

# The Debt Dilemma: Driver or Brake of Innovation in the EU?

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**Abstract:** In the current economic environment, the issue of increasing indebtedness is receiving considerable attention. This article delves deeper into a comprehensive analysis of how different forms of debt – from households to corporations to governments – affect innovation performance within the European Union (EU). Since the EU includes 25 different countries, it provides a rich background for this analysis covering the period from 2013 to 2021. By applying regression analysis techniques on a large dataset, this study offers a new insight into the complex relationship between indebtedness and innovation performance. A key part of this analysis is the Global Innovation Index, widely recognized as a metric for evaluating innovation performance among nations. The empirical findings of this study reveal a subtle dynamic: while government debt appears to be a drag on innovation performance, private sector indebtedness, including both households and non-financial institutions, shows a positive effect. This dichotomy underlines the crucial importance of implementing responsible fiscal policies that prioritize the promotion of innovation without jeopardizing financial stability. In addition, the research highlights the importance of fostering collaboration between the public and private sectors, supporting university research, and developing innovation incubators to create a robust innovation environment. In addition, this study not only clarifies the current status, but also identifies areas requiring further research, such as research into other factors influencing the innovation environment. However, it is important to acknowledge the limitations associated with the current understanding of the relationship between debt and innovation. These limitations underscore the need for continued refinement of methodologies and investigation of other factors that may influence this interaction, thereby providing fertile ground for future research efforts. In conclusion, this study contributes to a deeper understanding of how debt dynamics shape innovation outcomes in the EU context.

**Keywords:** Debt dilemma, Innovation performance, European Union

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## 1. Introduction

In the current global economy, innovations constitute a fundamental pillar of economic growth, sustainable development, resilience, and, notably, financial stability (Di Caro and Fratesi, 2018; Hysa et al., 2020; Shen et al., 2022). A country's ability to innovate and adapt to new technologies and market conditions not only determines its position in the international market but also significantly influences the quality of life of its citizens. Innovations bring benefits such as increased efficiency, the creation of new jobs, and the promotion of sustainable practices essential for addressing current economic, social, or environmental challenges.

Following the importance of innovation, many countries turn to financing research and development through debt (Croce et al., 2019; Fan et al., 2022). This trend raises the question of whether a higher level of debt truly benefits innovation performance or poses a potential risk to the country's economic stability. In the context of the European Union, where economic conditions and innovation capacities of individual member states vary significantly, this question is particularly relevant.

The aim of this article is to examine the relationships between debt indicators and innovation performance in EU countries, with the goal of identifying how household, non-financial institution, and government debt affect countries' ability to generate innovations. Previous research has only marginally addressed the issue of various forms of debt and innovation, leaving a significant gap in knowledge that we aim to fill. Specifically, we address the question of whether there is a connection between higher debt levels and better innovation performance, and if so, what type of debt has had the greatest impact on innovation in the EU in recent years.

Our research offers a new perspective on the so-called debt dilemma, i.e., the dilemma between further indebtedness in favor of innovation performance and the concurrent risk of financial collapse. We see our contribution in clarifying the impact of different forms of debt on innovation performance in EU countries, being among the few to include in the analysis the direct relationship between household debt and innovation performance. At the same time, we reveal a gap in current research – what is the impact of current restrictive fiscal policies on innovation performance? And finally, we discuss possible recommendations for policymakers regarding future forms of innovation support while considering the strengthening of fiscal sustainability due to growing global indebtedness.

This paper is structured as follows: Section 2 presents the latest findings from the known literature and hypothesis development, Section 3 briefly describes the methodology we used, Section 4 presents the results of

our research, which are then discussed in more detail in Section 5. Section 6 provides conclusions, including theoretical and practical implications, research limitations, as well as proposals for future research.

## **2. Literature Review and Hypothesis Development**

Currently, we observe an unabated interest among regional policymakers in innovations, which significantly impact not only the economic but also the societal environment. Innovations are considered a significant factor in economic growth (e.g., Prokop and Stejskal, 2019; Hysa et al., 2020; Fan et al., 2022), sustainable development (e.g., Silvestre and Țircă, 2019; Hysa et al., 2020), regional resilience (e.g., Di Caro and Fratesi, 2018; Bristow and Healy, 2020), and financial stability (Shen et al., 2022). It is important to note a certain synergy in the relationship between innovations and these key indicators – economies achieving higher levels of development, sustainability, resilience, and financial stability often excel in innovation (Lazaretti et al., 2019; Manzoor et al., 2023). Innovations not only contribute to strengthening these indicators but are also the result of their successful development.

The extensive positive effects associated with innovations necessitate the support of innovative activities. Considering current trends and policies within the EU (notably Horizon Europe and the European Fund for Strategic Investments), it is evident that innovation support is multifaceted and includes various initiatives aimed at digitalization, green transformation, and support for small and medium-sized enterprises (Henriques et al., 2022; Tabarés et al., 2022). Similarly, at the national level, there are various mechanisms for supporting innovation. Besides these, these include different forms of tax relief, national innovation strategies, support for university research, public-private partnerships, and in recent years, increasingly popular innovation incubators that provide startups and innovative firms with access to mentorship, networking, and funding (Cirule and Uvarova, 2022; Redondo et al., 2022). Their positive impact on innovation has been demonstrated in recent years, for example, in Spain and the Netherlands (Redondo et al., 2022) and in Latvia (Cirule and Uvarova, 2022).

In examining the dynamics between innovations and these indicators, it is legitimate to pay more attention to the area of financing. Justification for research in this area has been further reinforced in recent years by various crises that have had a significantly negative impact on the global economy and led to a dramatic increase in debt (Ellul et al., 2020; Wang et al., 2021). In terms of fiscal sustainability, it has been necessary in many countries to adopt restrictive fiscal policies. It has been shown that budget cuts in science and research, and especially the increasing taxation of corporations, hinder progress in this area, ultimately significantly limiting economic growth (Atanassov and Liu, 2020; Babina et al., 2023). Research in this area is currently highly relevant, particularly considering the global increase in public debt and the multifaceted effects of innovation. Despite this, there is still not enough scholarly resources that address this issue in detail. Moreover, it was not just public or government debt that increased; households and businesses also faced rising indebtedness. Alongside governments, examining the financial situation of households and businesses is entirely warranted – their improved financial situation enables the strengthening of innovative activity and supports the creation of new ideas and technologies (Poltorak et al., 2022). If households and businesses are less indebted and have stable incomes, they have more financial resources to invest in education, research, and the development of new products or services. Thus, while it might seem that there is a clear negative relationship between debt and innovations, this conclusion needs to be approached with necessary caution – it is one of many perspectives.

### **2.1 Innovation and Debt: Household Debt, Non-Financial Corporation Debt, General Government Debt**

Household debt is currently a highly discussed topic in the economy, yet its direct relationship to innovations is scarcely explored in the current literature. Therefore, indirect exploration of the relationship, as indicated in the preceding section, seems appropriate. A generally accepted conclusion is the negative relationship between household debt and consumption, which is an integral part of aggregate demand and thus a significant source of economic growth. For example, Ji et al. (2019) in the context of Dutch households between 2006–2015, Du Caju (2022) in the Belgian economy between 2010–2014, and Wong et al. (2022) in a sample of 4730 households in Malaysia for the year 2019 reached this conclusion. As a result of lower consumption, it can then be expected that households will have lower demand for innovative products, effectively presenting a significant brake on innovative activity (Guiné et al., 2020). The direct relationship between household debt and innovations is approached by Bernstein et al. (2017), who, in the period of 2008–2012, highlighted a significant aspect in the American economy, where the negative impact of the financial crisis on households led to a fundamental influence on the productivity of innovative workers, resulting not only in a limitation of innovation performance but also in the exacerbation of economic decline. Thus, to some extent, we can indeed perceive a negative relationship between household debt and innovations. Based on these conclusions, we formulate the following hypothesis:

*H1: Household debt has a negative impact on innovation performance.*

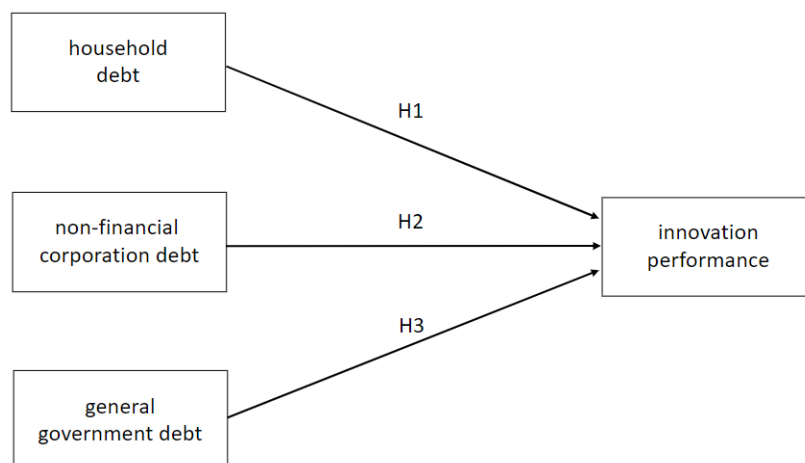
In terms of innovation generation itself, the perspective from businesses appears most important. Recent empirical studies have shown that particularly innovative firms heavily rely on debt financing (e.g., Wu et al., 2016; Ernst, 2019; Geelen et al., 2022). Their innovation growth largely depends on whether and how broadly companies in each region have access to loans. In this regard, a positive relationship between the amount of corporate debt and innovation activity can be observed (Cumming et al., 2016; Geelen et al., 2022). These considerations are partially confirmed by Wu et al. (2016), who addressed the role of specific informal debt as an integral part of corporate debt. They demonstrated on a sample of 3,235 firms from 31 Chinese provinces that the relationship between informal debt and corporate innovations follows a reversed U shape, with an optimal level of informal debt. Concerning corporate debt, the dependence between its amount and potentially different impacts on innovations is often discussed. While excessive debt, often accompanied by a negative effect in the form of a rating downgrade, tends to limit corporate innovations, low debt, on the other hand, successfully stimulates them. This conclusion was demonstrated both in the EU context (Bonfatti and Pisano, 2020) and in China between 2016–2020 (Yao et al., 2022). However, it is not an entirely straightforward conclusion – there are studies that partially refute this belief – Geelen et al. (2022) for an extensive period from 1975–2010 in the American economy revealed that even with higher levels of corporate debt, innovation is supported. In this context, debt can stimulate innovations from new businesses, which outweighs the negative impact of debt overload on innovations in existing businesses (Geelen et al., 2022). Thus, while there may be some debate over the relationship between corporate debt and innovations, especially regarding the level of this debt, based on the findings, we establish the following hypothesis:

*H2: Non-financial corporation debt has a positive impact on innovation performance.*

Similarly to corporate debt, government debt may have an impact on innovations in the shape of a reversed U. Li and Zeng (2020) demonstrated that between 2011–2015, the increase in government debt had a negative impact on green innovations in Chinese industrial sectors. Similar conclusions were drawn by Zhang and Jin (2022) from 2011–2017, likewise in the context of the Chinese economy. The European perspective on this relationship, in turn, is offered by Coccia (2013), where in the environment of 27 European countries between 1995–2009, a significant negative impact of government debt was demonstrated not only on innovations but also on employment. Croce et al. (2019), in their research, additionally note that government debt significantly affects innovative companies compared to companies with low research and development activity. They confirmed this conclusion on quarterly macroeconomic data and data from selected American companies between 1975–2013. In fact, government debt through the growth of government expenditures can indeed effectively stimulate innovations, as it includes, among other things, expenditures on science and research; however, if there is insufficient revenue cover in the long term, government debt may represent a significant brake on innovation in the future (Coccia, 2013; Croce et al., 2019; Fan et al., 2022). The prevailing conclusions based on these findings lead us to formulate the following hypothesis:

*H3: General government debt has a negative impact on innovation performance.*

Drawing upon the findings of our comprehensive review of individual factors influencing innovation performance and the formulated hypotheses, we introduce a conceptual model for our study (see Figure 1)



**Figure 1: Research framework**

### 3. Data and Methodology

To construct a linear regression model, we gathered data from 25 European countries. The data were collected from IMF and Eurostat databases for the years 2013-2021. Thus, we compiled a panel dataset spanning 9 calendar years, comprising a total of 225 observations. Specifically, our dataset includes the following countries: Austria, Belgium, Bulgaria, Croatia, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, and Sweden.

The dependent variable in our regression model is the Global Innovation Index (GII) score. This index, ranging from 0 to 100, reflects the innovation performance of individual countries (Svačinová, 2020; Oturakci, 2023). The independent variables in this model are household debt (HHD), non-financial corporation debt (NFD), and general government debt (GGD). The control variable in this model is unemployment (UNE).

An overview of the variables used is provided in the following table (see Table 1).

**Table 1: Overview of Variables**

Type	Variable	Description	Unit	Source	References
<b>Dependent</b>	GII	Global Innovation Index	Score (0-100)	GII	Oturakci (2023)
<b>Independent</b>	HHD	Household debt	% GDP	IMF	Bernstein et al. (2017)
	NFD	Non-financial corporation debt	% GDP		Ernst et al. (2019)
	GGD	General government debt	% GDP		Coccia (2013), Fan et al. (2022)
<b>Control</b>	UNE	Unemployment	% of the population in the labour force	EUROSTAT	Coccia (2013)

As the first step of the analysis, it was necessary to normalize the data. Normalization was performed using the min-max method. After normalization, we could proceed to construct the linear regression model. The linear regression model was built using the Gretl software. In addition to the results, the calculation also included the coefficient of determination, which helps determine the appropriateness of using the linear regression model for our dataset. For a detailed procedure of this statistical method, see, for example, Darlington and Hayes (2016).

### 4. Results

From the results of the regression model, it follows that all independent variables we tested within the hypotheses emerge as significant. Furthermore, the coefficient of determination, with a value of 0.662, indicates a relatively high suitability of using the linear regression model on the input dataset.

**Table 2: Results of the regression analysis**

Independent	Coeff. Estimate	Std. Error	t-value	p-value	significance
CONST	0.308	0.026	11.960	9.81E-26	***
HHD	0.798	0.050	15.950	1.39E-38	***
NFD	0.254	0.055	4.671	5.22E-06	***
GGD	-0.217	0.069	-3.161	0.002	***
UNE	-0.372	0.073	-5.060	8.82E-07	***
<b>R-squared 0.662</b>					

Signif. codes: '\*\*\*' 0.01, '\*\*' 0.05, '\*' 0.1

Based on the results presented in Table 2, we reject hypothesis H1, as even though the household debt indicator emerges significantly at a 99% level of significance, it is important to note the positive coefficient value, indicating that household debt positively influences the innovation performance of the state. Non-financial

corporation debt also emerges significantly at a 99% level of significance, likewise with a positive coefficient. In this case, hypothesis H2 regarding the positive impact of the debt indicator on innovation performance is confirmed. Finally, we also confirm hypothesis H3 regarding the negative impact of government debt on innovation performance, as this relationship is significant in our model at a 99% level of significance and has a negative coefficient value.

## **5. Discussion**

Based on the established hypotheses regarding the impact of selected debt indicators on innovation performance in EU countries between 2013-2021, we can draw the following conclusions. Firstly, hypothesis 1 concerning the negative influence of household debt on innovation performance is rejected. It is worth noting that establishing this hypothesis was challenging, mainly due to the limited number of studies that have directly addressed this relationship. The lack of interest in this relationship may stem from the difficulty in proving the actual impact of household debt on innovation performance, implying the need for further research and analysis. We emphasize that in our model, the strength of this relationship is the greatest. By rejecting this hypothesis, we contradict the results of the study by Bernstein et al. (2017), which focused on examining this relationship in the context of the American economy between 2008-2012. Given the differing conclusions between our study and theirs, several questions arise: could the difference in results be attributed to changing trends during these periods, or the distinct characteristics of the American economy compared to EU countries? While the period 2008-2012 may more prominently reflect the impacts of the global financial crisis and economic recession, since 2013, the effects of this crisis may have been increasingly less pronounced in the economic development of individual countries. Furthermore, global economic growth in recent years has increasingly relied on innovation as a key factor supporting competitiveness and productivity. Considering the different specifics, policies, regulations, and approaches of the American and European economies is also pertinent. However, for more specific conclusions, it would be appropriate to conduct further research that examines these and other factors in more detail and their impacts on the relationship between household debt and innovation performance in different periods and regions.

We hypothesized, beyond our chosen indicators, that household debt negatively affects consumption (Ji et al., 2019; Du Caju, 2022; Wong et al., 2022), which a decline in would result in innovation constraints. However, this effect did not occur in our case. One reason may be that our study includes 25 EU countries, whereas the selected studies exclusively examined this relationship in one country. In this context, it is necessary to consider that the economies of individual countries are highly diverse, with different socioeconomic conditions, policies, and market structures. Therefore, the impact of household debt on consumption and innovation may vary in each country.

On the other hand, we confirm hypothesis 2 regarding the positive impact of non-financial corporate debt on innovation performance. This aligns with the findings of studies by Cumming et al. (2016) and Geelen et al. (2022). Thus, we lean towards the view that non-financial corporate indebtedness plays a crucial role in supporting innovation and technological development in the economy, even despite higher corporate debt levels. It is pertinent to mention the economic context with low interest rates in the global economy during the analyzed period, which provided businesses with broader and cheaper access to credit, undoubtedly stimulating their innovation performance.

While we do not directly refute the conclusions of any of the mentioned studies, it is essential to note some debate regarding the size of non-financial corporate debt and innovation performance – excessively high debt may have significant negative impacts on financial and economic stability in the future, whether at the level of companies, regions, or individual countries (Bonfatti and Pisano, 2020; Yao et al., 2022). In extreme cases, excessive corporate debt at the expense of innovation may lead to increased vulnerability of companies, which may face financial distress or even insolvency due to worsened market conditions. As a result, negative impacts such as increased unemployment, lower product supply, and overall reduced competitiveness can be expected. In terms of optimization in this area, solutions are available both on the side of companies, particularly in active debt management, monitoring, evaluation, and control of credit risks, and on the side of the government – support through financial instruments and programs that enable (not only) companies to finance their innovation projects without excessive indebtedness.

Government programs to support innovation are reflected negatively in the growth of government debt; therefore, it was necessary within hypothesis 3 to also examine the relationship of this indicator to innovation performance. We confirmed the findings of Coccia (2013) that the growth of government debt significantly limits the innovation performance of European countries. Like our other hypotheses, this one was also confirmed at

the 99% significance level, albeit with the lowest coefficient, which may indicate some diversification of this relationship across EU countries. The results of our study suggest that excessive growth in government debt may have serious consequences for the innovation environment (Coccia, 2013; Croce et al., 2019; Fan et al., 2022). Excessive government debt can lead to a limitation of available financial resources for investment in research and development on one hand and increased uncertainty and distrust in economic stability on the other hand. This trend can be particularly problematic in the long term, as a lack of investment in innovation may jeopardize long-term economic growth and the country's competitiveness. It is therefore essential for governments to carefully manage their public finances and ensure a favorable environment for innovative activities. In this context, Ege and Ege (2019) point out that a favorable innovation environment is not only subject to appropriate economic conditions (financing) but also to legal regulation, the political system, and social influences. If these pillars are suitably stimulated by public policy, innovation outputs can be achieved with significantly lower financial resources. This idea is also confirmed by a study by Muscio et al. (2015), which arrives at the innovation paradox, where higher government spending on science and research does not necessarily mean higher innovation performance. A typical example of this paradox is the long-term situation in Eastern European countries. Based on these findings, the future direction of innovation support policies should increasingly focus on supporting the circulation of knowledge (innovation incubators, support for university research) and the collaboration between the private and public sectors (Cirule and Uvarova, 2022; Redondo et al., 2022). When these sectors cooperate and share resources and know-how, it can lead to synergistic effects and enhance the innovation potential of the economy while simultaneously reducing pressures on the growth of public debt. In relation to fiscal sustainability, public financial support should serve more as a complement in stimulating the innovation environment in the future, with the goal of policymakers being to make it targeted and maximally effective.

## **6. Conclusion**

Our study provides important insights into the relationship between debt indicators and innovation performance in 25 EU countries during the period 2013-2021. From the perspective of the debt dilemma, that is, whether debt is more of a driver or a hindrance to innovation, we conclude that this question is not straight forward and its answer is intertwined with many variables. In our case, it was revealed that while private debt (households and non-financial corporations) positively influenced innovation performance in EU countries, government debt, on the contrary, represented a significant brake on innovation. However, in terms of the clarity of these conclusions, it is necessary to note their possibly overly categorical nature, which leads us to the limitations of this research.

It can be assumed that by extending the analyzed period, especially to include the financial crisis, the results of our study would differ, and it would also be possible to discuss the impacts when including the years 2022 and 2023. These years can also be perceived in relation to our analyzed period as very specific regarding debt - innovation (lingering energy crisis, war in Ukraine and its impacts, etc.). Furthermore, it is necessary to emphasize that our study has its limitations due to the inclusion of 25 different EU countries with diverse socio-economic conditions, different levels of debt, and varying capacities for successful innovation. This fact affects the accuracy of our conclusions and implications in individual countries. In terms of methodology, we must also mention that our regression model was able to explain roughly 66% of the variability in the original data.

Future research should focus more closely on the direct relationship between household debt and innovation performance, as this relationship cannot be considered sufficiently explored in the current literature. In relation to fiscal sustainability, government budget cuts and potential limitations on science and research will continue to be highly relevant and discussed. Therefore, it is important to pay increased attention to this research issue. Similarly, it is pertinent to examine to what extent private debt positively influences innovation performance and from what level negative effects begin to prevail. This level is very likely to differ across countries, so it is necessary to consider the division of countries into different groups, for example, according to the GII score used. Similarly, one can consider the analysis of other factors, such as institutional factors, that may influence the debt-innovation relationship. Their significance may vary from country to country and they have a significant impact on the creation of a high-quality innovation environment.

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