

COMPETITIVENESS AND INNOVATION IN THE CONTEXT OF THE CIRCULAR ECONOMY

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ABSTRACT: *In a globalized economy, competitiveness and innovation are essential factors for sustainable development. In this context, the circular economy offers an efficient and sustainable growth model, promoting waste reduction, efficient use of resources and regeneration of materials. The paper analyzes the impact of the integration of circular economy principles on competitiveness and highlights the role of innovation as a driver of the transition to a more sustainable economic model. The study explores the improvement of economic and ecological performance, highlighting the benefits of implementing innovative technologies and policies favorable to the circular economy. The conclusions highlight the need for an integrated approach, where innovation and sustainability have become fundamental pillars of long-term competitiveness.*

Keywords: *Competitiveness, Innovation, Circular Economy, Sustainability.*

JEL Classification: Q55; Q56.

1. INTRODUCTION

The circular economy is a model of production and consumption in which existing materials and products are reused, repaired, refurbished, and recycled whenever possible. In this way, the product life cycle is extended. In practice, this means minimizing waste. At the end of a product's life cycle, its materials are preserved as economically as possible through recycling. Recycled materials can be used productively to create new value. This represents a shift away from the traditional linear economic model, which relies on large quantities of cheap and readily available materials and energy.

The European Union generates over 2.2 billion tons of waste each year and constantly updates its waste management legislation to promote the transition to a more sustainable model, known as the circular economy. Reusing and recycling products would slow down the consumption of natural resources, reduce landscape and habitat disruption, and help limit biodiversity loss.

Another benefit of the circular economy is the reduction of total annual greenhouse gas emissions. According to the European Environment Agency, industrial processes and product

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use account for 9.10% of the EU's greenhouse gas emissions, while waste management represents 3.32% [1].

It is estimated that more than 80% of a product's environmental impact is determined at the design stage, so creating more efficient and durable products from the outset will help reduce energy and resource consumption. Shifting to more reliable products that can be reused, upgraded, and repaired will lead to a reduction in waste. Packaging is an increasingly pressing issue, with an average European generating nearly 180 kg of packaging waste per year. The EU aims to improve packaging design to encourage reuse and recycling.

The transition to a circular economy could enhance competitiveness, drive innovation, boost economic growth, and create jobs -700,000 jobs in the EU alone by 2030. Redesigning materials and products for circular use would also foster innovation across various economic sectors. Consumers would benefit from more durable and innovative products, improving their quality of life and saving them money in the long run [1].

The European Union's circular economy policy has been strengthened in recent years, but it has not yet become sufficiently mandatory or well-directed to accelerate Europe's transition to a regenerative economy. This means shifting from the current focus on waste to a more direct use of resources. Developing a circular economy is a key component of the EU's efforts to combat climate change and pollution. Europe's heavy dependence on natural resources for materials, food, and fuel has a significant environmental and climate impact. However, after a rapid increase in resource consumption, this trend has recently stabilized, with EU GDP rising while overall material consumption has slightly declined. At the same time, Europe's reliance on global imports for raw materials, metal ores, and fossil fuels is increasing amid a more challenging geopolitical landscape.

The EU is taking measures to transition to a circular economy, which means abandoning linear production and consumption models. In recent years, Europe has made positive strides toward a circular economy, including higher recycling rates and the emergence of circular business models, such as the sharing economy.

By 2022, Europe had consumed more recycled materials than any other region in the world. However, progress in the EU has been slow, and the ambitious goal of doubling the level of circular economic activity by 2030 remains far from being achieved. Many circular economic policies are still relatively new, and some have yet to be fully implemented at the national level. Moreover, it will take time for the impact of these measures to ripple through business models, consumption patterns, and ultimately, resource use.

Future actions, such as setting targets and promoting higher-quality recycling - where materials retain their original function and value for as long as possible - will be crucial in strengthening the EU's resource independence and reducing imports. In addition to implementing eco-design principles, it is also essential to enhance circularity by maximizing product lifespan through reuse, repair, and refurbishment [2].

2. INNOVATION AND COMPETITIVENESS: PILLARS OF THE CIRCULAR ECONOMY FOR A SUSTAINABLE FUTURE

Innovation in the circular economy plays a crucial role in promoting sustainable production and reducing resource waste. By adopting circular economy strategies such as recycling and reuse, companies can manage resources efficiently and minimize environmental impact. Green innovation and corporate sustainability are key aspects of this process, and implementing resource efficiency policies and proper waste management can significantly contribute to achieving these goals.

By offering sustainable products and services, companies can support the circular economy and sustainable production. These represent innovative and advanced solutions that

help reduce environmental impact and ensure the efficient use of resources. Companies must recognize the importance of adopting sustainable practices and provide products and services that meet current needs without compromising the ability of future generations to meet their own.

Sustainable products and services can take various forms, including eco-friendly technologies, recyclable materials, and energy-efficient production processes. For example, some companies are involved in the production of lithium-ion batteries, which have a lower environmental impact and can be fully recycled. These batteries can be used in various industries, including logistics, to optimize equipment efficiency and performance.

In the following sections, we will analyze the latest available Eurostat data regarding competitiveness and innovation within the circular economy monitoring framework.

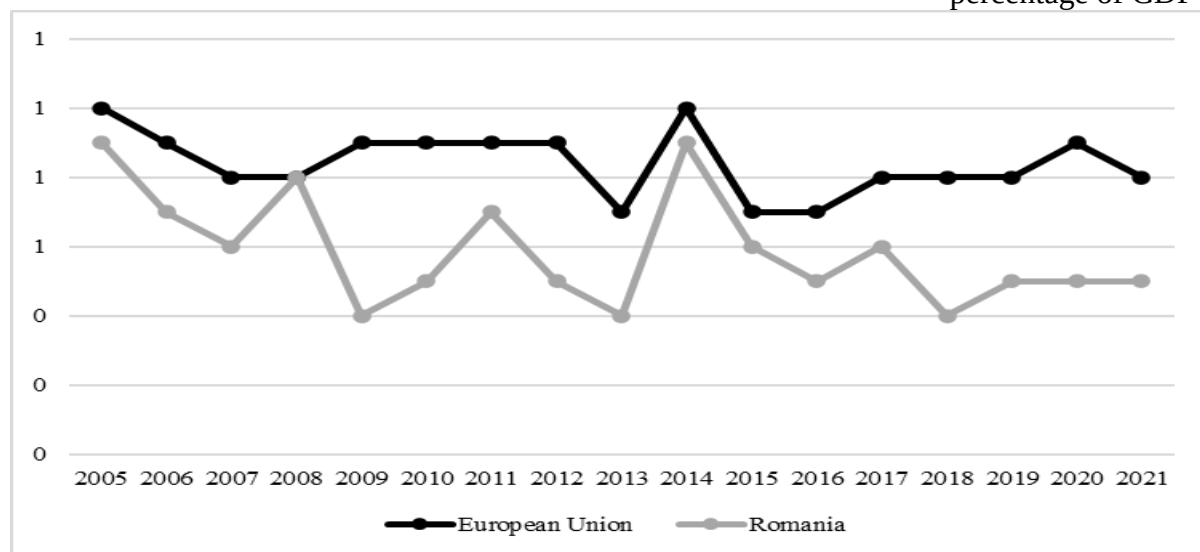
2.1. Private Investment, Jobs and Gross Value Added Related to Circular Economy Sectors – Indicators of Competitiveness

Private investments, jobs, and gross value added related to circular economy sectors are key indicators used to monitor progress toward a circular economy within the thematic area of "competitiveness and innovation." Innovation and investments (in eco-design, secondary raw materials, recycling processes, and industrial symbiosis) are essential elements of the transition to a circular economy. The circular economy can make a significant contribution to job creation and economic growth.

Analyzing job trends and the growth of relevant sectors helps determine whether the transition to a circular economy is delivering the expected results. Sectors closely linked to the circular economy, such as recycling, repair, and reuse, require a large workforce and contribute to local employment. It is important to note that the analyzed sectors represent only a subset of the broader economic impact of the circular economy [3].

Figure 1. Private investment related to circular economy sectors

- percentage of GDP -

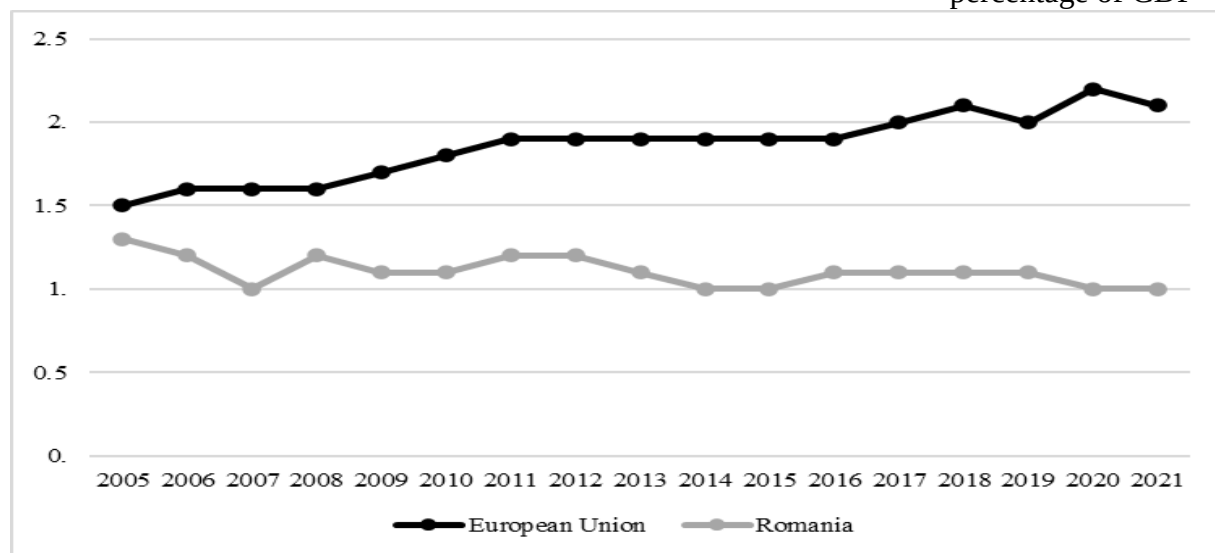


Source: Author owns processing based on Eurostat data (2025)

Private investments in circular economy sectors in Romania have generally been below the EU average, fluctuating between 0.4% and 0.9% of GDP between 2005 and 2021. The only year in which they reached the EU average was 2008, with 0.8% of GDP (Figure 1).

Figure 2. Gross added value related to circular economy sectors

- percentage of GDP -

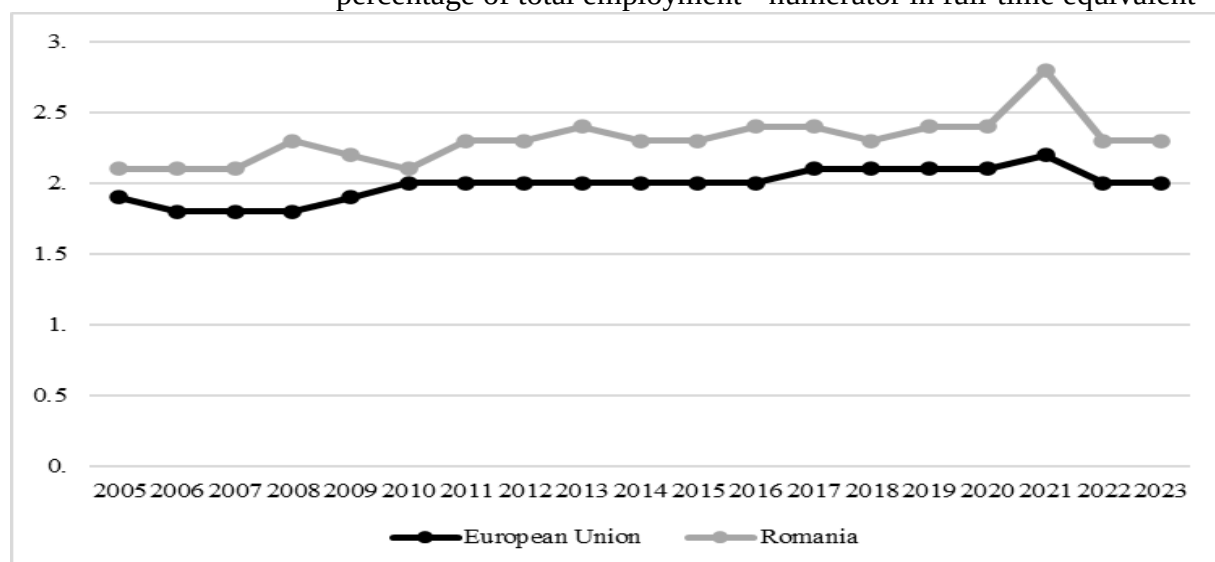


Source: Author owns processing based on Eurostat data (2025)

The gross value added in circular economy sectors in Romania has followed a downward trend, decreasing from 1.3% of GDP in 2005 to 1% of GDP in 2021, while the EU average has followed an upward trend during the same period, reaching 2.1% of GDP in 2021 (Figure 2). The gap between Romania and the EU average has been steadily increasing.

Figure 3. People employed in circular economy sectors

- percentage of total employment - numerator in full-time equivalent -



Source: Author owns processing based on Eurostat data (2025)

The employment level in circular economy-related sectors in Romania, measured as a percentage of total full-time employees, was above the EU average between 2005 and 2023, fluctuating between 2.1% and 2.8%, while the EU average ranged from 1.8% to 2.2%. The highest employment level in Romania's circular economy sectors was recorded in 2021 (Figure 3).

2.2. Patents Related to Waste Management and Recycling - Indicator of Innovation

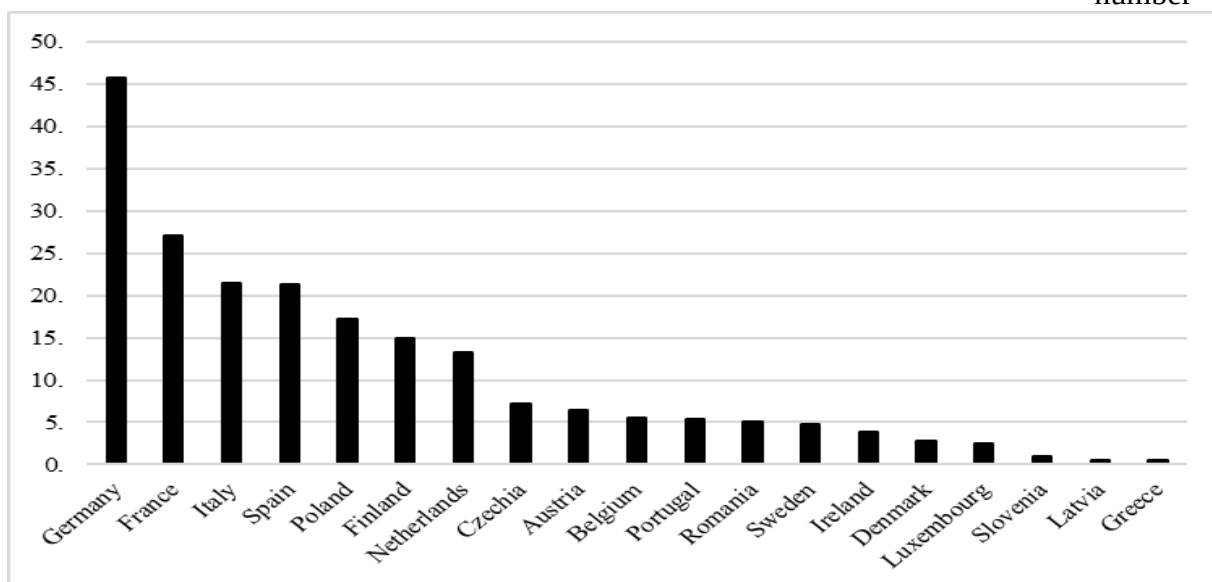
Waste management and recycling-related patents are an indicator used to monitor progress toward a circular economy within the thematic area of "competitiveness and innovation." Innovation will necessarily play a key role in the transition to a circular economy by developing new technologies, processes, services, and business models. Patent statistics are one of the widely used indicator families for assessing technological progress in a specific industrial sector. They are widely accepted as result-oriented indicators of innovation.

Recently, for example, the number of patent applications has been used as an indicator in the Raw Materials Scoreboard. The development of innovative techniques for waste collection, transport, storage, and especially material recycling will help reduce the EU's dependence on critical commodities, strengthen its resilience to potential disruptions in material supply, and support the competitiveness of domestic industries. The number of patent families in these fields thus provides insight into innovation activity in recycling and material reuse technologies within the EU, as well as in the global context [4].

This indicator measures the number of patents related to recycling and secondary raw materials. The term "patents" refers to patent families, which include all relevant documents for a distinct invention (e.g., applications submitted to multiple authorities), thereby preventing multiple counting. While the indicator provides insight into the most relevant innovative recycling technologies, it does not cover all waste management technologies or other circular economy-related services and business models. It is also important to highlight that not all relevant innovations are or can be patented [4].

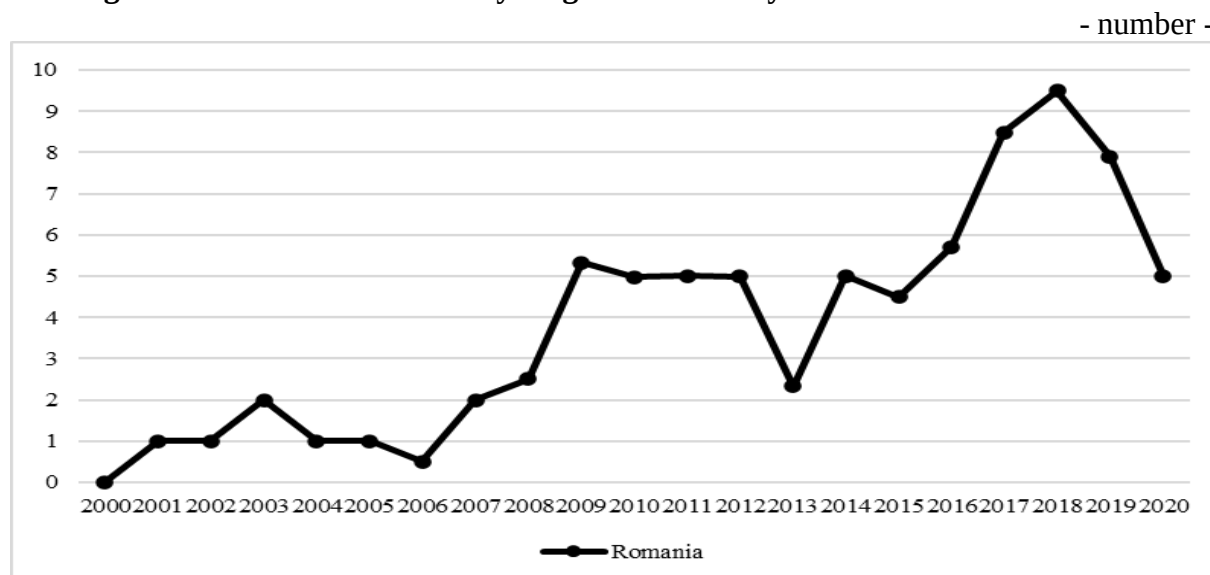
Figure 4. Patents related to recycling and secondary raw materials in UE (2020)

- number -



Source: Author owns processing based on Eurostat data (2025)

In Figure 4, only 19 out of the 27 EU member states are represented, as eight countries (Slovakia, Malta, Lithuania, Hungary, Estonia, Cyprus, Croatia, and Bulgaria) did not report any patents related to recycling and secondary raw materials to Eurostat in 2020, the latest year for which data is available. Germany ranks first with 45.67 patents related to recycling and secondary raw materials, followed by France with 27.09 patents and Italy with 21.51 patents. Romania ranks 12th in the EU hierarchy.

Figure 5. Patents related to recycling and secondary raw materials in Romania

Source: Author owns processing based on Eurostat data (2025)

According to the latest available data from the Eurostat database, between 2000 and 2020, Romania had a low number of patents related to recycling and secondary raw materials, reaching a peak of 9.5 patents in 2018 (Figure 5). This is linked to political, financial, and regulatory factors that seem to be one of the main challenges faced by companies and research institutions. The lack of multidisciplinary collaborations in the research phase, the lack of education regarding the circular economy, and the difficult organizational framework for research activities appear to be the main causes [5].

3. CONCLUSIONS

The circular economy can decisively contribute to achieving the EU's environmental objectives by reducing pressure on natural resources, ensuring sustainable growth, jobs, and the long-term competitiveness of the EU. However, the transition to this must be organized by both the private and public sectors at all levels of the value chain. The state contributes with actions in the legislative and educational sphere, in building the necessary infrastructure to collect and recycle waste separately from the population, but also through support measures granted to the private sector. On the other hand, the private sector has the obligation to adapt its products and make them easy to repair, reuse, and recycle, through investments in research and new technologies, partnerships with other companies or with the public sector.

The circular economy brings a series of advantages over the linear model, especially regarding environmental protection, pollution reduction, conservation of natural resources by reducing material consumption and dependence on raw materials, job creation, and generating savings for consumers, but it also requires efforts and collaboration between the private sector, the state, and civil society, to overcome the inherent challenges of any transition, related to: regulations and policies, market inertia, financing, workforce in the extractive sector, monitoring, and evaluation.

At the European level, through a set of initiatives and policies included in the European Green Deal, the circular economy guides the green transition towards a modern, competitive, and resource-efficient economy.

At the same time, the Circular Economy Action Plan identifies seven key sectors vital for achieving a circular economy: plastics, textiles, waste from electrical and electronic

equipment, food, water and nutrients, packaging, batteries and vehicles, buildings and construction. The initiatives target the entire life cycle of products, starting from how they are designed, promoting circular economy processes, encouraging sustainable consumption, and aiming to ensure that waste is prevented and that the resources used are kept in the EU economy for as long as possible [6].

Eco-innovation, by reducing environmental impact, increasing resilience to external pressures, and using resources more efficiently, is vital in supporting this transition to a circular economy and achieving the objectives of the European Green Deal. The 8th EU Environmental Action Programme supports the environmental and climate action objectives of the European Green Deal by accelerating the transition to a regenerative economy that gives back to the planet more than it takes, particularly "through continuous innovation, adaptation to new challenges, and co-creation." The biennial thematic report presents best practices, reasons, and challenges for eco-innovation to support a circular industrial transformation. Eco-innovation in companies leads to cost reduction, improves the ability to capture new growth opportunities, and enhances their reputation among customers. Eco-innovation is therefore a powerful tool for environmental protection, with a positive impact on the economy and society [7].

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