

Governmental Policies and Sustainable Outcomes in EU: How Innovations Change the Game?

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Abstract: Environmental degradation is one of the main challenges in today's world. Impact on the environment can be reduced through the introduction of clean and more efficient technologies. And innovation plays a crucial role in this process by replacing old equipment and methods. There are different ways how researchers understand sustainable innovations and sustainable innovation ecosystems. The terms "sustainable" and "sustainable development" have become very widely used in recent years. Sustainability is crucially important for the development of regions and national economies. Existing literature on the topic of sustainable innovation ecosystems includes vague and ambiguous definitions of sustainable innovation, as well as ways to measure it. A number of studies analyse the impact of different factors on conventional innovations and eco-innovations. However, not enough research has been done on the effects of innovations on all three dimensions of sustainable innovations, which are economic, environmental, and social. The aim of the article is to define whether governmental policies that promote innovation and sustainable development lead to environmental, social, and economic improvements in the EU countries. Our study uses the Eurostat data for 27 European Union countries. The literature review will include studies on sustainable innovation ecosystems. In the second chapter, we will describe the sustainable innovation ecosystems and ways to measure the sustainable outcomes of innovations. We study sustainable innovation ecosystems on a national level. We use partial least squares structural equation modeling (PLS-SEM) to determine the influence of governmental policies on sustainable outcomes, with product and process innovation as mediating variables. Under sustainable outcomes, we mean the economic, social, and environmental improvements on a national scale. The analysis is based on applying a quantitative method with empirical data using SmartPLS software. The results demonstrated a significant direct impact of governmental policies on innovation, as well as on environmental and social outcomes. However, they showed no indirect impacts connected to innovations. The results contribute to the current state of knowledge on sustainable innovation ecosystems and give policymakers valuable insights on factors that influence such ecosystems.

Keywords: Sustainable, Environmental policy, Eco-innovations, Governmental innovation, Firms, EU, PLS-SEM, SmartPLS

1. Introduction

Increasingly concerned with the deterioration of the environment and the quality of human life, caused mainly by society's profit orientation (Tran et al., 2023), environmental and sustainability research has become one of the fastest-growing fields today. In the field of environmental issues, research has focused, for example, on consumers' green intentions and behavior (Hoang & Tung, 2024) or the green activities of companies, for example, the banking sector (Cardona Valencia & Calabuig Tormo, 2023). In the field of sustainability, current literature has focused mainly on factors that can determine the green behavior of companies (Horbach et al., 2023; Kotkova Striteska et al., 2024), how the government sector can support corporate initiatives in sustainability (Karman et al. 2024a; Sein and Darfo-Oduro 2024), and circular economy practices (Karman et al., 2024b). The main reason for this boom can be considered the threat to ecological stability (White et al., 2021), which represents a significant threat to human health (Bouchoucha, 2021) and social well-being (Omri et al., 2022), which stimulates interest in sustainable practices and innovation (Dmytrenko et al., 2024).

"Environmental degradation" includes climate change (Nguyen et al., 2023), biodiversity loss (Tan et al., 2022), pollution, and natural resource depletion (Ali et al., 2021). Addressing these issues has become a priority for researchers, policymakers, and industries. There is a growing emphasis on sustainable solutions across sectors. Innovations in technologies and practices are crucial in mitigating environmental degradation (Arranz, 2020; Durán-Romero et al., 2020). Sustainable innovations addressing environmental, economic, and social issues are essential to holistic development (Purvis et al., 2019). These innovations increase productivity and competitiveness while ensuring environmental protection and social well-being (Zhang et al., 2021). Sustainable innovation ecosystems involving diverse stakeholders are fundamental for sustainable growth (Durán-Romero et al., 2020; Janahi et al., 2022).

However, the literature (Purvis et al., 2019; Wei et al., 2022) reveals a lack of consensus on definitions and metrics for sustainable innovation, leading to confusion and research gaps. Many studies have examined the impact of various factors on traditional innovation and eco-innovation (Baeshen et al., 2021), but comprehensive research on the three-dimensional effects of innovation—economic, environmental, and social—is scarce.

Our study assesses whether government policies promoting innovation and sustainable development lead to improvements in these three dimensions in EU countries. Using Eurostat data from 27 EU countries, we evaluate the efficacy of government policies in promoting sustainable outcomes. Advanced analytical techniques, such as partial least squares structural equation modeling (PLS-SEM), and empirical data through SmartPLS software, enable a nuanced understanding of the relationship between government policies and sustainable outcomes. This approach explores the mediating effects of product and process innovations on achieving sustainability goals. The anticipated results will provide insights into sustainable innovation ecosystems and guide future policy and research directions in sustainable development.

The rest of the paper is organized as follows: Section 2 reviews the literature on governmental policies and sustainable innovations. Section 3 describes the data and methodology. Section 4 presents the results and discussion. The final section concludes with a summary of contributions and suggestions for future research.

2. Theoretical Background

2.1 Sustainable Innovations

The term "sustainable" has become a buzzword in recent years (Brink, 2022). The Brundtland Report (1987) of the United Nations defines sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". Sustainability is crucial for the development of regions and national economies. However, "sustainable" often causes confusion by being used synonymously with 'eco-friendly' (Nill & Kemp, 2009; Karakaya et al., 2014; Wei et al., 2022). True sustainability includes economic, social, and environmental dimensions, known as the "three pillars of sustainability" (Purvis et al., 2019). Boons et al. (2013) pointed out that sustainable innovation is a three-dimensional concept. Eco-innovation, reducing negative environmental impacts (Horbach et al., 2012), is part of sustainable innovation, which improves performance in all three sustainability aspects (Boons et al., 2013). Mazaheri et al. (2022) and Hermundsdottir and Aspelund (2021) include all three pillars in their assessments of market-based instruments and firm competitiveness, respectively.

Despite the belief that environmental protection hinders economic growth, both are interconnected. Economic growth provides financial resources, while the natural environment underpins economic activities. Both are crucial for societal well-being. Innovations promote sustainability by saving money and reducing pollution (Gunarathne, 2019). Efficient production methods exemplify how economic growth and environmental protection can coexist. Innovation, a goal of sustainable development by the UN, influences production processes and end products. Gunarathne and Peiris (2017) found that eco-innovations positively impact economic and social indicators. Innovations that reduce energy consumption and enhance recycling foster both environmental and economic sustainability, preserving financial resources (Ashford & Hall, 2010). Innovations for social sustainability include healthier working conditions and creating jobs for disadvantaged groups.

2.2 Role of Policymakers in Enhancing Sustainability

Porter and Van der Linde (1995) were among the first to study the influence of environmental policy on innovativeness, proving the positive impact on competitiveness and sustainability. According to Demirel and Kesidou (2019), three main drivers for innovation are market pull, technology push, and regulation stimulus. Hojnik and Ruzzier (2016) highlighted regulatory pressure as a driver and barrier for eco-innovations, noting companies invest in environmental innovations only if economically beneficial. Government regulations, alongside technology push and market requirements, are key innovation determinants (Horbach et al., 2012). Díaz-García et al. (2015) noted innovation is driven by internal and external factors, including government regulation.

Researchers (Ramanathan et al., 2017; Cohen and Tubb, 2018) recognize the positive impacts of governmental policies on reducing greenhouse gas emissions, though overly restrictive policies can have adverse effects (Mulatu, 2018; Wolde-Rufael and Mulat-Weldemeskel, 2021). Firms lack incentives to innovate if policies are too lenient (Ben-David et al., 2021). Studies in the EU (Neves et al., 2020) and OECD (Martínez-Zarzoso et al.,

2019) countries show stringent environmental policies positively influence carbon dioxide emissions. Governments enhance eco-innovations through measures like environmental taxes (Bashir et al., 2020), emission trading schemes (Zimmermannová et al., 2019), and subsidies (Gerarden, 2023). Regulation efficiency depends on internal (management, human resources) and external (government pressure and support) factors (Chu et al., 2018).

2.3 Approaches to Measure Sustainable Innovations

Gunarathne (2019) attempted to define a framework for measuring sustainable innovation, dividing indicators into economic, social, and environmental directions. Rauter et al. (2019) developed the Sustainability Innovation Performance indicator with four dimensions: social, environmental, process efficiency, and product sustainability. Gunarathne and Peiris (2017) highlighted the difficulty of finding a universal measuring system due to the complexity of sustainability dimensions. They used economic indicators like output and cost, environmental indicators like reduced land use, and social outcomes like projected salary increases. Measuring social benefits remains challenging, partly due to data availability. Common indicators for measuring sustainability in innovations are summarized in Table 1.

Table 1: Examples of sustainable innovation indicators

Economic	Social	Environmental
Profit from the sale of new product	Increase in employees' income thanks to new technology	Energy saved
Cost savings from the adoption of new technology	New workplaces created	Water saved
Increase of firm's worth	Taxes paid increase	Air, soil, and water pollution decreased
New consumers and suppliers	Safety improvements	Waste reduced

3. Hypotheses Development and Methods

This study draws upon the existing literature that emphasizes the multifaceted nature of sustainability (Purvis et al., 2019) and the integral role of governmental policies in fostering innovation within firms. It is evident from the review that while environmental, economic, and social dimensions of sustainability are interconnected, the impact of governmental policies through innovation acts as a critical mediator in achieving sustainable outcomes. Studies highlighted in the theoretical background, such as those by Porter and Van der Linde (1995) and others, demonstrate a positive correlation between regulatory frameworks and innovation in the corporate sector. These findings suggest that well-designed government interventions can catalyze advancements in sustainable practices among firms. Given this backdrop, the study formulates its hypotheses to systematically investigate the direct and mediated influences of governmental policies on the economic, environmental, and social outcomes of European firms. The hypotheses aim to capture the dynamic interactions between policy-driven innovation activities and broader sustainability goals, thereby contributing to a deeper understanding of sustainable innovation ecosystems within the European Union. We establish the following hypotheses:

H1: Governmental policies have a positive influence on the economic outcomes of European firms through innovation.

This hypothesis builds on the evidence suggesting that public procurement for innovation and other policy instruments enhance firm-level economic performance by fostering innovation outputs and outcomes, thus supporting broader economic sustainability (Stojčić et al., 2020).

H2: Governmental policies have a positive influence on the environmental outcomes of European firms through innovation.

Reflecting on the regulatory impacts of initiatives like the EU Emissions Trading Scheme (ETS), this hypothesis posits that environmental regulations effectively induce firms to adopt eco-friendly practices, thereby aligning with environmental sustainability objectives (Martin et al., 2016).

H3: Governmental policies have a positive influence on the social outcomes of European firms through innovation.

This hypothesis is grounded in the findings of Ludvig et al. (2018), who explore the potential of EU and national policies to support social innovation in rural areas. Their research underscores the significant impact of these

policies on enabling community-oriented innovations, which cater to vulnerable social groups and address societal challenges at large. The effectiveness of such policies in promoting participatory inclusion and supporting the social fabric of rural communities highlights their critical role in achieving social sustainability. The influence of innovations as a tool for sustainable development was, in particular, proven by Loučanová et al. (2022), who studied the innovativeness of Slovak SMEs. Skare & Porada-Rochon (2022) proved that innovation is a crucial factor in reaching sustainable growth on macro and micro levels through the application of energy efficiency measures.

This study employs a quantitative approach to assess the influence of governmental policies on the sustainability outcomes of European firms. Utilizing a robust dataset, primarily sourced from Eurostat, we examine the domains of Science and Innovation alongside Sustainable Development. Additional data regarding the Human Development Index (HDI) is derived from the United Nations database. These datasets provide a comprehensive view of the innovation landscape across the European Union, allowing for nuanced analyses of policy impacts on firm performance.

To analyze the relationships posited in the hypotheses, Partial Least Squares Structural Equation Modelling (PLS-SEM) is employed using SmartPLS 4.0 software. This method was chosen for its ability to handle complex models and small samples effectively, which is particularly pertinent given that the dataset comprises observations from all 27 EU member states.

The dataset was rigorously prepared by removing empty and missing values to ensure the integrity of the analysis. PLS-SEM was applied to evaluate the impact of independent variables on dependent variables through mediating variables, providing insights into how governmental policies influence sustainability outcomes at the firm level. By structuring the methodological approach around these components, the study aims to provide a thorough understanding of how governmental initiatives in the realm of innovation and environmental regulation can drive sustainable development within the European business sector. The study's variables are carefully defined to capture the multifaceted nature of governmental policies and their impact on firm-level innovation and sustainability outcomes. These variables are categorized into latent and manifest types, as detailed in Table 2.

Table 2: Variables description

Latent variable	Manifest Variable	Type	Source
Environmental policies (GP)	Public R&D expenditures as % of GDP	Independent	Eurostat
	Total taxes as % of GDP		
Governmental innovation (Innov)	Enterprises with process innovations (as % to all)	Mediating	
	Enterprises with product innovations (as % to all)		
Economic (Econ)	FDI per capita	Dependent	
	Employment rate		
Environmental (Env)	Recycling rate		
	Circular material use rate		
Social (Soc)	Income distribution		
	Corruption Perception Index (social)		
Control (Ctrl)	GDP per capita	Control	
	Human Development Index		UN

4. Results and Discussion

The following Figure 1 and Table 3 describe the results of the SEM model.

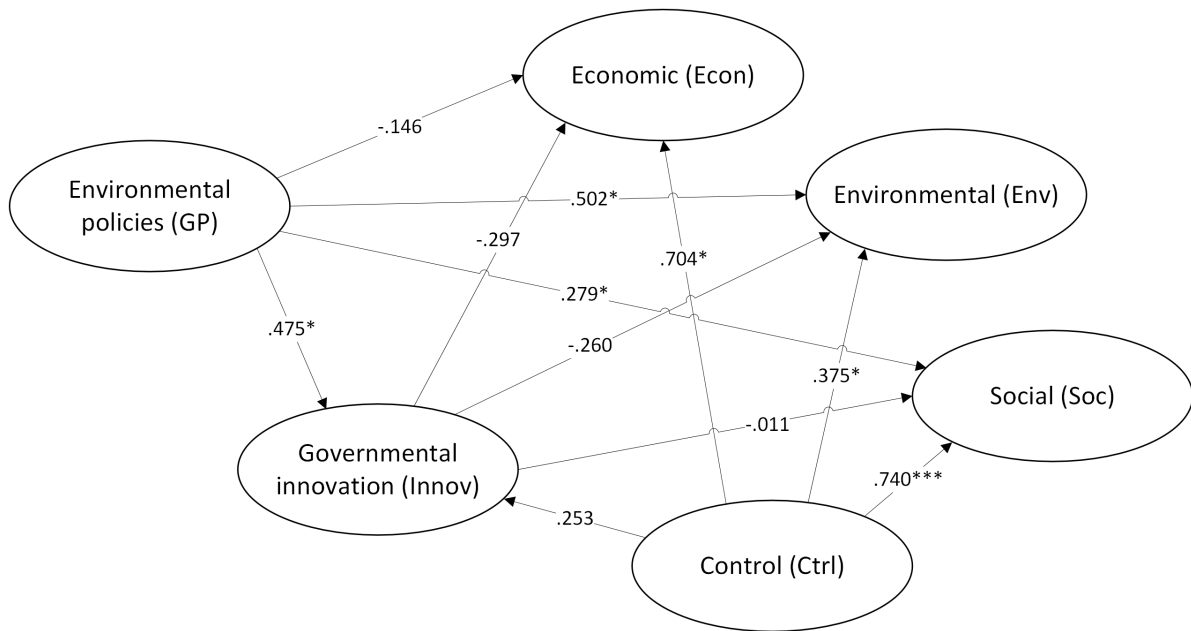


Figure 1: Bootstrapping results for the SEM model

Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; solid line = direct relationship, dashed line = indirect relationship.

Table 3: Direct Effects

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (O/STDEV)	P values	
GP -> Econ	-0.146	-0.466	0.450	0.325	0.745	
GP -> Env	0.502	0.503	0.208	2.415	0.016	*
GP -> Innov	0.475	0.516	0.186	2.550	0.011	*
GP -> Soc	0.279	0.260	0.121	2.298	0.022	*
Innov -> Econ	-0.297	-0.094	0.384	0.772	0.440	
Innov -> Env	-0.260	-0.250	0.240	1.087	0.277	
Innov -> Soc	-0.011	-0.001	0.129	0.086	0.931	
Ctrl -> Econ	0.704	0.797	0.330	2.136	0.033	*
Ctrl -> Env	0.375	0.363	0.189	1.986	0.047	*
Ctrl -> Innov	0.253	0.207	0.226	1.120	0.263	
Ctrl -> Soc	0.740	0.750	0.116	6.408	0.000	***

Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

The results of the SEM analysis indicate that government environmental policies (GP) have a positive direct impact on environmental (Env) and social (Soc) outcomes. In contrast, the data reveal that government environmental policies do not exert a notable effect on economic outcomes (Econ). It was also found that government policies have a positive effect on innovation (Innov). However, these innovations do not further affect any outcomes (Econ, Soc, Env). With regard to the control variable (Ctrl), the analysis demonstrated a significant positive effect on all three sustainable outcomes (economic, environmental, and social), with a specifically significant impact on social indicators. At the same time, the impact of the control variable on innovation was not statistically important.

As previously indicated, government policies do exert an influence on innovation. However, the impact of innovation on economic, social, and environmental outputs is not statistically significant. To further substantiate or refute the hypothesis that the innovation variable plays a mediating role, we conducted an indirect effects analysis. The results of this analysis are presented in Table 4.

Table 4: Indirect Effects

	Original sample (O)	Sample mean (M)	Standard Deviation (STDEV)	T statistics (O/STDEV)	P values
GP -> Innov -> Econ	-0.141	-0.049	0.189	0.744	0.457
GP -> Innov -> Env	-0.124	-0.131	0.143	0.868	0.386
GP -> Innov -> Soc	-0.005	-0.002	0.073	0.072	0.942
Ctrl -> Innov -> Econ	-0.075	-0.018	0.141	0.534	0.594
Ctrl -> Innov -> Env	-0.066	-0.044	0.088	0.748	0.454
Ctrl -> Innov -> Soc	-0.003	0.001	0.041	0.069	0.945

Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

The results show that none of the indirect effects of government environmental policies (GP) through innovation (Innov) on economic (Econ), environmental (Env), or social (Soc) outcomes were statistically significant. These findings suggest that innovation does not function as a significant mediator in the relationship between government policies and these outcomes. Similarly, the control variables (Ctrl) through innovation did not have a statistically significant indirect effect on any of the outcomes. This confirms that the direct effects of government policies and control variables are crucial to understanding their effects on outcomes.

Results showed that governmental policies have a positive impact on innovations and on environmental and social outcomes. The stimulating effect of governmental policies on innovation was proved, in particular, by Horbach et al. (2012), Díaz-García et al. (2015), and Martin et al. (2016). Nevertheless, no effect of innovations or of governmental policies through innovations was recorded. Thus, our result is different from those of Loučanová et al. (2022) and Skare & Porada-Rochon (2022), who stated that innovation is crucial in achieving sustainability. Therefore, all our hypotheses were partially confirmed. Hypothesis number one was proven for the direct impact of governmental policies on innovations. Hypotheses number two and three were confirmed for the impact of policies on environmental and social outcomes. However, none of the hypotheses were proven fully, as there was no mediating effect of innovations in the selected countries. Thus, our outcomes contradict the results of Stojčić et al. (2020) for economic outcomes but partially confirm the results of Martin et al. (2016) and Ludvig et al. (2018) for environmental and social outcomes, respectively. The positive impact of environmental policies on environmental outcomes was also concluded by Martínez-Zarzoso et al. (2019), Wang et al. (2020), Wolde-Rufael and Mulat-Weldemeskel (2021), and Albulescu et al. (2022), who proved that governmental policies, in particular R&D expenditure, reduce the environmental pollution. Besides that, this study confirms the impact of governmental policies on innovation, which was approved by Stojčić et al. (2020). At the same time, results also disapproved of the statements made by Porter and van der Linde (1995), who proved the positive influence of governmental policies on economic performance. Control variables have a higher influence on sustainable outcomes than governmental policies do. However, governmental policies are more efficient in promoting innovation.

5. Conclusions

The article is an important contribution to the field, previously rarely studied – sustainable effects of innovations. Previous papers on the topic concentrate mainly on the theoretical side of sustainable innovations without measuring their real-life application. In our study, where we tested whether innovations lead to the achievement of sustainable outcomes, we came to the conclusion that governmental policies positively influence three types of indicators only directly and not through innovations. Innovations turned out to be not significant in improving the sustainable development indicators considered. So far, to the best of our knowledge, no similar studies have been done. For policymakers in the EU countries, our results show, that innovativeness doesn't necessarily mean sustainable outcomes. Nevertheless, the results also show that, despite the absence of indirect effects, governmental environmental policies are efficient not only in stimulating environmental indicators but also in improving social standards and innovativeness. Also, no matter what's the level of innovativeness, HDI and GDP per capita lead to sustainable improvements. For business strategies, the results mean that firms have to weigh various factors when introducing innovations.

Our research has certain limitations, as our data is restricted by the availability of indicators in the Eurostat database. For future research, we suggest studying the other indicators that are used to measure sustainability. For example, health indicators could be studied as social outcomes, GHG pollution levels as environmental, and GDP change as economic. Results for such indicators may differ from the results for indicators we used. Innovations could also be studied at the enterprise level, considering the effects of other governmental policies, like, e.g., environmental taxes.

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