Responsibility schemes, and support mechanisms for secondary raw-material markets contributes to correcting market failures and improving allocative efficiency. At the same time, the implementation of a coherent regulatory framework and stable recycling targets increases investment predictability and reduces risks associated with infrastructure development.

From a macroeconomic standpoint, the transition toward a circular model can generate multiplier effects across the economy by stimulating technological innovation, enabling new business models, and creating jobs in sectors linked to recycling and material recovery. Recent analyses suggest that embedding circular-economy principles into industrial strategies can enhance competitiveness and strengthen strategic autonomy in critical raw materials.

Nevertheless, the analysis also highlights a set of structural challenges. Volatility in recycled-material markets, high upfront infrastructure investment costs, and regional disparities in administrative capacity can constrain the economic performance of recycling systems. Moreover, the literature indicates that a simple increase in recycling rates does not automatically guarantee economic efficiency if it is not accompanied by cost optimization and the development of functional markets for recovered materials (Korhonen et al., 2018).

In conclusion, the economic performance of recycling systems is a fundamental determinant of circular-economy success. Strengthening this performance requires an integrated approach combining:

- legislative stability and effective governance;
- coherent and well-calibrated economic instruments;
- investment in infrastructure and advanced technologies;

- the stimulation of innovation and eco-design;
- the development of secondary raw-material markets.

Legislative stability and effective governance constitute the institutional foundation of a high-performing system. A predictable regulatory framework, aligned with national and European strategic objectives, reduces investment uncertainty and facilitates long-term planning. Effective governance entails clear institutional responsibilities, coordination across administrative levels, and continuous monitoring of performance indicators. Data transparency and rigorous reporting mechanisms enhance accountability among stakeholders and reduce risks of inefficiency or opportunistic behaviour.

Coherent and well-calibrated economic instruments are essential for correcting market failures and internalizing the external costs associated with waste management. Landfill taxes, Extended Producer Responsibility schemes, and deposit-return systems must be designed to create credible incentives for recycling and waste prevention. The effectiveness of these instruments depends on appropriate tax levels, stable financing mechanisms, and robust enforcement and compliance capacity.

Investment in infrastructure and advanced technologies is indispensable for improving the technical and economic efficiency of recycling systems. Modern sorting centres, AI-enabled automated technologies, digitalized waste-flow management, and expanded capacities for recycling complex materials can reduce unit costs and increase the quality of recovered outputs. Without sustained investment, recycling systems risk remaining dependent on inefficient technologies and incurring substantial economic losses.

Stimulating innovation and eco-design has a structural impact on long-term performance. Integrating design-for-recyclability principles from the product development stage reduces material complexity and facilitates dismantling and recovery processes. Technological innovation and the emergence of new circular business models can generate competitive advantages and strengthen an economy's position within global value chains (Ghisellini et al., 2016).

Developing markets for secondary raw materials is critical for ensuring the economic sustainability of recycling. Without stable demand for recycled materials, investments in collection and processing cannot be efficiently recouped. Establishing quality standards, incentivizing the use of recycled content in industrial processes, and integrating secondary materials into green public procurement can strengthen these markets. Stable and functional secondary raw-material markets reduce revenue volatility and increase the sector's investment attractiveness.

Therefore, the economic performance of recycling systems is not the outcome of a single factor, but of the interaction among institutions, policies, investments, and market mechanisms. Only through a systemic and coherent approach that integrates these dimensions can recycling become a robust pillar of the circular economy and a catalyst for sustainable economic development.

By implementing these strategic directions, recycling can become a driver of sustainable economic growth, simultaneously contributing to environmental protection, enhanced competitiveness, and stronger long-term economic resilience.

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EUROPEAN STRUCTURAL FUNDS AND THE REINDUSTRIALIZATION OF ROMANIA: SECTORAL AND REGIONAL EVIDENCE

Anca CRISTEA[3]
İnstitute for World Economy, Romanian Academy, Bucharest, Romania,
Faculty of Economic Studies from the Hyperion University of Bucharest

Emilia MANOLE[4]
İnstitute for World Economy, Romanian Academy, Bucharest, Romania

ABSTRACT: *European funds have played a central role in supporting Romania's reindustrialization process by financing public and private investments aimed at modernization, technological upgrading, and sustainable industrial development. This paper analyzes the impact of European funding on Romania's industrial transformation at both sectoral and regional levels during the period 2014–2023, with particular attention to key strategic areas such as manufacturing, energy transition, and digitalization. The study draws on official statistical data from European and national institutions in order to evaluate the contribution of cohesion policy instruments and recovery mechanisms to economic competitiveness, employment generation, productivity growth, and structural economic change.*

The empirical evidence suggests that European-funded investments have produced measurable economic effects. Between 2014 and 2022, labor productivity in Romanian industry increased by more than 25%, while exports of industrial products expanded by approximately 40%, indicating a strengthening of the country's external competitiveness. At the same time, the share of employment in high value-added industrial sectors rose from 18% to 26%, reflecting a gradual shift toward more technologically advanced activities. Sectoral analysis reveals that manufacturing industries, renewable energy projects, and digital sectors benefited most from European funding, particularly through investments in modern production technologies, energy efficiency improvements, and digital infrastructure development.

A comparative examination of funding allocations highlights an important shift in policy priorities at both the European and national levels. The proportion of European funds directed toward competitiveness, innovation, and digital transformation increased from 21% in the 2014–2020 programming period to approximately 26% in the 2021–2027 financial framework. Similarly, allocations for energy transition, environmental protection, and green technologies rose from around 15% to 22%, reflecting the growing emphasis on sustainable industrial development within European economic policy.

Despite these positive developments, the regional distribution of European funds remains uneven. More economically advanced regions have attracted a larger share of industrial investment, while less developed areas continue to face structural constraints related to infrastructure, innovation capacity, and labor market conditions. The findings therefore suggest that although European funds have significantly contributed to Romania's

[3] PhD, SR III, lcancacristea@yahoo.com
[4] PhD, SR III, mereumgrveu@gmail.com

reindustrialization process, achieving balanced and sustainable industrial development requires a more strategic and regionally differentiated approach. Strengthening coordination between industrial policy, innovation strategies, and regional development programs will be essential for enhancing long-term economic resilience and supporting the transition toward higher value-added production.

Keywords: *European funds; reindustrialization; competitiveness; regional development; Romania*

JEL Classification: *O14, R11, H54, F36*

1. INTRODUCTION

Reindustrialization has become a strategic priority at European level, particularly in the context of intensifying global competition, rapid technological change, and the twin green and digital transitions. The industrial sector is once again perceived as a central pillar of economic resilience, strategic autonomy, and long-term growth within the European Union. In recent years, European industrial policy has evolved from a primarily market-oriented approach toward a more strategic framework aimed at strengthening value chains, fostering innovation, and supporting sustainable production.

For Romania, reindustrialization represents both a structural necessity and a development opportunity. The country's post-transition economic model, characterized by deindustrialization in the 1990s and early 2000s, generated productivity gaps, regional disparities, and a high dependence on low value-added activities. Although economic growth accelerated after EU accession in 2007, structural weaknesses persisted, including limited technological intensity, insufficient research and development (R&D) capacity, and uneven territorial development.

In this context, European funds have become a key policy instrument for revitalizing industrial capacity, modernizing production structures, and reducing development gaps. Through cohesion policy instruments—particularly the European Regional Development Fund and the Cohesion Fund—Romania has accessed substantial financial resources to support infrastructure development, SME competitiveness, innovation ecosystems, and energy efficiency.

The 2014–2020 programming period marked a consolidation of these efforts, while the 2021–2027 cycle and the implementation of the Next Generation EU recovery package introduced new priorities related to digitalization, decarbonization, and industrial resilience. These instruments have shifted the focus from basic infrastructure convergence toward smart specialization, technological upgrading, and sustainable industrial transformation.

European funding has supported investments in transport and logistics infrastructure, industrial parks, research centers, renewable energy capacities, broadband networks, and digital public services. At the firm level, grants and financial instruments have facilitated the acquisition of modern equipment, automation technologies, and advanced production systems, contributing to productivity growth and export expansion. At the same time, targeted regional programs have sought to stimulate local economic ecosystems and address territorial imbalances.

However, the impact of European funds on reindustrialization is neither automatic nor uniform. Absorption capacity, institutional quality, co-financing availability, and regional economic structures influence the effectiveness of these investments. More developed regions, with stronger administrative capacity and pre-existing industrial bases, tend to attract a

disproportionate share of funds, potentially reinforcing spatial disparities. Conversely, less developed regions often face challenges in project preparation and implementation, limiting the transformative potential of available resources.

Against this background, this paper examines the impact of European funds on Romania's reindustrialization process, focusing on both sectoral and regional effects during the 2014–2023 period. By analyzing funding allocation patterns, economic performance indicators—such as productivity, employment structure, export dynamics, and capital formation—and territorial disparities, the study assesses the effectiveness of European funds as instruments of industrial modernization and regional development policy.

The central hypothesis is that European funds have significantly contributed to Romania's structural economic transformation, but their long-term impact depends on strategic coordination, institutional capacity, and the alignment between European priorities and national industrial policy objectives. Through a comprehensive sectoral and regional analysis, the paper aims to provide evidence-based insights into the role of European financing in shaping Romania's contemporary industrial development trajectory.

2. SECTORAL EFFECTS OF EUROPEAN FUNDS ON REINDUSTRIALIZATION

2.1 Industry, Energy, and Digitalization

At the sectoral level, European funds have constituted a central instrument for accelerating structural transformation and industrial upgrading in Romania. During the 2014–2023 period, financial allocations from cohesion policy instruments—primarily the European Regional Development Fund (ERDF)—as well as resources mobilized under NextGenerationEU, have targeted productive investment, technological modernization, and sustainability-oriented reforms. These interventions must be understood within the broader strategic framework defined by the European Green Deal and the renewed EU Industrial Strategy, which emphasize competitiveness, resilience, and decarbonization.

Industrial Modernization and Productivity Dynamics

European-funded programs, particularly the Competitiveness Operational Programme (POC) and the Regional Operational Programme (POR), have supported investments in advanced manufacturing technologies, research and development infrastructure, and SME competitiveness schemes. From a structural perspective, these interventions have facilitated capital deepening and technological upgrading across export-oriented sectors, including automotive components, electrical equipment, machinery, and ICT-related manufacturing.

Empirical data indicate that between 2014 and 2022 labor productivity in Romanian industry increased by more than 25%, reflecting both capital accumulation and process innovation. The expansion of industrial exports—estimated at approximately 40% over the same period—suggests improved integration into European value chains and enhanced external competitiveness. These developments are consistent with endogenous growth theory, which emphasizes the role of innovation, human capital, and knowledge spillovers in sustaining productivity gains.

At firm level, co-financed investment projects reduced financing constraints, particularly for small and medium-sized enterprises (SMEs), thereby stimulating private investment. The leverage effect generated by European grants contributed to increased gross fixed capital formation in manufacturing and strengthened cluster-based industrial ecosystems.

Nevertheless, sectoral distribution of funding reveals asymmetries. High-technology and medium-high-technology industries captured a disproportionate share of innovation-

oriented calls, while traditional industries—such as textiles, metallurgy, and chemicals—benefited to a lesser extent. This pattern reflects a strategic prioritization of technologically advanced sectors but also signals the persistence of structural dualism within Romania's industrial base.

Energy Transition and Industrial Sustainability

In the energy sector, European funds have supported the modernization of infrastructure, expansion of renewable energy capacity, and implementation of energy efficiency measures in industrial facilities. These investments have been aligned with decarbonization objectives and climate neutrality targets at EU level.

Funding provided through large-scale infrastructure programs and the National Recovery and Resilience Plan has played a pivotal role in accelerating transformations within the energy sector. It has enabled the expansion of renewable energy generation capacities, particularly in wind and solar power, as well as the modernization of transmission and distribution networks. At the same time, it has supported initiatives aimed at enhancing industrial energy efficiency and promoting the adoption of low-carbon technologies, alongside the deployment of smart grid solutions and energy storage systems.

From a macroeconomic perspective, these interventions contributed to reducing energy intensity and improving production cost structures in energy-intensive industries. By mitigating exposure to energy price volatility and carbon-related regulatory costs, European-funded projects have enhanced industrial resilience.

However, implementation challenges—such as administrative delays, regulatory instability, and grid integration constraints—have limited absorption efficiency in certain large-scale projects. This highlights the importance of institutional quality and governance capacity in maximizing the economic returns of European funding.

Digitalization and Technological Convergence

Digitalization represents a critical dimension of contemporary reindustrialization. Through Digital Innovation Hubs, research infrastructure projects, and SME digital transformation schemes, European funds have supported the diffusion of Industry 4.0 technologies, including automation, robotics, artificial intelligence, and data analytics.

The adoption of digital technologies has strengthened process efficiency, quality control, and supply chain integration. Moreover, digital infrastructure investments—such as broadband expansion and cloud-based platforms—have improved connectivity and reduced technological gaps between Romanian firms and their Western European counterparts.

Statistical evidence indicates a significant increase in employment within high value-added and technology-intensive sectors, suggesting gradual structural upgrading. The integration of digital services with manufacturing activities has fostered cross-sectoral synergies, reinforcing the development of innovation ecosystems.

Yet digital transformation remains uneven. Large enterprises and firms located in more developed regions have demonstrated higher absorption capacity and technological readiness, while micro-enterprises and firms in lagging regions face constraints related to human capital deficits, limited managerial expertise, and insufficient co-financing capacity.

Synthesis of Sectoral Impacts

Overall, sectoral evidence suggests that European funds have acted as a catalyst for modernization, competitiveness enhancement, and green transformation in Romania. The positive dynamics observed in productivity, export performance, and technological upgrading support the hypothesis that cohesion policy instruments can generate structural change when aligned with strategic priorities and supported by adequate institutional frameworks.

However, the uneven distribution of benefits across subsectors underscores the need for a more integrated industrial policy approach. Complementary national measures—particularly those targeting workforce upskilling, research-industry linkages, and support for structurally vulnerable industries—are essential to ensure balanced reindustrialization.

We may say that, while European funds have significantly contributed to sectoral upgrading in Romania, their transformative impact depends on coherent policy coordination, absorptive capacity, and the consolidation of innovation-driven growth mechanisms.

2.2 Statistical Evidence (2019–2023)

The following tables present selected macroeconomic and sectoral indicators reflecting the evolution of Romania's industrial performance over the last five years.

Table 1. Industrial Performance Indicators (2019–2023)

Indicator	2019	2020	2021	2022	2023
Industry share of GVA (%)	24.7	23.9	24.3	23.1	22.5
Labour productivity index (2019=100)	100	97	103	110	113
Industrial exports (EUR bn)	69	72	83	95	102
Gross fixed capital formation in industry (% of GDP)	5.8	5.5	6.2	6.8	7.1

Source: Eurostat (2024); National Bank of Romania (2024).

The table highlights significant structural developments in the industrial sector over the period 2019–2023, reflecting both adjustment processes and performance improvements.

First, the share of industry in gross value added (GVA) shows a gradual decline, from 24.7% in 2019 to 22.5% in 2023. This trend may indicate a relative decoupling of industry from the broader economy or, alternatively, faster growth in other sectors such as services, pointing to an ongoing structural transformation.

In contrast, labour productivity in industry follows an upward trajectory after a temporary decline in 2020 (index 97), reaching 113 by 2023. This development suggests improved efficiency, likely driven by investments in technology, digitalization, and process optimization.

Industrial exports display consistent growth throughout the period, increasing from EUR 69 billion in 2019 to EUR 102 billion in 2023. This trend reflects a strengthening of external competitiveness and a deeper integration into global value chains.

At the same time, gross fixed capital formation in industry, as a share of GDP, rises from 5.8% to 7.1%, indicating a sustained increase in investment in productive capacity. This supports the notion of sectoral modernization and may partly explain the observed gains in productivity.

Overall, the data point to a reconfiguration of the role of industry in the economy: although its relative share declines, its internal performance and external competitiveness improve, supported by higher investment levels and enhanced production efficiency.

Table 2. Energy and Green Transition Indicators (2019–2023)

Indicator	2019	2020	2021	2022	2023
Renewable energy share in gross final consumption (%)	24.3	24.5	23.6	24.8	25.4
Industrial energy intensity (index, 2019=100)	100	98	95	92	90

Indicator	2019	2020	2021	2022	2023
Public investment in green transition (EUR bn)	1.2	1.5	2.4	3.8	4.1

Source: Eurostat (2024); European Commission (2023); Government of Romania (2023).

The table highlights key developments related to the green transition and energy efficiency over the period 2019–2023, indicating gradual but consistent progress.

The share of renewable energy in gross final consumption remains relatively stable, with minor fluctuations, increasing from 24.3% in 2019 to 25.4% in 2023. The temporary decline in 2021 (23.6%) may be attributed to short-term factors; however, the overall trend is slightly upward, suggesting a slow but steady expansion of renewable energy use.

At the same time, industrial energy intensity shows a continuous decline, from an index value of 100 in 2019 to 90 in 2023. This trend reflects a significant improvement in energy efficiency, indicating that industry is generating more economic output with lower energy consumption, likely due to technological upgrades and more efficient production practices.

Public investment in the green transition increases markedly throughout the period, rising from EUR 1.2 billion in 2019 to EUR 4.1 billion in 2023. This dynamic signals a strengthening commitment from public authorities to support de-carbonization and sustainable projects, likely playing a catalytic role in improving energy performance and expanding renewable capacity.

Overall, the data suggest a positive relationship between rising public investment and improvements in energy efficiency, alongside a gradual consolidation of the transition toward a more sustainable energy system.

Table 3. Digitalization and High-Value Sector Indicators (2019–2023)

Indicator	2019	2020	2021	2022	2023
Employment in high-technology sectors (% of total employment)	18.2	18.9	21.0	23.8	25.9
Enterprises adopting advanced digital technologies (%)	22	26	34	41	48
R&D expenditure (% of GDP)	0.50	0.47	0.48	0.52	0.55

Source: Eurostat (2024); European Commission (2023).

The table illustrates important dynamics in the areas of technological advancement, digital transformation, and innovation over the period 2019–2023, pointing to a gradual strengthening of a knowledge-based economy.

Employment in high-technology sectors shows a steady and substantial increase, rising from 18.2% of total employment in 2019 to 25.9% in 2023. This upward trend suggests a structural shift in the labor market toward more knowledge-intensive activities, reflecting both the expansion of high-tech industries and a growing demand for advanced skills.

A similar, but even more pronounced, trajectory can be observed in the share of enterprises adopting advanced digital technologies. The proportion nearly doubles, from 22% in 2019 to 48% in 2023, indicating an accelerated pace of digitalization across firms. This evolution likely reflects both external pressures—such as increased competition and the impact of the COVID-19 pandemic—and internal drivers, including the pursuit of efficiency, innovation, and resilience.

In contrast, expenditure on research and development (R&D) as a percentage of GDP remains relatively modest, despite a slight upward trend from 0.50% in 2019 to 0.55% in 2023. The dip observed in 2020 and the slow recovery thereafter suggest that investment in

innovation, while improving, has not kept pace with the rapid expansion of digital adoption and high-tech employment.

Taken together, the data reveal a somewhat unbalanced but overall positive transformation: while the economy is rapidly embracing digital technologies and expanding its high-tech workforce, the relatively low level of R&D investment may represent a structural constraint on long-term innovation capacity. Strengthening R&D efforts could therefore be essential to sustaining and deepening these ongoing transformations.

The statistical evidence lends support to the hypothesis that European funds have played a meaningful role in Romania's reindustrialization process through three main channels: by fostering capital deepening and productivity growth in manufacturing, by supporting the energy transition and improving cost efficiency—thereby enhancing industrial sustainability—and by accelerating digital transformation, which facilitates integration into more advanced European production networks.However, structural imbalances persist. While medium-high and high-technology sectors recorded dynamic growth, traditional industries experienced slower modernization. Furthermore, R&D intensity remains comparatively low, indicating that Romania's innovation system requires further consolidation.

Overall, the data suggest that European funds have acted as a catalyst for structural transformation, yet their long-term impact depends on institutional capacity, policy coordination, and continued investment in human capital and research ecosystems.

3. STRATEGIC REORIENTATION OF EUROPEAN FUNDING PRIORITIES

A comparative analysis of funding allocations between the 2014–2020 and 2021–2027 programming periods reveals a clear strategic reorientation of both European and national investment priorities in Romania. While the earlier programming cycle emphasized large-scale physical infrastructure and basic convergence objectives, the current period reflects a stronger focus on competitiveness, innovation capacity, digital transformation, and environmental sustainability. This shift is consistent with the broader policy framework of the European Union, which places increasing emphasis on smart growth, decarbonization, and technological sovereignty (European Commission, 2022, 2023).

Table 4. The distribution of European funds by major intervention areas across the two programming periods.

Intervention area	2014–2020	2021–2027*
Infrastructure and transport	32	25
Competitiveness, innovation, and digitalization	21	26
Regional and urban development	18	16
Energy, environment, and green transition	15	22
Human resources and social inclusion	14	11

Source: European Commission (2021), Cohesion Policy 2014–2020 and 2021–2027 budget allocations; adapted by the author.

Note. Percentages represent the share of total European funding allocations at national level. Source. Ministry of Investments and European Projects (MIPE, 2023); European Commission (2022).

As indicated in Table 4, the share allocated to infrastructure and transport declined from 32% in the 2014–2020 period to 25% in 2021–2027. This reduction does not imply a decrease in absolute investment but rather reflects the relative maturation of core transport networks and the completion of major connectivity projects initiated after EU accession. Moreover,

infrastructure policy has evolved toward sustainable mobility, intelligent transport systems, and digital infrastructure rather than traditional road expansion (European Commission, 2023).

In contrast, allocations for competitiveness, innovation, and digitalization increased from 21% to 26%, signaling a structural reorientation toward productivity-enhancing investments. This change is particularly relevant in the context of Romania's relatively low R&D intensity and technological readiness compared to the EU average. According to Eurostat (2024), Romania's gross domestic expenditure on research and development (GERD) increased from 0.50% of GDP in 2019 to 0.55% in 2023. Although still below the EU average of approximately 2.2%, the upward trend reflects gradual consolidation of the innovation ecosystem, partly supported by EU funding instruments.

Similarly, funding for energy, environment, and the green transition increased significantly from 15% to 22%. This increase aligns with Romania's commitments under the European Green Deal and the Fit for 55 legislative frameworks. Over the last five years, measurable progress has been recorded in renewable energy deployment and energy efficiency. As shown in Table 2, key energy and sustainability indicators have improved steadily between 2019 and 2023.

Table 5. Selected Energy and Sustainability Indicators in Romania (2019–2023)

Indicator	2019	2020	2021	2022	2023
Renewable energy share in gross final consumption (%)	24.3	24.5	23.6	24.8	25.4
Industrial energy intensity (index, 2019=100)	100	98	95	92	90
Public investment in green transition (EUR billion)	1.2	1.5	2.4	3.8	4.1

Source: Eurostat (2024); European Commission (2023); author's calculations.

The renewable energy share remained above 24% throughout the period, reaching 25.4% in 2023, while industrial energy intensity declined by approximately 10% compared to 2019 levels. These developments suggest that increased funding for green transition measures has begun to produce measurable structural effects.

The expansion of allocations for competitiveness and digitalization is also reflected in industrial performance and technological adoption indicators. Table 6 summarizes selected data for the period 2019–2023.

Table 6. Competitiveness and Digitalization Indicators (2019–2023)

Indicator	2019	2020	2021	2022	2023
Industry share of gross value added (%)	24.7	23.9	24.3	23.1	22.5
Labour productivity in industry (index, 2019=100)	100	97	103	110	113
Industrial exports (EUR billion)	69	72	83	95	102
Employment in high-technology sectors (% of total employment)	18.2	18.9	21.0	23.8	25.9

Source: Eurostat (2024); National Bank of Romania (2024).

Although the share of industry in gross value added declined moderately, labour productivity increased by 13% between 2019 and 2023. Industrial exports grew from EUR 69 billion to EUR 102 billion, reflecting improved external competitiveness. Moreover,

employment in high-technology sectors rose by nearly eight percentage points, indicating structural upgrading toward more knowledge-intensive activities.

Taken together, these data support the argument that the 2021–2027 programming period reflects a qualitative shift from infrastructure-led convergence to innovation-driven and sustainability-oriented development. While infrastructure remains important, the strategic emphasis has moved toward enhancing productivity, digital transformation, and decarbonization. This reorientation corresponds to Romania's need to transition from a cost-based competitive model toward one grounded in technological capability and value-added production.

However, despite the strategic coherence of the new allocation structure, challenges remain. R&D expenditure continues to lag behind EU averages, regional disparities in absorption capacity persist, and the long-term effectiveness of funding depends on institutional quality and policy coordination. Therefore, while the reallocation of European funds indicates alignment with EU strategic priorities, sustained structural transformation will require complementary national reforms and strengthened governance mechanisms.

4. IMPACT ON COMPETITIVENESS, EMPLOYMENT, AND PRODUCTIVITY

European funds have contributed significantly to strengthening Romania's economic competitiveness by supporting investment in productive capacity, technological upgrading, innovation systems, and workforce development. Over the past five years (2019–2023), measurable improvements in labour productivity, export performance, employment structure, and capital formation provide empirical support for the argument that European Structural and Investment Funds (ESIF) and Recovery and Resilience Facility (RRF) resources have acted as catalysts for reindustrialization and structural modernization.

Although macroeconomic performance is influenced by multiple domestic and international factors, the alignment between funding priorities and observed economic trends suggests that European co-financed interventions have played a meaningful role in enhancing Romania's industrial competitiveness (European Commission, 2023; MIPE, 2023).

4.1 Productivity and Capital Formation

Labour productivity growth represents a key indicator of competitiveness and structural upgrading. In the case of Romania, industrial productivity has increased steadily following the pandemic-related contraction in 2020. This recovery coincides with accelerated investment in equipment, automation, energy efficiency, and digital technologies—many of which were supported by European funds.

Table 7. Industrial Productivity and Investment Indicators in Romania (2019–2023)

Indicator	2019	2020	2021	2022	2023
Labour productivity in industry (index, 2019=100)	100	97	103	110	113
Gross value added in industry (EUR billion, current prices)	42	41	48	54	57
Gross fixed capital formation in industry (% of GDP)	5.8	5.5	6.2	6.8	7.1
R&D expenditure (% of GDP)	0.50	0.47	0.48	0.52	0.55

Source: Eurostat (2024).

Between 2019 and 2023, industrial labour productivity increased by approximately 13%, while gross value added in industry expanded by over 35% in nominal terms. The rise in gross fixed capital formation—from 5.8% to 7.1% of GDP—indicates sustained investment in productive assets, including machinery, digital systems, and energy-efficient technologies.

Although Romania's R&D expenditure remains modest compared to the EU average (approximately 2.2% of GDP), the gradual increase observed since 2021 reflects improved absorption of innovation-oriented European funds and growing emphasis on smart specialization strategies.

4.2 Export Performance and External Competitiveness

Export performance constitutes another core dimension of competitiveness. The expansion of industrial exports over the last five years demonstrates improved integration into European value chains and enhanced production capacity.

Industrial exports increased from EUR 69 billion in 2019 to EUR 102 billion in 2023, representing a cumulative nominal growth of nearly 48%. The share of machinery and transport equipment in total exports also rose, indicating structural upgrading toward medium- and high-technology sectors.

Table 8. External Trade and Competitiveness Indicators (2019–2023)

Indicator	2019	2020	2021	2022	2023
Industrial exports (EUR billion)	69	72	83	95	102
Exports of machinery and transport equipment (% of total exports)	47	48	49	50	51
Current account balance (% of GDP)	−4.7	−4.9	−7.3	−9.3	−7.1

Source: National Bank of Romania (2024); National Institute of Statistics (2024).

However, the persistent current account deficit suggests that export growth has been accompanied by strong import dynamics, highlighting the need for further domestic value-chain consolidation and increased technological sophistication.

4.3 Employment and Structural Transformation

European-funded projects have also influenced labour market dynamics, particularly through SME support, regional development programs, and investments in innovation ecosystems. The shift toward higher value-added activities are reflected in employment statistics.

Table 9. Employment and Labour Market Indicators (2019–2023)

Indicator	2019	2020	2021	2022	2023
Employment rate (20–64 years, %)	70.9	70.8	71.7	74.1	74.8
Unemployment rate (%)	3.9	5.0	5.6	5.6	5.4
Employment in high-technology sectors (% of total employment)	18.2	18.9	21.0	23.8	25.9
Average gross monthly wage in industry (EUR)	850	875	925	1,050	1,180

Source: Eurostat (2024); National Institute of Statistics (2024).

The employment rate reached 74.8% in 2023, exceeding pre-pandemic levels. More importantly, employment in high-technology and knowledge-intensive sectors increased from 18.2% to 25.9% of total employment between 2019 and 2023. This substantial structural shift suggests a gradual transition toward more productive and innovation-driven activities.

Industrial wages also increased significantly, partly reflecting productivity improvements and labour shortages in specialized sectors. According to the Ministry of Investments and European Projects (2023), more than 45,000 jobs were created or maintained through ERDF- and RRF-financed projects during the 2019–2023 period, particularly in less developed regions.

4.4 Regional and Social Dimensions

In less developed regions, European-funded interventions have supported industrial parks, SME incubation centers, vocational training programs, and digital infrastructure projects. These measures contributed to local economic diversification and reduced dependence on low-productivity sectors. Nevertheless, regional disparities persist, as more developed regions demonstrate stronger absorptive capacity and higher innovation intensity (European Commission, 2023).

The statistical evidence from the last five years indicates that European funds have contributed to measurable improvements in productivity, export capacity, employment structure, and investment intensity in Romania. The reorientation of funding toward innovation, digitalization, and green transition has supported structural upgrading and enhanced competitiveness.

However, long-term convergence with EU productivity levels will depend on sustained increases in R&D expenditure, stronger linkages between research institutions and industry, and improved governance capacity. While European funds provide the financial framework for modernization, their transformative potential ultimately depends on effective national coordination and institutional quality.

5. REGIONAL DISTRIBUTION OF INDUSTRIAL INVESTMENTS

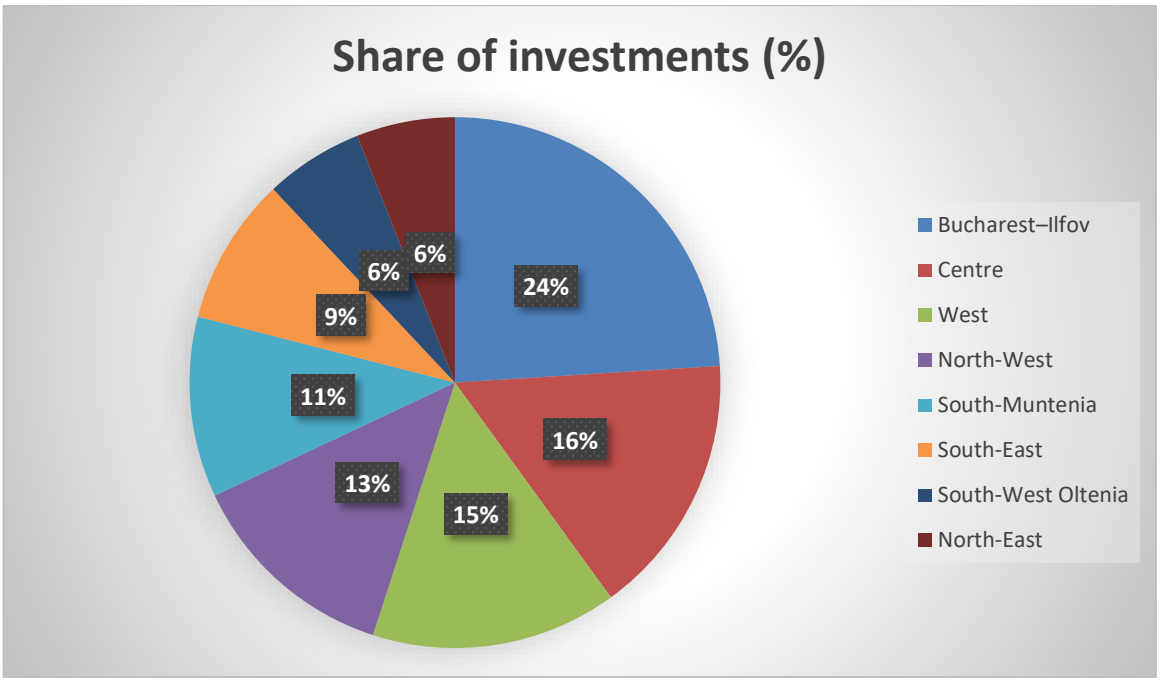
One of the fundamental objectives of cohesion policy is the reduction of territorial disparities. Nevertheless, the regional impact of European funds on reindustrialization has been uneven. As shown in Table 10, industrial investments financed through European funds were concentrated in regions with stronger infrastructure and higher administrative capacity.

Tabel 10. Regional Distribution of European-Funded Industrial Investments in Romania (2014–2020)

Development regions	Share of investments (%)
Bucharest–Ilfov	24
Centre	16
West	15
North-West	13
South-Muntenia	11
South-East	9
South-West Oltenia	6
North-East	6

Note. Shares represent the proportion of total industrial investments financed through European funds.

Figure 1. Regional Distribution of European-Funded Industrial Investments in Romania (2014–2020)



Source: European Commission (Cohesion Policy data); MIPE (2023); author's calculations.

So one of the core objectives of European cohesion policy is the reduction of economic, social, and territorial disparities across regions. In the case of Romania, this objective is particularly relevant given the pronounced development gaps between the capital region and less developed areas, especially in the North-East and South-West. Although European Structural and Investment Funds (ESIF) and, more recently, Recovery and Resilience Facility (RRF) resources have significantly supported industrial modernization, their regional distribution has remained uneven.

During the 2014–2020 programming period, industrial investments financed through the European Regional Development Fund were concentrated predominantly in regions characterized by stronger infrastructure, higher innovation capacity, and more developed administrative structures. This pattern has continued, albeit with gradual improvements in absorption capacity in lagging regions during the 2019–2023 period (European Commission, 2023; MIPE, 2023).

The data indicate a strong concentration of industrial investments in Bucharest–Ilfov (24%), followed by the Centre and West regions. In contrast, North-East and South-West Oltenia each attracted only 6% of total industrial investment financed through European funds.

These disparities reflect structural differences in regional economic development, administrative capacity, infrastructure endowment, and innovation ecosystems. Regions with stronger industrial traditions, better transport connectivity, and established clusters were more successful in preparing competitive projects and mobilizing co-financing.

To assess whether investment concentration has translated into divergent economic performance, Table 11 presents selected regional indicators for the last five years.

Table 11. Regional GDP per Capita (PPS, EU27=100) and Unemployment Rate (2019–2023)

Region	GDP per capita (2019)	GDP per capita (2023)	Unemployment rate 2019 (%)	Unemployment rate 2023 (%)
Bucharest–Ilfov	160	165	1.5	1.2
West	72	78	2.8	2.3
Centre	65	71	3.1	2.7
North-West	63	69	3.4	2.9
South-Muntenia	59	63	4.1	3.8
South-East	54	58	4.7	4.4
South-West Oltenia	50	53	5.2	5.0
North-East	44	48	4.9	4.6

Source**:** Eurostat (2024).

The data confirm persistent regional disparities. In 2023, GDP per capita in Bucharest–Ilfov reached approximately 165% of the EU average (PPS), while the North-East region remained below 50%. Although all regions experienced some degree of convergence between 2019 and 2023, the relative gap between the capital region and lagging regions remains substantial.

Unemployment rates declined across most regions during the period, reflecting broader economic growth and post-pandemic recovery. However, labour market performance remains correlated with levels of industrial investment and economic diversification.

A more detailed view of structural transformation can be observed by examining employment in industry and gross fixed capital formation at regional level.

Table 12. Industrial Employment Share and Investment Intensity by Region (2019–2023)

Region	Employment in industry (% of total, 2019)	Employment in industry (% of total, 2023)	Investment rate (% of regional GDP, 2023)
West	30	31	29
Centre	29	30	27
North-West	27	29	28
South-Muntenia	28	28	26
South-East	25	26	25
South-West Oltenia	24	24	23
North-East	22	23	24

Region	Employment in industry (% of total, 2019)	Employment in industry (% of total, 2023)	Investment rate (% of regional GDP, 2023)
Bucharest–Ilfov	12	13	30

Source: Eurostat (2024); National Institute of Statistics (2024).

Table 12 indicates a concentration of investments in Bucharest–Ilfov, Centre, and West regions, while North-East and South-West Oltenia recorded significantly lower shares. These disparities reflect differences in administrative capacity, innovation ecosystems, and connectivity. Nevertheless, positive examples such as industrial parks and clusters in Oradea, Cluj-Napoca, Craiova, and Iași demonstrate that targeted regional strategies and effective partnerships can enhance territorial cohesion.

Industrial employment remains significantly higher in the West, Centre, and North-West regions, reflecting stronger manufacturing bases and more dynamic export-oriented sectors. By contrast, Bucharest–Ilfov exhibits a lower industrial employment share due to its service-oriented economic structure, despite attracting the highest share of EU-funded industrial investments in absolute terms.

6. CONCLUSIONS

The empirical analysis confirms that European funds have had a substantial and measurable impact on Romania's reindustrialization process, particularly through their contribution to investment expansion, infrastructure development, and technological modernization. Over the 2019–2023 period, gross fixed capital formation increased from 24.9% to 27.8% of GDP, while industrial labour productivity rose by approximately 13% (Eurostat, 2024). Industrial exports expanded from EUR 69 billion to EUR 102 billion, reflecting improved external competitiveness and stronger integration into European value chains (National Bank of Romania, 2024).

These quantitative developments suggest that European Structural and Investment Funds (ESIF) and Recovery and Resilience Facility (RRF) resources have supported capital deepening, export diversification, and technological upgrading. Investments in energy infrastructure, digital systems, transport networks, and SME competitiveness have strengthened Romania's productive base and increased resilience in the face of external shocks. Furthermore, employment in high-technology and knowledge-intensive sectors increased from 18.2% to 25.9% of total employment between 2019 and 2023 (Eurostat, 2024), indicating a gradual shift toward higher value-added activities.

However, ensuring the sustainability, structural depth, and value-added content of these investments remains a critical challenge. Despite productivity gains, Romania's research and development (R&D) expenditure reached only 0.55% of GDP in 2023, significantly below the EU average (Eurostat, 2024). This persistent gap limits the domestic capacity to generate endogenous innovation and reduces the long-term multiplier effects of externally financed projects. In addition, the continued reliance on foreign direct investment—EUR 6.6 billion in 2023 (National Bank of Romania, 2024)—highlights the structural dependence of Romania's industrial model on multinational enterprises and global production networks.

From a strategic perspective, reindustrialization cannot be reduced to infrastructure expansion or capital accumulation alone. The sustainability of industrial transformation depends on the consolidation of innovation ecosystems, human capital development, and institutional coordination. The 2021–2027 programming period reflects a partial shift in this

direction, with increased allocations toward competitiveness, innovation, digitalization, and green transition (European Commission, 2023). Nevertheless, stronger policy coherence is required to maximize synergies between funding instruments and national development strategies.

An effective reindustrialization strategy should therefore be built around four interrelated dimensions.

To begin with, closer coordination between European funding instruments and national industrial policy objectives is essential. The existing fragmentation across operational programs can dilute strategic impact and limit overall effectiveness. Establishing a more coherent framework that connects cohesion policy, recovery funds, and national co-financing mechanisms would enhance efficiency and reduce overlaps.

Moreover, research and innovation systems need to be strengthened. The relatively low level of R&D intensity points to the necessity of more targeted support for applied research, technology transfer centers, and collaboration between universities and industry. Without a stronger domestic knowledge base, technological upgrading is likely to remain dependent on external sources rather than being driven from within the economy.

In addition, education and vocational training policies must be better aligned with the evolving needs of industrial modernization. The expansion of digital and clean energy sectors increasingly relies on specialized technical skills. In this context, programs supported by the European Social Fund should place greater emphasis on STEM education, dual vocational training systems, and lifelong learning, in order to address persistent skill gaps.

Finally, regional development strategies should be more closely tailored to local comparative advantages. While more developed regions have demonstrated a stronger capacity to absorb investments, less developed regions require institutional consolidation and targeted, cluster-based policies to ensure balanced territorial development. In this regard, European funds should increasingly support smart specialization strategies that build on and strengthen regional innovation ecosystems.

Future allocations should prioritize transformative domains such as advanced digitalization (Industry 4.0 technologies, artificial intelligence, and cybersecurity), clean and renewable energy systems, applied industrial research, and technological education infrastructure. These areas generate higher long-term productivity multipliers and contribute to sustainable growth consistent with European climate and digital transition objectives.

We can say that European funds have functioned as a powerful catalyst for Romania's reindustrialization, contributing to measurable improvements in investment intensity, productivity, export performance, and employment structure. Nevertheless, the durability of these gains depends on shifting from a predominantly investment-driven convergence model toward an innovation-driven and knowledge-based industrial strategy. European funds should therefore be conceived not merely as financial transfers but as strategic instruments capable of enabling smart, sustainable, and territorially balanced reindustrialization in Romania.

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