FINANCIAL CHALLENGES OF INVESTING IN ECO-INNOVATION

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DOI: https://doi.org/10.65672/jfme.2025.1.27

Abstract:

Eco-innovation represents the entrepreneurial and innovative potential of companies aimed at sustainable business practices based on the introduction and development of eco-innovations. Sources of financing for eco-innovation include bank loans, green loans, as well as external funding sources. The research in this paper focuses on the analysis of financial support measures for eco-innovation from the perspective of their relevant impact on fostering eco-innovations. By applying quantitative and qualitative research methods grounded in an analytical approach, the study examines the National Recovery and Resilience Plans (RRP) of EU countries in relation to the achieved Eco-Innovation Index in the domains of Eco-Innovation Inputs and Eco-Innovation Outputs. The obtained results are synthesized to underscore the need for enhanced financial support, viewed through the lens of how direct and indirect measures contribute to various relevant dimensions of eco-innovation.

Keywords: *finance, financial support measures, statistical analysis, eco-innovation, Eco-Innovation Index*

JEL classification: *G11, G23, Q56*

Introduction

The concept of eco-innovation is most commonly examined in the context of its contribution to waste reduction and environmental initiatives within business processes (Janahi et al., 2021). In this regard, the role of eco-innovation in promoting efficient resource use and cleaner production is analyzed (Malinauskienė et al., 2018; Spirko et al., 2016).

The integration of innovation and sustainability fosters the development of innovations that have a positive environmental impact, commonly referred to as sustainable innovations, green innovations, ecological innovations, or eco-innovations (Carrillo-González et al., 2025), which in turn support green supply chain management (GSCM). GSCM encompasses strategies for supply chain development, green investments, and the sustainability of both enterprises and governmental institutions, where the strategic implementation of GSCM encourages value co-creation and positively affects firm performance in terms of innovation and financial outcomes (Xu et al., 2020).

Given the increasing number of stakeholders involved in the development and maintenance of eco-innovations, the literature emphasizes the importance of public support and policy

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programs, which, through governance models and financing mechanisms, provide support for the circular economy—such as the Recovery and Resilience Plan (RRP).

The European Commission adopted the RRP as a strategic document that each EU Member State prepares within the framework of the Recovery and Resilience Facility (RRF), which serves as the central instrument of the EU's "NextGenerationEU" recovery package. The goal is to strengthen economic resilience, foster green and digital transitions, support innovation, ensure sustainability, and promote social inclusion (EC, 2022a; EC, 2022b).

The RRF defines six policy areas that Member States must address in their National Recovery and Resilience Plans (NRRPs), as outlined in the European Commission Regulation 2021/241: green transition, digital transformation, smart, sustainable, and inclusive growth, social and territorial cohesion, health, economic, social and institutional resilience, and policies for future generations.

Financial resources available through the RRF represent a significant opportunity to accelerate eco-innovation (EU Eco-Innovation Index 2022, 2022). To measure and monitor the performance of EU countries in transitioning toward a climate-neutral and circular economy, the Eco-Innovation Index was developed (Green Forum, EC Europa, 2022; EU Eco-Innovation Index 2022, 2022).

Literature Review

The research is based on the following theoretical approaches: the drivers of eco-innovation include institutional factors and public policies, as well as market, economic and financial, behavioral, technological, and organizational factors (Diaz Lopez & Montalvo, 2015; Orjuela-Ramirez et al., 2024). Eco-innovations lead to the development of various types of business models that enable reuse, remanufacturing, green products, and other sustainable practices (Chioatto et al., 2024).

The literature analyzes the sources of financing for eco-innovation and highlights the evolution of financing forms and models, from traditional sources to green financial instruments. Funding sources are classified into traditional bank loans and green loans, as well as external sources of financing, including EU funds, government grants, and crowdfunding (Incekara, 2021).

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In addition, the literature highlights the importance of green finance as a key driver of the sustainable transition (Marín-Rodríguez et al., 2024), as well as its impact on the development of green patents and the improvement of firms' business performance (Marín-Vinuesa et al., 2018).

Innovative financing models for eco-innovation are also discussed, particularly those based on project-based innovation financing, which mobilizes private capital for sustainable infrastructure development (González-Ruiz et al., 2018; Morea & Gebennini, 2021).

The role of green financial instruments is reflected in the production of renewable energy (Alharbi et al., 2022), improvements in energy efficiency, and enhanced ESG performance of enterprises (Zhao et al., 2024). Green finance and green investments increasingly incorporate impact investing, where investors accept lower financial returns in exchange for generating social and environmental benefits (Fu et al., 2023).

The literature also examines the financing of eco-innovations through the Recovery and Resilience Plan (RRP), highlighting the sectoral and structural reforms stimulated by these financial instruments. A 2024 European Commission study explores tools for analyzing the macroeconomic impact of structural reforms, noting that the evolution of these programs remains a challenge (García et al., 2024).

Furthermore, the 2025 European Commission study reveals that more than 2,800 sectoral reform and investment measures financed through the Recovery and Resilience Facility (RRF) are projected to generate a total economic impact of €891.7 billion for the EU by 2030—comprising €546.2 billion in direct effects and €345.5 billion in indirect (spillover) effects (Joint Research Centre, 2025).

The application of the FIDELIO model (an economic impact assessment model) is used to evaluate the direct and indirect effects of RRF funding across sectors and EU Member States (Michels et al., 2025).

A review of the aforementioned studies shows that while the implementation measures and effects of the RRF are analyzed, the value of the Eco-Innovation Index is not explicitly linked to the financial framework or the allocation of monetary resources.

Methodology and Data

The research is based on a combination of quantitative and qualitative methods aimed at examining the relationship between eco-innovation, as measured by the Eco-Innovation Index, and financial support provided through the Recovery and Resilience Facility (RRF).

The research design consists of a descriptive and comparative analysis of the Eco-Innovation Index and RRF financial allocations, as well as a rank analysis to assess the relationship between the Eco-Innovation Index and Eco-Innovation inputs.

Data sources include: Eco-Innovation Index (EU, Eco-Innovation Index Reports, 2022), RRF financial data (European Commission, Country Reports, 2022), and Policy documents, specifically national Recovery and Resilience Plans (European Commission, Country Profiles, 2022).

Results

The Recovery and Resilience Facility (RRF) was developed as a key instrument of the EU's NextGenerationEU recovery plan in response to the crisis caused by the COVID-19 pandemic. The primary objective of the RRF is to enhance resilience and support the green and digital transitions, with a total budget of €650 billion (Recovery and Resilience Facility, 2022).Financial resources under the Recovery and Resilience Plans (RRPs) are allocated in the form of RRF Grants and RRF Loans.

The data analysis shows that the majority of financial resources within the Recovery and Resilience Plans (RRP) are allocated as RRF grants (54.21%), with the largest amounts directed to Italy, Spain, and Poland—together accounting for 65.34% of the total funding. The smallest allocations were observed in Ireland, Cyprus, and Denmark.

The Value of the Eco-Innovation Index as a Measure of National Economic Progress: The Eco-Innovation Index assists in monitoring the performance of EU Member States in terms of eco-innovation, where eco-innovation and the circular economy are strategic investment priorities. The Eco-Innovation Index encompasses five key areas (Green Forum, EC Europa, 2022):

Eco-Innovation Inputs: Financial and human investments in eco-innovation (research budgets, education, number of researchers).
Eco-Innovation Activities: Company engagement in eco-innovation (ISO 14001 certifications, number of involved firms).
Eco-Innovation Outputs: Outcomes of activities, such as the number of patents and scientific publications in the field of eco-innovation.
Resource Efficiency Outcomes: Efficiency in resource use (water, energy, raw materials) as well as greenhouse gas (GHG) emission intensity.

Socio-Economic Outcomes: Positive social and economic impacts of eco-innovation (e.g., number of green jobs, growth of the green sector, exports from the eco-industry).

The Eco-Innovation Index showed a steady increase from 2013 to 2022, with positive trends observed in the improvement of the GHG emission productivity indicator, which contributed to the overall growth of the Index values: Austria from 5.1 to 6.2, Germany from 3.2 to 5.0, and Ireland from 2.9 to 6.0. However, negative trends were recorded in eco-innovation activities, specifically in ISO 14001 certifications, eco-innovation patents, and exports of products from the eco-industry (EU Eco-Innovation Index, 2022).

Table 1: Eco-Inovation Index in 2022

EU	Eco-Innovation Index	Eco-innovation activities	Eco-innovation inputs	Eco-innovation outputs
Austira	0.721	0.254	0.781	0.641
Belgium	0.414	0.124	0.577	0.515
Bulgaria	0.239	0.567	0.155	0.147
Croatia	0.368	0.570	0.211	0.319
Cyprus	0.393	0.504	0.082	0.546
Czechia	0.460	0.777	0.615	0.258
Denmark	0.695	0.288	0.799	0.916
Estonia	0.479	0.809	0.248	0.518
Finland	0.738	0.566	0.853	0.883
France	0.542	0.136	0.822	0.399
Germany	0.585	0.192	0.879	0.673
Greece	0.421	0.284	0.702	0.373
Hungary	0.337	0.583	0.498	0.197
Ireland	0.458	0.287	0.337	0.481
Italy	0.537	0.577	0.603	0.319
Latvia	0.437	0.320	0.263	0.463
Lithuania	0.430	0.558	0.274	0.337
Luxembourg	0.742	0.222	0.493	0.764
Malta	0.331	0.130	0.123	0.187
Netherlands	0.493	0.239	0.516	0.536
Poland	0.279	0.083	0.252	0.282
Portugal	0.438	0.113	0.445	0.394
Romania	0.351	0.547	0.174	0.177
Slovakia	0.392	0.673	0.282	0.240
Slovenia	0.480	0.459	0.672	0.551
Spain	0.483	0.546	0.464	0.291
Sweden	0.667	0.544	0.744	0.832

Source: EU, Country profiles, 2022.

The analysis of the data presented in Table 1 shows that the Eco-Innovation Index has an EU average of 0.4523, with the highest values recorded in Luxembourg, Finland, and Austria. The lowest values were observed in Bulgaria, Poland, and Malta.

The Eco-Innovation Inputs have an EU average of 0.4944, with the highest values in Germany, Finland, and France, and the lowest values in Bulgaria, Malta, and Cyprus.

Based on the aforementioned relationships, rank positions of countries with the highest values of the Eco-Innovation Index and Eco-Innovation Inputs were determined.

Table 2: Rank Eco-Innovation Index and Eco-Innovation inputs

EU	Rank Eco-Innovation Index	Rank Eco-Innovation inputs	Deviation
Luksemburg	1	14	+13
Finland	2	2	0
Austria	3	5	+2
Germany	6	1	-5
France	7	3	-4

Source: Author, based on EU, Country profiles, 2022.

There is no observed impact of the size of RRF funding on the Eco-Innovation Index for countries with the highest Eco-Innovation Index values, which can be explained by the fact that RRF funds are not solely intended to strengthen eco-innovation. However, the relationship between Eco-Innovation Inputs and the Eco-Innovation Index demonstrates a direct impact and a stronger connection between the scale of investments directed towards eco-innovation and the contribution to enhancing the eco-innovative capacity of national economies. This relationship is most evident in the case of Finland and least pronounced in Luxembourg.

The analysis of direct and indirect financial support measures is based on the classification of EU Member States into three categories (Author, based on Country Profiles, 2022):
- Countries that have identified the relevance of eco-innovation and have explicitly reflected the contribution of direct and indirect financial support measures to eco-innovation;
- Countries that have identified the relevance of eco-innovation but have not expressed this through the contribution of direct and indirect financial support measures;
- Countries that have neither identified the relevance of eco-innovation nor expressed any contribution of direct or indirect financial support measures to eco-innovation.

The segmented analysis based on the three groups shows the following (Table 3; Figure 1):
1) Ten countries have demonstrated the contribution of both direct and indirect financial support measures to eco-innovation: Austria, Bulgaria, Czechia, Denmark, Finland, Germany, Italy, Latvia, Slovakia, and Luxembourg.
Luxembourg implemented measures contributing to eco-innovation by addressing climate action, circular economy, and biodiversity protection. One such support instrument is the Fit4Circularity program. Luxembourg is the only country that has evaluated the impact of these measures on eco-innovation using a scale-based approach (low, medium, and high). All three measures were rated as low in terms of direct impact on eco-innovation, while Fit4Circularity was assessed as having a high impact specifically on the circular economy.
Countries expressed their relevance to eco-innovation through the following types of activities:
Cross-cutting – Implementing intersectoral approaches to strengthen eco-innovation.
Introduction of eco-design – Designing products that minimize environmental impact throughout their life cycle.

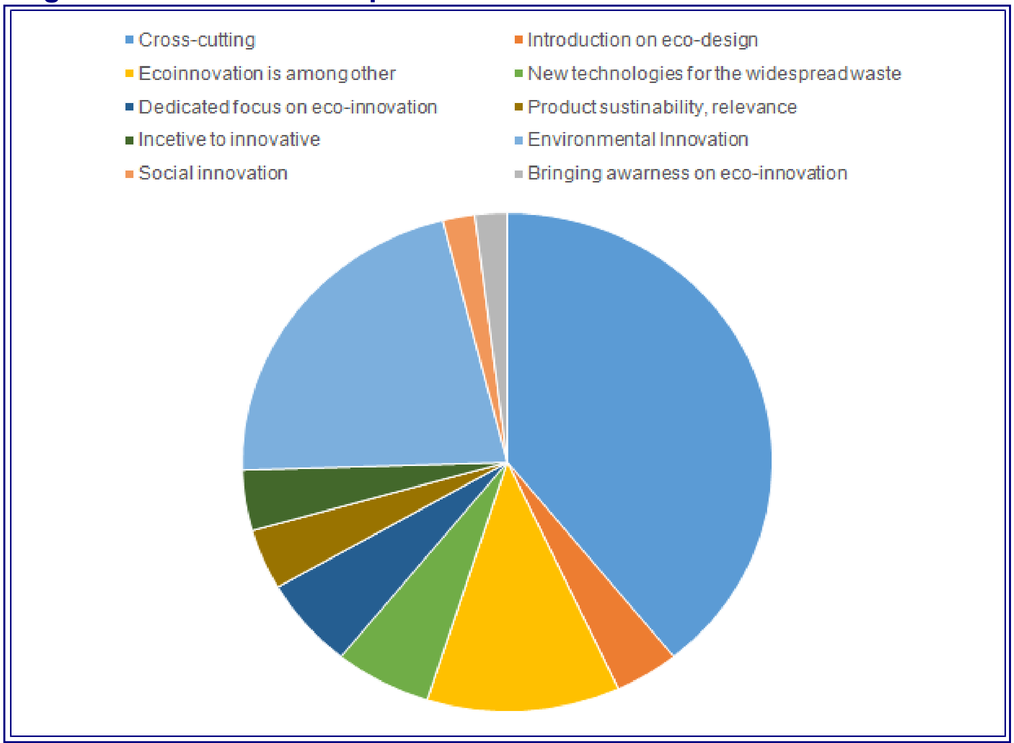
New technologies for widespread waste – Applying innovative solutions to manage large volumes of waste.
Dedicated focus on eco-innovation – Targeted financial support explicitly directed at eco-innovation.
Eco-innovation is among other topics – Projects addressed eco-innovation among other thematic areas.
Environmental innovation – Innovations aimed at reducing the negative environmental footprint.
Product sustainability and relevance – Supporting production that is sustainable and socially responsible.
Social innovation – Promoting ideas and approaches that are environmentally sustainable and socially inclusive.
Bringing awareness on eco-innovation – Public information and education campaigns highlighting the importance and benefits of eco-innovation.
Within the structure of implemented direct measures, cross-cutting measures dominate, accounting for 44%, and envirnomental innovation at 25%. In contrast, their contribution through indirect measures is lower, at 22%, indicating a greater dispersion of relevant impacts across indirect support mechanisms.
2) Financial support through the RRP is recognized as relevant to eco-innovation, the circular economy, and resilience goals. Belgium, Cyprus, Estonia, France, Greece, Hungary, Ireland, Lithuania, Malta, Poland, Portugal, Slovenia, Spain, and Sweden have acknowledged the relevance of eco-innovation, but did not explicitly reflect this relevance through direct or indirect financial support measures. Malta did not specifically highlight the relevance of the circular economy or eco-innovation in its RRP, while Slovenia linked eco-innovation relevance primarily to contributions in the area of green energy.
3) Croatia and Romania neither identified the relevance of eco-innovation in their national recovery plans nor expressed any contribution of financial support measures toward eco-innovation.

Table 3: Direct/indirectfinancial supportand relevance foreco-innovation

Country	Direct	Relevance to Eco-innovation	Indirect	Relevance to Eco-innovation
Austria	10	Cross-cutting	-	-
Bulgaria	1 1	Introduction on eco-design New technologies for the widespread waste	3	Introduction on eco-design
Czechia	4 3	Cross-cutting Ecoinnovation is among other topics	-	-
Denmark	3	Cross-cutting	2	Cross-cutting
Finland	3 2	Eco-innovation among other topics Dedicated focus on eco-innovation	1	Dedicated focus on eco-innovation
Germany	8	Environmental Innovation	2	Environmental Innovation
Italy	3	Cross-cutting	2	Cross-cutting
Latvia	1 2 1 1	Introduction on eco-design Product sustainability, relevance Social innovation Bringing awarness on eco-innovation	1 2	Product sustainability, relevance Bringing awarness on eco-innovation
Luxembourg	2	Cross-cutting Incetive to innovative	2	Cross-cutting Incetive to innovative
Netherlands	3	Environmental Innovation	3	Environmental Innovation
Slovakia	2	New technologies for the widespread waste	-	-

Source: EU, Country profiles, 2022.

Figure 1: Forms of the impact of financial measures on eco-innovation



Source: Author, based on Table 3

Specific forms of direct and indirect support include the following measures:

- Tax incentives,
- Subsidies,
- Loans and credits,
- Tax relief for consumers adopting/purchasing green technologies/products,
- Green public procurement,
- Eco-innovation challenges, prizes, and awards,
- Training for enterprises and consumers and
- Clusters, networks, and platforms.

In the case of the Netherlands, the forms of direct and indirect support are closely linked to the relevance of eco-innovation:Tax relief for consumers adopting/purchasing green technologies/products and Clusters, networks, and platforms contribute to the cross-cutting component.Tax incentives and subsidies contribute to the incentive to innovate component.The remaining four forms of support are relevant from the perspective of key objectives related to eco-innovation.

Key findings of the study indicate that there is no direct correlation between RRF funding and the value of the Eco-Innovation Index, which is to some extent consistent with the diverse priorities of RRF financial allocations, including digital transformation and other sectors. On the other hand, a stronger and more direct relationship has been identified between the Eco-Innovation Index and Eco-Innovation Inputs as a measure of financial investments in eco-innovation.Furthermore, ten EU Member States have implemented both direct and indirect financial support measures with clearly defined relevance to eco-innovation. This segmentation highlights the need to strengthen a coherent reporting system on direct and indirect support measures at the EU level.Direct support measures tend to be more targeted and focused on a few specific areas directly related to eco-innovation, whereas indirect measures are dispersed across various domains such as eco-design,environmental innovation, product sustainability and relevance, social innovation and bringing awareness on eco-innovation.

The limitations of the study lie in the undefined time horizon between the investment and the measurement of its effects; the uncertainty as to whether investments contribute to short-term or long-term eco-innovation outcomes; the constraints related to the comparability of Index data across different years due to limited availability of harmonized data; and the lack of coherence in how support measures are presented across individual EU countries.

Conclusions

The financing of eco-innovation represents one of the key challenges for the development of EU countries and their transformative capacity toward a green transition.

Establishing mechanisms that ensure the convergence of systemic approaches to circular economy development and the availability of financial resources is essential for closing the gap between identified development potential and actual investment levels.

To monitor progress in eco-innovation and the contribution of eco-innovation to the circular economy, national economies identify key forms of relevance. Eco-innovations stimulate eco-innovativeness through cross-cutting approaches, the introduction of eco-design, new technologies for widespread waste management, a dedicated focus on eco-innovation, environmental innovation, product sustainability and relevance, social innovation, and raising awareness about eco-innovation. In addition to their impact on the environment, eco-innovations also emphasize the importance of strengthening cross-sectoral collaboration and initiatives.

National economies strive to foster the development of sustainable production—from product design, to resource efficiency, to sustainable waste management—indicating a commitment to promoting eco-innovativeness throughout the entire product life cycle. From the perspective of enterprises, eco-innovations enable numerous and diverse contributions to sustainable development.

In the coming period, it is essential that all countries establish clear links between direct and indirect support measures and their relevance to eco-innovation, and that the contribution to the growth of eco-innovativeness is expressed through measurable outcomes.

The establishment of a clear methodological framework will enable coherence and uniformity in reporting results. However, this does not diminish the financial contribution of the RRP to fostering eco-innovation.

In addition to traditional banking sources of eco-innovation financing, it will be necessary in the future to develop alternative financing mechanisms that can strengthen the eco-innovation potential of countries—grounded in innovation in product design, production, and waste management.

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