

# Impact of Financial Leverage on the Relationship between Eco-Innovation and Financial Performance: Conceptual Paper

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## Abstract

Sustainability is an issue that concerns all stakeholders, including shareholders and the environment. While shareholders are interested in creating value for their investments, environmentalists are interested in creating value for current and future generations. Eco-innovation may be a compromise between these stakeholders. It may even encourage shareholders to adopt it because green growth may boost their economic growth. Companies entering the world of eco-technology may mean that they need new sources of financing. This means that leverage, as a major source of financing, may play a fundamental role in enhancing or inhibiting these businesses. Therefore, this study encourages more research into the link between eco-innovation and corporate financial performance. Further, it encourages more research into how financial leverage can improve or weaken this link.

**Keywords:** Eco-Innovation, Financial Leverage, Financial Performance

## Introduction

For a long time, people have considered firms as a fundamental catalyst for innovation and the generation of knowledge (Przychodzen & Przychodzen, 2015). Due to today's fierce competition, globalization has become ubiquitous across all sectors. Continuous globalization and rapid technological progress have heightened the significance and necessity of open innovation, which is acknowledged as a vital component of the United Nations' Sustainable Development Goals for 2030 (Obradović et al., 2021). The open innovation paradigm has gained prominence in academic research and industrial applications (Obradović et al., 2021). Researchers have elaborated on the open innovation model over the years by delineating openness in multiple ways (Thao & Xie, 2024). Open innovation contrasts with traditional closed innovation, occurring when companies engage with various external partners during the innovation process (Ngo, 2023). Chesbrough and Bogers (2014) defined open innovation as a distributed innovation process that depends on intentionally managed knowledge flows across boundaries and utilises both monetary and non-monetary mechanisms aligned with

the organisation's business model to facilitate and encourage knowledge sharing. Lichtenthaler (2008) defined open innovation as systematically relying on a firm's dynamic capabilities to internally and externally execute the principal technology management tasks. Rauter et al. (2019) assert that this viewpoint hinges on the external integration of organisations with their stakeholders, including customers, suppliers, competitors, and research institutions. Mansour, Saleh, et al. (2024) argued that open innovation dynamics involve collaborative innovation strategies, where organisations partner with external entities to create new solutions or improve existing ones. They also argued that by implementing open innovation, enterprises can reduce expenses, mitigate risks, and shorten timelines in their production and innovation processes. In short, knowledge is a crucial asset, often serving as a company's competitive advantage.

Interestingly, there is evidence indicating that open innovation activities can serve as a catalyst for eco-innovation (Bo & Kexin, 2021; Mubarak et al., 2021). Eco-innovation is also known as green, sustainable, or environmental innovation. Chesbrough (2003) has highlighted that companies focused on eco-innovation are increasingly utilising open innovation strategies as the boundaries of internal and external knowledge become more fluid. The concepts of open innovation and eco-innovation have gained prominence in recent years due to the ongoing threats of global warming and environmental degradation, which significantly affect the global population (Tjahjadi et al., 2020). So, the necessity to address climate change and the environmental crisis is more urgent than ever, and innovation policies are essential for developing solutions (Arranz, 2024), in particular eco-innovation. Eco-innovation aims to reduce negative environmental impacts in comparison to competing products (Singh et al., 2022).

Put differently, eco-concerns have motivated practitioners and scholars for decades. Numerous environmental issues require businesses to prioritise conservation efforts for nature and the environment. Companies must differentiate their products, minimise production costs, improve product quality, and innovate processes to promote eco-growth and meet environmental protection standards (Lee & Min, 2015). Tough international rules, more eco-conscious consumers, and agreements on eco-innovation have caused big changes in competition and business strategies across all industries (Borsatto & Amui, 2019; García-Granero et al., 2018; Mansour, Saleh, et al., 2024; Takalo & Tooranloo, 2021). Proponents of environmental sustainability assert that eco-innovation mitigates expenses and enhances long-term financial outcomes (Yao et al., 2019). Also, because of pressure from stakeholders, companies are under a lot of pressure to improve the environmentally friendly things they do (Kraus et al., 2020) by using environmental management techniques (Borsatto & Amui, 2019). Because ecological innovation is so important to businesses, senior management needs to come up with the right policies and plans (He et al., 2021; Javed et al., 2023). The Chief Executive Officers (CEOs) possess the ultimate authority to determine all critical policymaking procedures, including the formulation of organisational policies, especially those pertaining to environmental sustainability and the execution of eco-friendly innovations (Hossain et al., 2023; Ullah et al., 2023).

Besides, eco-innovation encompasses the adoption of sustainable practices and systems, including the advancement of environmentally friendly processes and products (Tjahjadi et

al., 2020). Sustainability holds considerable importance, and the demand for eco-growth has become progressively urgent. Society now requires companies to convert their business models into sustainable frameworks through eco-innovation to sustain a competitive advantage. Currently, corporations globally are prioritizing their environmental performance (Fuentes-Fuentes et al., 2023). In short, eco-innovation is essential for attaining sustainable development, conserving energy, and safeguarding the environment (Ai et al., 2024). Hence, eco-innovation has become at the core of the corporate sustainability discussion.

Implementing sustainable practices is a crucial factor for contemporary enterprises (Shu et al., 2016). However, there needs to be a more balanced approach to both environmental sustainability and economic development because of rules and regulations, social pressure, smart consumers, and limited resources (Tang et al., 2018). This is especially true in economies that are growing quickly, where the conflict between environmental sustainability and economic growth is very strong. In this regard, eco-innovation initiatives are crucial for the ecological transformation of nations, and the prerequisite for companies to engage in eco-innovation is the potential for improved financial performance (Ai et al., 2024). As a result, eco-innovation strategies effectively harmonize environmental conservation and economic development (Tjahjadi et al., 2020). The significance of eco-innovation strategies has increased owing to their contributions to environmental sustainability, financial advancement, and enhancement of overall quality of life (Fuentes-Fuentes et al., 2023; Lin et al., 2019; Nadeem et al., 2020). In short, eco-innovation serves as a catalyst for economic advancement (Hordofa et al., 2023).

Zheng and Iatridis (2022) assert that manufacturing companies must confront environmental issues to achieve sustainable growth. Eco-innovation methods specifically prioritise environmental considerations while improving product design and packaging competitiveness (Aastvedt et al., 2021). These tactics significantly improve resource productivity for businesses. Resource-based theory says that incorporating eco-innovation into business practices can have a direct effect on profits and, in turn, improve firm performance (Asni & Agustia, 2022; Mansour, Saleh, et al., 2024; Przychodzen & Przychodzen, 2015). Gu (2023), Lee and Min (2015), and Tariq et al. (2019) affirm that the adoption of eco-innovation practices can enhance financial performance. Consequently, companies must prioritise environmental investments while maintaining profitability to satisfy shareholders' expectations (Zhang et al., 2019).

In fact, firm financial performance is influenced by two distinct consequences of eco-innovation: the cost effect and the compensation effect. Ai et al. (2024) argued that there are three main aspects of the compensatory effect of eco-innovation. First, eco-innovation reduces penalties for environmental pollution and increases legitimacy due to its contribution to enhancing environmental governance capabilities and energy efficiency. Second, eco-innovation enhances the overall firm financial performance, market share, and competitiveness due to its contribution to enhancing a firm's positive social image, enhancing sustainable competitive advantages, and enabling firms to obtain eco-patents (intellectual property). Third, firms engaging in eco-innovation are likely to benefit from favourable government policies, such as technical assistance, resource allocations, and policy loans.

Thus, the compensatory impact of eco-innovation on firm financial performance is positively affected by these factors.

Ai et al. (2024) also argued that there are three main aspects of the cost effect of eco-innovation. In the beginning, innovation theory says that eco-innovation has explicit costs, like fixed and variable costs and the transformation costs of eco-innovation into outcomes such as trial production fees. Second, cost theory says that eco-innovation has implicit costs of capital occupation, known as opportunity costs. These costs happen when more money is spent on eco-innovation instead of other opportunities or the chance for companies to grow, change, or improve. Finally, eco-innovation, according to innovation evolution theory, is risky due to market and technological uncertainties facing the innovation process, which jeopardizes the firm's reputation and legitimacy. Thus, the cost impact of eco-innovation on firm financial performance is adversely affected by these factors. In short, eco-innovation can be considered an investment project that has returns and incurs costs. The project achieves success when its returns surpass its costs, thereby achieving "*integrated sustainability*<sup>1</sup>."

In summary, ongoing innovation has become an essential strategy to address competitive, customer, and regulatory pressures (Fernando et al., 2019). Consequently, the sustainable innovation strategies have become exceedingly vital. Notwithstanding the international consensus on sustainable development (Al-Sanasleh et al., 2025a, 2025b), it is imperative to align incentives with the objectives of individual enterprises to foster eco-innovation and expansion. The results of eco-innovation are benefits; they help save energy and cut down on pollution; they make businesses more competitive; and they promote an eco-image, all of which have a positive effect on their financial performance (Ai et al., 2024; Xie et al., 2019).

However, Ai et al. (2024) claimed that eco-innovation requires a big initial fixed investment and ongoing cash flow support, which can cause financial losses and higher risks. This may adversely affect firm financial performance. Consequently, the correlation between eco-innovation and firm financial performance remains ambiguous. Ambiguous circumstances present numerous challenges when executing eco-innovation initiatives in firms. The study by Yao et al. (2019) demonstrated that eco-innovation and financial performance have a negative correlation. The influence of green innovation on corporate financial performance demonstrates heterogeneity (Ai et al., 2024). Yao et al. (2019) revealed that both eco-product and eco-process innovation negatively relate to firm value. The interactions between eco-innovation and regulation intensity, environmental agency pressure and public pressure are positively related to firm value.

The results of previous empirical studies are contradictory regarding the relationship between eco-innovation and firm performance. One important explanation for these conflicting results is that they may be affected by sample selection, analytical techniques, and empirical design (Zhang et al., 2019). Another important explanation for these conflicting results is that firm business outcomes, such as financial performance, environmental performance, management decisions, etc., are likely to be influenced a) by company-level differences, such as differences in capital structures and b) by country-level differences, such as economic,

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<sup>1</sup> "*Integrated sustainability*" uses here to describe financial sustainability performance and environmental, societal and governance sustainability performance.

social and institutional differences. Therefore, the present study proposes to empirically investigate the impact of these factors on the relationship between environmental innovation and firm performance. The present study will focus on financial leverage only.

Companies that want to innovate need to be able to support their efforts with a steady flow of cash because innovation initiatives are characterised by considerable investment, prolonged durations, and high risk (Becker et al., 2005). Previous studies have indicated that there are factors that restrict companies' ability to access consistent and adequate stable cash flow, which may hinder eco-innovation initiatives and negatively affect companies' performance. Financial leverage is one of these factors. Leverage ratio indicates a corporation's debt risk and is a crucial determinant of the likelihood of corporate default (Yang & Suh, 2023). In this regard, Ai et al. (2024) argued that firms with high leverage face greater debt risk and cannot easily access sufficient ongoing cash flows to support green innovation. This significantly increases the crowding-out effect of financial constraints, increases the risk of green innovation, and deteriorates firms' financial performance.

Elevated leverage correlates with increased average bankruptcy risk (Altman, 1984). The existence of asymmetric information and agency issues hampers creditors' ability to monitor and regulate managers effectively (Danso et al., 2019). As a result, lenders are dissuaded from providing loans to firms with high leverage, even when their investments yield positive net present values. The conviction that elevated leverage among corporations contributed to increased revenue led to a significant escalation in risk-taking behaviour during the decade leading up to the global financial crisis of 2007/2008 (Danso et al., 2021). The crisis weakened macroeconomic and financial frameworks, leading to increased operational instability across numerous developed and developing markets.

Additionally, Danso et al. (2021) contended that firm proprietors or executives may recognise the inefficiency in debt monitoring, suggesting that an escalation in leverage results in additional capital for pursuing inefficient or discretionary investments, thereby adversely impacting firm performance. Debt overhang issues can result in underinvestment, thereby causing suboptimal performance (Myers, 1977). Consequently, even when highly leveraged companies recognise new and favourable net present value investment opportunities, they may be unable to issue additional debt. When new debt is issued, the money made from new investments is used to pay off old debts. This means that new debtors may have trouble getting enough payments from the money made from new projects (Tsuruta, 2015). The inability to secure additional funding due to excessive leverage will prevent firms from capitalizing on potentially lucrative future investment opportunities that they are unable to pursue (Danso et al., 2021).

In contrast, acquiring external cash flow via leverage is a crucial avenue for companies to enhance investment in innovation. In this regard, Ai et al. (2024) contended that corporate eco-innovation initiatives are significantly reliant on external funding. Innovation endeavours are frequently protracted and perilous, necessitating stability and ample cash flow to guarantee ongoing advancement. Consequently, innovation initiatives necessitate financial backing, and internal funding is often inconsistent. This encourages companies to borrow money and use a small part of their own funds to handle a large amount of cash. This helps

ensure steady investment in R&D for green innovation (Ai et al., 2024). In short, leverage is an essential component of business activities, including corporate eco-innovation.

Ofek (1993) demonstrated that elevated levels of leverage typically result in enhanced firm performance. This happens because high leverage comes with strict rules and supervision that require management to stay disciplined in their operations. In simple terms, leverage helps with better supervision and makes it less likely for managers to act in their own interests. This keeps things in order by making sure that lenders' rights are upheld (Qian & Yeung, 2015). In addition, companies with high debt levels can quickly react to financial problems. Their management can easily make changes to operations, like asset restructuring and workforce reductions, or adjust financial plans, like reducing dividends or restructuring debt, if their performance drops. Consequently, the use of leverage contributes to maintaining the firm's sustainability. Further, capital structure plays a crucial role in shaping both strategic and operational decisions for most enterprises (Anderson et al., 2004).

Despite the importance of environmental innovation at the corporate and environmental levels, it has not received sufficient research (Mansour, Al Zobi, et al., 2024; Mansour, Saleh, et al., 2024). This paper posits several enquiries based on the aforementioned considerations: What is the correlation between eco-innovation and firm financial performance? Does leverage exacerbate the risks associated with eco-innovation and consequently impact firm financial performance? Answering the questions posed requires building a conceptual framework to formulate hypotheses that enable researchers to conduct empirical studies to determine how eco-innovation initiatives affect financial performance. Furthermore, it is crucial to ascertain how leverage influences this relationship. The results of future empirical research will provide evidence for regulatory and legislative bodies to revise or enhance eco-innovation regulations to satisfy all stakeholders, including those interested in protecting the environment or those interested in improving the self-esteem of their companies.

In summary, in recent years, businesses have faced growing pressure to adopt eco-innovation strategies to address environmental concerns while maintaining financial sustainability. However, the financial implications of eco-innovation remain ambiguous, particularly in the presence of financial leverage. While some firms benefit from eco-innovation through cost reductions, enhanced reputation, and regulatory compliance, others may struggle with the financial burden associated with green investments. This study is motivated by the need to bridge this gap and understand how financial leverage moderates the eco-innovation–financial performance relationship. By exploring this dynamic, we seek to provide actionable insights for both corporate decision-makers and policymakers aiming to promote sustainable financial growth.

This study contributes to the existing literature by integrating the concepts of eco-innovation, financial performance, and financial leverage into a unified framework, offering a novel perspective on corporate sustainability strategies. Unlike prior research that has largely examined eco-innovation in isolation, this study encourages more research into how financial leverage may strengthen or weaken the link between eco-innovation and financial performance. Future research findings can help firms optimize their financial structures while pursuing sustainability goals. Additionally, they will have practical implications for investors

and policymakers, offering guidance on fostering an environment where eco-innovation is both financially viable and strategically beneficial.

### **Literature Review and Hypotheses Development**

#### *Eco-Innovation and Financial Performance*

Green management, as proposed by ecological modernization theory, serves as a means for companies to incorporate environmental concerns into their operations by promoting innovation (Lin et al., 2019). Innovation is a crucial asset, often serving as a company's competitive advantage according to resource-based perspectives. Green management involves assessing the influence of sustainable practices on a company's competitiveness and profitability (Huang & Li, 2017). In the economic model, corporations are highly encouraged to spearhead innovation, particularly regarding environmental performance. Consequently, innovative sustainable solutions rapidly proliferated in the market, expediting the transition to a more sustainable paradigm. Hence, eco-innovation is likely to yield economic or financial benefits for corporations (Mansour, Saleh, et al., 2024). Eco-innovation and sustainable development have received substantial policy support, indicating a favourable future. Companies anticipate that eco-innovations will yield future advantages through cost reduction, including enhanced raw material utilisation and heightened consumer demand (Alos-Simo et al., 2020; Carrión-Flores & Innes, 2010), in accordance with transaction cost theory. Consequently, transaction cost economics profoundly influences eco-innovation.

Mansour, Saleh, et al. (2024) gathered distinct data from 383 worldwide non-financial corporations using the Refinitiv Eikon database from 2013 to 2022. They found a positive relationship between eco-innovation and corporate performance. Their findings substantiate that emphasising eco-innovation can benefit large corporations in various aspects, such as increasing productivity, circumventing penalties, entering new markets, enhancing environmental reputations, and securing a competitive advantage—all of which ultimately improve corporate performance. A sample of 88 environmentally innovative firms was analysed by Aguilera-Caracuel and Ortiz-de-Mandojana (2013), and the results revealed a positive correlation between green innovation intensity and firm profitability. However, in the comparison between green innovative firms and non-green innovative firms, it is noted that green innovative firms do not achieve enhanced financial performance. They argued that the link between green innovation and financial performance might be affected by national rules and standards, like strict environmental laws. Finally, Aguilera-Caracuel and Ortiz-de-Mandojana (2013) argued that green innovation includes new technologies that save energy, reduce pollution, or help recycle waste. It can also include designing eco-friendly products and corporate environmental management.

Doran and Ryan (2012) demonstrated that eco-innovation is more valuable than non-eco-innovation in determining firm performance. Wang and Ahmad (2024) used 280 publicly traded non-financial companies in South Asia. Data was collected from companies' annual and CSR reports spanning 2012 to 2022. They indicated that green innovation significantly enhances all metrics of financial performance. They argued that investing in sustainable product and process innovations can help businesses reduce environmental problems and avoid fines. This also allows them to create new market opportunities and achieve more success with their eco-friendly products. They also argued that creating environmentally

friendly products is closely linked to enhancing eco-competencies, bolstering a firm's eco-image, and augmenting its financial performance. Liu (2024) examined firm-specific data from the S&P 500 covering the period from 2001 to 2022. He indicated that the adoption of eco-innovation reduces firm volatility and credit risk while simultaneously improving firm value and emission performance. He argued that eco-investments and developing policies promote sustainability through eco-innovation. Zhang et al. (2019) examined manufacturing companies in China from 2000 to 2010 and discovered a positive and significant correlation between green patenting and firm performance. Their empirical findings demonstrated that the eco-innovation practices of manufacturing firms in China can generate long-term advantages for sustainable economic performance. In consideration of the preceding discourse, this study posits the following hypothesis:

*H1: There is a positive relationship between eco-innovation and financial performance*

#### *Interactive Effect of Financial Leverage and Eco-Innovation on Financial Performance*

Eco-innovation output necessitates substantial investments in research and development (R&D) and human capital, etc. Financing is required for these eco-innovation investments. The most likely financing options are debt and/or equity financing. The differences between using debt and equity to finance a company can impact its risk, profit, and growth. This means that the choice of financing can greatly influence management's decision to invest in risky research and development projects (Wang & Thornhill, 2010). In an impact market, leverage exerts ambiguous and intricate influence on corporate investment behaviours (Khan et al., 2019). The relationship between capital leverage and corporate investment is a prominent subject in the field of corporate finance (Chang et al., 2021). Previous research has been undertaken and yielded inconsistent and contradictory findings concerning the financial leverage-green innovation nexus. The same is true for the relationship between financial leverage and firm performance. In this context, it is crucial to understand how corporate eco-innovation impacts corporate financial performance under financial leverage.

Many researchers claimed that in most markets, the influence of financial leverage as a monitoring mechanism to enhance firm performance is minimal. Consequently, substantial cash flows resulting from financial leverage may prompt managers to engage in discretionary behaviours that negatively impact firm performance. Leverage adversely affects corporate investment returns more significantly in firms characterised by low-growth opportunities, elevated information asymmetry, and increased volatility (Aivazian et al., 2005; Danso et al., 2019; Doan & Nguyen, 2018; Vengesai & Kwenda, 2018; Vo, 2019). Green companies with high debt may face a greater risk of not being able to pay back loans and might find it hard to get new funding from outside sources. This challenges managers to rectify weaker balance sheets to reduce external financing costs, which could lead them to miss out on profitable investment chances (Gebauer et al., 2018).

Ai et al. (2024) argued that having too much debt creates financial risks, problems between owners and managers, and the chance of bankruptcy. These issues increase the risks and costs related to eco-innovation, which negatively affects a company's financial performance and adds to overall risk. This means that companies with a lot of debt face challenges getting funding, which makes it harder and more expensive for them to invest in environmentally friendly innovations. This can negatively affect their overall financial performance. Danso et



al. (2021) analysed data from 2,403 Indian firms spanning 1995–2014, yielding a total of 19,544 firm-year observations. Panel econometric techniques were utilised to examine the relationship between leverage and performance. They pointed out that financial leverage is negatively and significantly connected to firm performance. Iqbal et al. (2022) gathered firm-level data from the CSMAR database over a ten-year period, from 2007 to 2016. They found that leverage adversely affects output innovation, as indicated by the quantity of inventions. This indicates that leverage is more detrimental to the highest level of inventions in China.

However, other researchers suggested that having more debt reduces costs related to management by encouraging managers to work better for the benefit of shareholders. This is backed by evidence showing that higher debt levels are linked to better company performance. The ideal level of a firm's operating leverage is associated with investment objectives and production adaptability (Sarkar, 2018; Staglianò & Andrieu, 2017). Chang et al. (2021) argued that when companies have high debt levels, environmentally friendly firms might have better investment options and more profitable projects. This encourages managers to invest in these profitable opportunities, which helps reduce conflicts of interest between them and the shareholders. This study proposes the following hypothesis based on the preceding discussion:

*H2: Financial leverage moderates the relationship between eco-innovation and financial performance*

### **Conclusion**

This study seeks to improve sustainability research by encouraging more researchers to investigate how various institutional and dynamic factors affect the connections between different aspects of sustainability. More specifically, this study highlights eco-innovation as one of the most important indicators of sustainability and its impact on corporate financial performance as one of the most important tools of financial sustainability. This study shows that financial leverage is a main source of funding for companies, which can greatly affect their choices about operating and investing, like in eco-innovation. This study predicts that high debt ratios reduce efforts directed towards eco-innovation because they are busy generating cash flows to pay off debts, which means that firms' financial performance is likely to suffer.

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