THE EFFECT OF GREEN INNOVATION CAPABILITIES ON FINANCIAL PERFORMANCE

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THESIS APPROVAL PAGE

I certify that in my opinion the thesis submitted by Sara HAMID ALI ELAMAMI titled “THE EFFECT OF GREEN INNOVATION CAPABILITIES ON FINANCIAL PERFORMANCE” is fully adequate in scope and quality as a thesis for the degree of Master of Science.

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DECLARATION

I hereby declare that this thesis is the result of my work and all information included has been obtained and expounded by the academic rules and ethical policy specified by the institute. Besides, I declare that all the statements, results, and materials, not original to this thesis have been cited and referenced literally.

Without being bound by a particular time, I accept all moral and legal consequences of any detection contrary to the statement as mentioned earlier.

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Signature :

FOREWORD

Firstly, I would like to extend my deep and sincere gratitude to my supervisor, Prof. Dr. Serhan GURKAN, for his outstanding competence in supervision, outstanding guidance, exceptional expertise, and unwavering support throughout my research work. I greatly appreciate his assistance, prompt and timely responses, and invaluable insights, which greatly facilitated the timely completion of this research.

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ABSTRACT

Green innovation significantly enhances companies' competitive advantage, which can substantially improve a company's financial performance. This study investigates the impact of green innovation capabilities on financial performance. In this study, "green innovation" is represented by the "environmental innovation score," "environmental products," and "product impact minimization" scores created by Eikon Definitive and measured under the ESG score. Data from 47 automotive and automotive parts companies operating in 9 countries between 2012 and 2021 were utilized. The study's findings were obtained by analyzing ten different research models. In contrast to other studies, this research addresses financial performance under three distinct classifications, providing a detailed understanding of organizational performance. Furthermore, both historical and future performance expectations of businesses were considered in the study. Panel data analysis was employed for hypothesis testing. The results suggest that green innovation has significant and intricate effects on companies' financial performance.

Keywords: Green Innovation, Financial Performance, Sustainability, ESG Score.

ÖZ

Yeşil inovasyon, şirketlerin rekabet avantajını büyük ölçüde artırmaktadır. Bu durumun bir şirketin finansal performansını önemli ölçüde geliştirebileceği söylenebilir. Bu çalışma, yeşil inovasyon yeteneklerinin finansal performans üzerindeki etkisini incelemektedir. Çalışmada "yeşil inovasyon", Eikon Refinitive tarafından oluşturulan ve ESG puanı altında ölçülen "çevresel inovasyon puanı", "çevresel ürünler" ve "ürün etkisi azaltma" puanları ile temsil edilmektedir. Çalışmada, 9 ülkede faaliyet gösteren 47 otomobil ve otomobil parçaları şirketinin 2012 ile 2021 yılları arasına ilişkin verileri kullanılmıştır. Çalışmanın sonuçları, on farklı araştırma modelinin çözümü vasıtasıyla elde edilmiştir. Organizasyonel performansı ayrıntılı bir şekilde anlamak için bu araştırma, diğer çalışmalardan farklı olarak finansal performansı üç ayrı sınıflandırma altında ele almıştır. Buna ek olarak, çalışmada hem işletmelerin geçmiş performansları hem de gelecekteki performanslarına ilişkin beklentiler kullanılmıştır. Hipotez testleri için panel veri analizinden yararlanılmıştır. Sonuçlar, yeşil inovasyonun şirketlerin finansal performansı üzerinde önemli ve karmaşık etkileri olduğunu önermektedir.

Anahtar Kelimeler: Yeşil İnnavasyon, Finansal Performans, Sürdürülebilirlik, ESG Skoru.

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ARŞİV KAYIT BİLGİLERİ (in Turkish)

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ABBREVIATIONS

IS	**:** Innovation Score
EP	**:** Environmental Products
ESG	**:** Environmental, Social, and Governance Scores
PIM	**:** Product Impact Minimization
ROE	**:** Return On Equity
ROE12FWD	**:** Fwd Return on Equity 12m
RI	**:** Return Index
PB12FWD	**:** 2m Fwd Price/Book Ratio
MV	**:** Market Value

SUBJECT OF THE RESEARCH

The subject of this research revolves around the examination of the relationship between green innovation capabilities and firm financial performance within the context of sustainable manufacturing. It investigates the conceptual framework of green innovation, explores its definitions, and assesses its indicators, including environmental products, and product impact minimization. Additionally, the study delves into the non-financial assessment of enterprises and the importance of ESG (Environmental, Social, and Governance) scores. The central objective is to analyze how green innovation capabilities influence financial performance, employing panel data analysis and empirical results from a sample of companies operating in the automotive industry between 2012 and 2021. The research aims to provide insights into the effects of non-financial assessments on financial performance, thus contributing to a deeper understanding of the intricate interplay between green innovation and firm financial outcomes.

PURPOSE AND IMPORTANCE OF THE RESEARCH

The primary purpose of this research is to comprehensively investigate the relationship between green innovation capabilities and firm financial performance, with a particular focus on their implications for companies operating in the automotive and automotive parts sector. Green innovation, represented by indicators such as the environmental innovation score, environmental products, and product impact minimization, is at the core of this study.

The significance of this research lies in its ability to shed light on how green innovation can significantly enhance a company's competitive advantage, leading to substantial improvements in financial performance. By examining data from 47 companies across nine countries over nine years (2012 to 2021), this study offers a robust empirical analysis.

Moreover, the research uniquely categorizes and analyzes financial performance under three distinct classifications, allowing for a more nuanced and detailed understanding of organizational performance. It takes into account both historical and future performance expectations of businesses, providing a holistic perspective on the impact of green innovation.

Furthermore, the adoption of panel data analysis for hypothesis testing adds rigor to the study, reinforcing its credibility and validity. The research findings, which reveal the significant and intricate effects of green innovation on companies' financial performance, hold substantial implications for both academia and industry, offering valuable insights for businesses striving to integrate sustainability practices into their operations.

METHOD OF THE RESEARCH

This investigation employs panel data analysis as its primary methodology, which offers several advantages. One of the most apparent benefits is the utilization of a more extensive sample size for drawing meaningful inferences.

HYPOTHESIS OF THE RESEARCH / RESEARCH PROBLEM

The research hypotheses explore the relationships between green innovation scores and various financial performance indicators. Hypotheses 1a to 5c propose positive associations between different aspects of green innovation (green innovation score, environmental product score, and product impact minimization score) and financial metrics, including return on equity, the 12-month forward estimate of return on equity, total return index, the 12-month forward estimate of the price-book ratio, and market value. The study aims to test these hypotheses to determine if high levels of green innovation positively affect a company's financial performance and market valuation.

POPULATION AND SAMPLE (IF AVAILABLE)

The research applies stringent criteria for data selection from 2012 to 2021, focusing on green innovation activities. Criteria include 1) Automobiles & Auto Parts Companies, due to their significant environmental impact, regulatory pressures, consumer demands, cost-saving potential, and role in sustainability; 2) G20 countries, given their global environmental influence, resource consumption, air quality concerns, energy security, economic growth potential, and leadership role in international agreements; and 3) Ensuring complete data sets to avoid biases, reduced sample sizes, loss of information, and other disadvantages associated with missing data. The study utilizes data from 47 companies in 9 countries, meeting these criteria.

SCOPE AND LIMITATIONS / DIFFICULTIES

The study does have certain limitations that should be acknowledged. Firstly, the research relies on data collected from the automotive and auto parts sectors, which may limit the generalizability of the findings to other industries. Additionally, while panel data analysis allows for a larger sample size, it does not eliminate the possibility of omitted variable bias or endogeneity concerns. Furthermore, the study's results are based on the available data for the specified time frame, and factors outside of this period may not be considered. Finally, the research focuses on the relationships between green innovation and financial performance, which is a complex and multifaceted relationship influenced by various external factors not fully explored in this study.

1. THE CONCEPTUAL FRAMEWORK

This section has been created to explain the basic concepts in detail.

1.1. The Concept of Green Innovation

This study aims to explain the relationship between green innovation and financial performance. Green innovation has recently received increasing attention in the academic environment, and financial performance has improved over time. In recent years, companies have focused on green innovation as an important strategy to achieve sustainable development. Green innovation has recently received attention as a crucial element in the transition to more sustainable production and consumption models that seek to add value to a variety of stakeholders, including consumers and companies.

The concept of green innovation has three main components: organization, process, and product. The aim of the first two is to combine product innovation (product quality) and process innovation (production efficiency) with environmental objectives. The three concepts are complementary to each other as they all deal with resources and their characteristics, as well as their use, management, and collection methods (Triguero et al., 2013).

Innovation is the process of transforming an invention or concept into a product or service that is valuable to consumers or for which they are willing to pay a price. The customer requirements and expectations are better met as a result. As there are several different definitions of innovation, it is a popular area of research. Numerous studies have been conducted in the area of developing industries and inventions. According to studies on innovation, innovations increase productivity and profitability, increase efficiency, and reduce companies' investment costs (Hsu 2009). Rogers (1995) predicted many years ago that innovations with more advantages over existing products would be adopted faster and more widely.

Most businesses did not consider the advantages that green technologies could provide, such as the benefit of lower emissions that are associated with a higher selling price. One of the first studies to look at the effects on the environment was by (Russo and Fouts, 1997). They claim that effective corporate environmental management is crucial.

Green innovation has become a fundamental catalyst for the advancement of sustainable development due to businesses' perception that it serves as a mechanism to address consumer demands and regulatory requirements while simultaneously enhancing efficiency through the optimal utilization of natural resources. Despite the undeniable environmental benefits associated with green innovation, the impact it will have on corporate financial prosperity remains uncertain.

It has been widely acknowledged that a significant factor that impacts economic growth, environmental sustainability, and overall well-being is the concept of green innovation (Bansal and Gao, 2006; Dangelico and Pujari, 2010). Companies that are actively involved in green innovation are continuously undergoing a process of change and advancement, resulting in noticeable developments in the form of environmentally friendly products or technologies (Marcus and Fremeth, 2009).

Globally, green innovation strategies such as reducing materials and preventing air pollution are recognized as one of the main themes of sustainable development. These environmental issues can be addressed through green innovation, but according to several studies, the contribution of green innovation to business innovation portfolios is negligible (Hull and Rothenberg, 2008). The absence of green innovation may be due to barriers to this form of innovation, such as a knowledge gap, capital market aversion in the capital market, and insufficient political backing (Runhaar et al., 2008).

Previous research studies have shown that internal corporate governance, governing corporate operations, and environmental legislation will undoubtedly have an impact on the progress of environmentally friendly innovations. In addition, the implementation of these green innovations has the potential to achieve several competitive advantages, ultimately improving companies' overall sustainability. Furthermore, green innovations have been found to have great potential to significantly impact the financial performance of organizations (Abdi et al., 2022). However, it should be noted that there are some differences in the conceptual depiction of green innovation, as presented by many scholars (Chen et al., 2006; Driessen et al., 2013). Furthermore, it is important to acknowledge that there are various external factors associated with green innovation, as indicated by multiple sources (Rennings, 2000; Wiki and Hansen, 2019; Wang et al., 2020).

In 1996, the concept of green innovation was described as implementing practices that improve companies' financial performance. Furthermore, Borghese et al. (2015) define green innovation as introducing novel processes and allocating resources that can potentially reduce production costs and improve financial performance. Previous research shows the importance of green innovation for the economic and financial outcomes of companies, as well as for strengthening all organizations or companies (Asadi et al. 2020; Tamayo-Orbegozo et al. 2017).

Absorptive capacity has been found to significantly drive the impact of green innovation, and it has been experimentally found that green innovation significantly increases the competitive advantage of companies (Hashem 2019), and green innovation can be an important factor in improving the financial performance of companies. Therefore, there may be no final explanation for the emergence of green innovation if, as a result, the shortcomings can be overcome by investigating green innovation in multi-agent situations from several perspectives (Coelho 2022).

1.1.1. Definitions of Green Innovation

According to research by Rennings and Rammer (2011), the term "green innovation" encompasses various activities relevant institutions undertake to develop, implement, or introduce novel concepts, behaviors, products, and processes. These efforts are aimed at reducing administrative or financial costs. Incorporating green innovation into organizations is a multilayered process that draws on theoretical frameworks such as legitimacy, stakeholder, resource dependency, and higher-order theories.

According to the literature, there are general categories into which variables that affect green innovation can be divided. Contextual factors include (a) company characteristics, including company size and firm financial performance; (b) company characteristics at the firm level; and (c) internal factors, primarily related to the personality traits of individuals.

Green innovation can take various forms and can be technological, organizational, social, or institutional. However, it is generally divided into green product and process innovation (Rennings and Rammer, 2011). This study uses it to evaluate companies' innovation of green products (Berrone et al., 2013). In addition, a description of innovation was included in the patent files, allowing us to classify patents according to their technological area, such as companies.

Green innovation can be defined as developments that support corporate management processes and are called 'green innovation' (Chen et al., 2006). Green innovation can increase the value of a product and thus pay off for a company at the expense of reducing its impact. Green innovation is divided into two categories: product innovation and process innovation. To develop new products or processes, companies need motivation and the ability to develop unique and innovative ideas (Chen, 2009).

Studies on green innovation can generally be divided into two categories. While the second category considers green innovation to be the financial practices of a company, the first category defines green innovation as the capabilities of a company. This means that green innovation consists of new technological developments or management practices that improve the firm's financial performance.

1.1.2. Sustainable Manufacturing

Sustainable manufacturing involves companies committed to replenishing currently used resources and creating resources for the future, aligning with the ethical goal of achieving intergenerational equality. The field of sustainable development emphasizes the implementation of socially and economically equitable practices in the business sector (Foroughi et al., 2019).

Research on sustainable management systems in small and medium-sized manufacturing companies reveals that companies are in the early stages of implementation. Sustainable manufacturing practices are primarily suitable for production and process-orientated companies. Therefore, it is essential to consider the product life cycle and sustainable management, expanding beyond production and process-orientated approaches (Rosini and Hakim, 2021).

Sustainable development achievement through the design, development, and seamless integration of production processes depends on professionals with extensive training and expertise in sustainable development. The proportion of managers with academic qualifications is a notable measure of the "academics" variable. We hypothesize that board members' academic knowledge and experience can enhance the firm's potential for green innovation (Chavez et al., 2015).

In the successful implementation of innovation, various functions such as marketing and sales, product development, research and development, and production play vital roles throughout the innovation process. The business model must encompass a supply chain that supports a high level of effective competitiveness, including sourcing, manufacturing, and distribution. This consistent commitment to a sustainable production process through the introduction of green innovation is likely to provide companies with a competitive advantage.

Green innovation encompasses activities that lead to the provision of sustainable production processes and products, enabling companies to achieve their economic goals. Researchers have shown a growing interest in studying the origins and consequences of green innovation due to its importance in achieving sustainable development (Wong, 2013).

For small and medium-sized enterprises (SMEs) to thrive, especially in emerging economies, embracing innovation is essential for sustainable economic growth. Despite challenges and market competition, SMEs have taken the initiative to introduce green innovation. Factors such as financial resources, management style, human resources, production processes, technology, and innovation capability influence the management of green innovation in SMEs.

Corporate social responsibility (CSR) is a reliable long-term sustainable indicator for the future, introducing contemporary concepts that give credence to the evaluation of previously implemented measures (Duan et al., 2018). Green innovation plays a vital role in promoting the sustainable growth of manufacturing companies and enhancing their competitiveness in the market.

Using a sample of manufacturing firms, we experimentally tested our hypotheses. As emerging economies emphasize green innovation practices, manufacturing firms increasingly engage in green production and innovation, significantly affecting their financial success and sustainable growth.

Companies recognize that innovation is a decisive factor in gaining a competitive advantage in terms of financial profitability, accounting, stock market returns, and company expansion. A study by Geroski (2005) examined the impact of innovation and patents on various aspects of business performance, highlighting the predominantly indirect impact of innovation. Companies understand the value of progress, driven by factors such as intense global market competition and the added value of existing goods and services. Advancement remains one of the most crucial tools companies use to improve production processes, compete in the market, and build a solid reputation with their target audience (McAdam and Keogh, 2004).

1.1.3. The Importance of Green Innovation for Business

Performance in finance, business markets, and innovation are just a few examples of effective supply chain management. The risk of failure in the marketplace is one of the main issues with innovation; therefore, sharing resources and knowledge can speed up the innovation process and reduce costs. The main goal of collaborating with other partners is to gain access to this type of important resource, while also emphasizing how challenging it is for a company to have all the resources needed for innovation. Knowledge is one of the crucial factors required for creativity.

Some argue that a robust internal control environment discourages managers from engaging in risky innovative ventures, as the extensive controls required may hinder their efforts to engage in green innovative ventures (Bergeron and Zither, 2010). Conversely, others argue that an environment characterized by high-quality internal controls is more likely to alleviate financial constraints and improve firms' access to financial resources when a favorable and profitable medium arises, thus motivating managers to allocate funds to green innovation (Hall and Lerner, 2010).

Proactive individuals actively participate in the process of developing new ideas and systems. A diverse range of innovative activities is encompassed within a single composition. This composition also includes elements of high business value and long-term viability. Manufacturers and suppliers of various products and materials belong to this group of organizations. For these companies, the introduction of green innovation means a significant change in all areas of their operations. Green innovation can be seen as a systematic approach to innovation that encompasses all areas of business. As these players introduce green innovation into the rest of the value chain, this goes hand in hand with a proactive mindset.

Putting CSR into practice can help companies implement green supply chain management and green innovation. In this case, companies can understand that corporate social responsibility is a tool for enhancing the company's reputation among its customers. By using green supply chain management and green innovation strategies, environmental management organizations can improve customer satisfaction. Therefore, to achieve the goals of green supply chain management and green innovation and improve business performance, managers must understand the importance of corporate social responsibility.

The importance of green innovation for companies in promoting economic success and development is clear. Companies should also improve communication between suppliers, consumers, and other stakeholders and integrate green innovation initiatives into supply chain management. On the other hand, commercial organizations can make a financial contribution and promote the provision of resources more effectively. To achieve a "win-win" situation between environmental protection and economic development, policymakers should prioritize the organizational structure of business groups. Companies should also support green innovation and utilize the group's resources.

According to studies by Lin et al. (2013), Sukarno et al. (2019), and Tariq et al. (2019), the importance of green innovations in increasing business profitability and reducing risks is clear. However, according to several other studies (Testa and D'amato, 2017; Trump and Gunter, 2015), green product innovations do not seem to have a significant impact on business performance. According to the results, the relationship between green innovation and business performance needs further investigation.

1.1.4. Indicators of Green Innovation

According to Jimenez et al. (2012), green innovation is defined as all actions carried out by relevant stakeholders of an enterprise to encourage the creation and dissemination of methods, tools, management systems, and other tools that benefit the environment and help the organization achieve certain environmental goals.

According to Rodriguez et al. (2017) the most important indicators of green innovation are (i) When developing or designing products, companies choose materials that generate the least amount of pollution, (ii) When developing or designing products, companies choose components that use the least amount of resources and energy, (iii) Companies build or design their products with as few materials as possible, (iv) Companies will carefully consider how quickly their items can be reused, recycled and described for product development or design, (v) Effectively reducing emissions of hazardous substances or waste is the goal of the company's manufacturing process, (vi) Waste and emissions that can be effectively processed and reused are recycled during the manufacturing process of the company, (vii) Effectively reduce the company's use of water, energy, coal, and oil during production, Making a product efficiently reduces the need for raw materials.

According to Melander and Pazirandeh (2019), green innovation is a complex innovation development with many obstacles, where each character represents the ideal option for innovation and cooperation. Green innovation should be used in all departments of work to minimize waste. According to Sodwana et al. (2019), this method entails the creation of a management system based on a basic strategy that can outweigh external interests, such as customers and competing companies. Green innovation is determined by a ratio-based study of the company's annual report using several factors. The following are the indications that have been used: the product contains fewer non-useful or dangerous elements (green materials). Environmentally friendly products are used and materials or parts used in the manufacturing process can be recycled or regenerated (Agustina et al., 2019).

In parallel with the explanations in the literature, Thomson Reuters lists the following items as indicators of green innovation. Since we used Thomson-Reuters data in our analysis, we examine these indicators in more detail in this section.

1.1.4.1. Environmental Products

Environmental products, often eco-friendly or green, encompass goods and services meticulously crafted to exert minimal ecological impact throughout their life cycle. These products are frequently forged from sustainable materials, hewn using energy-efficient processes, and tailored for facile recyclability or responsible disposal. Illustrative instances include reusable water receptacles, energy-saving appliances, organic clothing, and biodegradable detergents.

Undeniably, the surge in green innovation across industries has materialized due to increased awareness and concern for environmental issues among communities and stakeholders. Gupta and Barea assert that green innovation, encompassing aspects such as processes, products, and marketing, represents the foremost recourse for companies striving to comply with environmental regulations while simultaneously manufacturing environmentally friendly products cost-effectively. However, the conception of green innovation involves substantial challenges and expenses, particularly in terms of technology implementation and development. Consequently, the necessity to spread green knowledge among companies emerges, separating it from conventional innovations.

Numerous studies (Boehe and Cruz, 2010; Cruz et al., 2013) underscore that the innovation and differentiation of environmental products can lead to significant reductions or even eliminations of environmental costs (Dunk, 2002). Environmentally responsible manufacturing and design have the potential to reduce environmental risks, increase productivity, enhance product quality at lower cost, and reduce waste generation (Zhang et al., 1997; Judge and Douglas, 1998). Environmental product quality emerges as one of the most formidable determinants of company performance (Gilley et al., 2000; Dunk, 2002; Douglas, 1998).

Firms producing environmental products must diligently cultivate relationships with their suppliers and employ tactics such as environmental audits and supplier vetting. Distinctions can be drawn between novel product developments and enhancements to pre-existing offerings. Furthermore, a dichotomy may be drawn between products whose environmental benefits stem from their functionalities or applications and those derived from innovations in the manufacturing process or clean technology initiatives.

Recognizing the burgeoning demand for components of environmental products is pivotal, as it stimulates companies to embrace environmental labeling more assertively than the influence exerted by the mere presence of such products on a firm's positioning.

Undoubtedly, environmental products, alternatively labeled as eco-friendly or green products, hold a particular allure for Chief Executive Officers (CEOs) due to their potential to engender positive change while harmonizing with corporate sustainability objectives. These products are meticulously crafted to mitigate their ecological footprint throughout their life cycle, from production to disposal. CEOs are essential in championing and propagating such products' development, production, and adoption within their organizations.

1.1.4.2. Noise Reduction

Noise reduction is a technique employed to diminish unwanted or irrelevant sounds, involving the identification and elimination of background noise while preserving the desired signal. Various methods, such as wave attenuation and the application of machine learning algorithms, are utilized. Noise reduction finds applications in sound processing, imaging, telecommunications, and more, contributing to improved clarity and the accentuation of crucial information amid surrounding noise (Dimitrijević et. al., 2017).

In an era characterized by growing environmental consciousness, the concept of noise reduction has transcended its traditional confines, extending into the realm of green practices and sustainability. As champions of change and innovation, CEOs are uniquely positioned to champion noise reduction initiatives within green contexts, contributing to a more harmonious coexistence of industrial progress and environmental equilibrium.

CEOs possess the potential to steer their company's trajectory. By endorsing sustainable technologies and practices, they can markedly reduce noise pollution in green contexts. From the integration of quieter machinery to investments in renewable energy sources like solar or wind power, executives can manifest their dedication to minimizing their firm's environmental footprint.

Effectively addressing the challenges of noise reduction, executives can collaborate with environmentalists, sound engineers, and other domain experts. By forging partnerships with noise mitigation specialists, executives can ensure that their greenfield projects are conceived and executed with maximal noise reduction considerations.

Executives can foster a culture of environmental consciousness among their workforce, instilling a sense of responsibility for noise reduction. Involving employees as active participants in the company's green initiatives can be achieved through training programs, workshops, and regular communication, reinforcing the message that everyone plays a role in accomplishing noise reduction objectives (Le, 2022).

1.1.4.3. Hybrid Vehicles Usage

Hybrid vehicles combine a gasoline engine with an electric motor to improve fuel efficiency and reduce emissions. They switch between the two power sources according to driving conditions. Hybrid cars are popular for their eco-friendliness and reduced fuel consumption, making them a good option for city driving and stop-and-go traffic. However, its effectiveness depends on the driving patterns and individual preferences of the user. Hybrid vehicles are considered a green innovation because they contribute to reducing greenhouse gas emissions and dependence on fossil fuels. By utilizing both gasoline and electric power, hybrids improve fuel efficiency and emit fewer pollutants compared to traditional gasoline-only vehicles. This technology promotes sustainability and environmental conservation, making it an important step toward a more eco-friendly transportation sector (Joohee, 2021).

Hybrid vehicles show the synergy between green innovation and financial performance. Their eco-friendly nature attracts environmentally conscious consumers, often leading to increased sales. Additionally, reduced fuel consumption translates into cost savings for owners over time. Companies that invest in hybrid technology can position themselves as forward-thinking and attract a customer base concerned about sustainability. This positive image, coupled with potential savings in fuel, contributes to improved financial performance and long-term viability in the market. (Wang H et al., 2018).

The benefits of using hybrid vehicles are numerous. They offer better fuel economy compared to traditional gasoline vehicles, leading to cost savings and reduced dependence on fossil fuels. Additionally, hybrids produce fewer greenhouse gas emissions and pollutants, contributing to improved air quality and a smaller carbon footprint. (Chai Wen and Mohd Noor, 2015).

The results of the study show that customer opinions on the emotional value associated with the use of hybrid vehicles have a significant impact on their attitudes towards these vehicles and their intentions to purchase them. Previous studies have found that emotional values have a significant and favorable impact on behaviors associated with environmentally responsible consumption (Gonçalves et al., 2016; Khan and Mohsin, 2017; Solaiman and Halim, 2017).

For example, Toyota's long-standing superiority in the global automotive market seems to be in jeopardy due to Tesla's recent entry into the luxury car market with its innovative electric vehicles (Johore, 2021). As a plan to challenge Tesla's disruptive electric cars, Toyota has also launched more radical product developments, introducing gasoline-electric hybrid cars, plug-in hybrids, battery-electric vehicles, and hydrogen fuel cell vehicles (Teece, 2018).

1.1.4.4. Product Impact Minimization

Reducing the product impact for environmental improvement in the field of green innovation involves creating solutions that address environmental challenges while promoting sustainable consumption and production. This includes developing products with minimal resource use, reduced emissions, and extended life cycles. Innovations may comprise advanced materials, energy-saving technologies, and intelligent design strategies facilitating repair, reuse, and recycling. By aligning with green innovation principles, companies can drive positive environmental change, promote economic growth, and contribute to a resilient and eco-friendly future (Smith et.al., 1990).

Minimizing a product's impact requires consideration of its environmental, social, and economic consequences. This can be achieved through sustainable design, responsible sourcing, efficient manufacturing, and waste reduction strategies.

Efforts to mitigate the environmental impacts of products are multifaceted, incorporating strategic approaches. Sustainable design, emphasizing the development of products with durability, reparability, and reliance on materials with lower environmental footprints, extends product lifespan and reduces replacement frequency, conserving resources. Life cycle thinking is integral, examining a product's lifespan from raw material extraction to disposal and identifying opportunities to minimize environmental impact at each stage (Matrix and CleanProd, 2010).

Efficiency in resource utilization is crucial, as is optimizing production processes to reduce energy consumption, water usage, and material waste. Embracing circular economy practices incorporating design principles enabling reuse, remanufacture, or recycling reduces new resource demand and waste. Conscious material selection, using renewable, biodegradable, or recyclable materials and avoiding harmful ones, is a part of this strategy.

Addressing environmental impact also involves strategic packaging solutions, favoring eco-friendly alternatives to minimize waste and avoid non-recyclable materials. Developing energy-efficient, low-emission products contributes to climate change mitigation. Consumer education is vital, enlightening them about the environmental consequences of their choices and promoting responsible usage and disposal (Tiberius et al., 2020).

Collaboration across the supply chain is indispensable for implementing sustainable practices. Adherence to regulations ensures that products meet environmental standards, minimize damage, and ensure safety. A commitment to continuous innovation is emphasized, as well as investing in research and development for new technologies, materials, and processes to further reduce products' environmental impact. Collectively, these strategies form a comprehensive approach to sustainability and minimizing the ecological footprint of products.

By adopting these methods, individuals and companies can significantly reduce the overall environmental impact of products.

1.2. Indicators of Financial Performance

Strategic business plans often include quality plans that align with the organization's mission and vision statements. Effective implementation of these plans involves personnel teams at all levels, focussing on consumer-focused strategic planning. The primary objective is to improve customer satisfaction, a crucial metric in strategic planning and measurement.

Measurement processes within an organization extend beyond traditional financial metrics, incorporating factors such as improvement and innovation. These broader goals emphasize strategic value in both innovation and continuous improvement.

Financial subsidies and tax incentives significantly influence business performance and innovation capacity. The development trajectory of each business is unique; Enterprise capability can navigate stable enterprises through innovation-driven transitions. In contrast, financial support is vital to the growth and innovation of emerging firms. This study uses the age of the enterprise and economic indicators as control variables to differentiate established and growing businesses, validating the moderating impact of financial aid and tax incentives.

Financial performance indicators, including those related to the Joint Cooperative Programme (JCP) and financial ratios, are essential for company-wide analysis. Operational effectiveness, driven by the CEO and Standing Committee, is crucial for working capital management and ultimately impacts the bottom line.

Senior executives typically focus on financial performance indicators such as sales, profits, stock prices, and capital costs. These indicators align with supply chain goals across organizations. Management of business operations is key to financial outcomes, reflecting the integrated movement of goods, information, and money. There is also a focus on a range of financial performance indicators that consider the capacity of the supply chain from a short-term perspective.

If evaluation of business performance is possible using financial indicators, the data may come from primary or secondary sources. These indicators include operational versus financial metrics and their respective data sources. Key financial indicators are as follows:

Return on Equity (ROE): This measures the efficiency of generating profits from shareholders' equity. As Van Horn and Wachowicz (2005) suggested, ROE is dependent on its existence and impacts asset values.

Return on Asset (ROA): ROA indicates how effectively a company uses its assets to generate profits, varying between sectors due to capital investment differences. ROA is calculated by comparing net income with total assets (McRae et al., 2014).

Net Income: This reflects a company's performance over an accounting period and is linked to market risk (Rusdiyanto and Narsa, 2019). Under Financial Reporting

Standards, net income includes accruals from revenue recognition and fair value adjustments (Barth et al., 2001a; Dechow and Schrand, 2004).

Book-to-Market Ratio: This ratio indicates a stock's value, revealing whether a company is undervalued and its attractiveness to investors.

Market Value: Calculated as the sum of common and preferred stock, long-term debt, and short-term net assets debt. Market value reflects future cash flows and asset liabilities (Rust, Lemon, and Zeithaml, 2004).

Price-Earnings Ratio: Defined by Brigham and Houston (2006), this ratio indicates how much investors are willing to pay per dollar of earnings, correlating with expected earnings growth.

These indicators provide a comprehensive framework for assessing business performance from multiple financial perspectives.

1.3. Non-Financial Assessment of Enterprises

The participation of female directors, the educational backgrounds of directors, and the percentage of independent commissioners do not significantly impact the quality of profits in nonfinancial companies. However, the development of integrated reporting, which combines financial and non-financial indicators to reveal an entity's economic and social dimensions over short, medium, and long terms, is a notable advancement in business information disclosure.

The number of enterprises engaging in nonfinancial reporting is increasing, yet challenges persist in applying current rules and reporting frameworks effectively. This undermines the credibility of nonfinancial reporting. A detailed study of the approaches and principles of nonfinancial reporting is crucial for addressing these challenges and enhancing these reports' practical and scientific utilization.

Furthermore, it is essential for companies, especially micro, small, and medium enterprises in construction, to understand and choose optimal project financing options. This is crucial to promote sustainable cities and environmental practices (Rostami et al., 2014).

Digital transformation can alleviate financing constraints for nonfinancial companies, which often face high financing restrictions and resort to unregulated financing sources due to limited access to formal finance (Si Dengue et al., 2022; Sun Zhidong and Liu Dingdong, 2022). Digital tools can improve the accuracy of risk assessment, management supervision, and investment decision-making, reducing speculative activities and shadow banking in non-financial institutions (Lin Chuan et al., 2022; Zhao Shi and Xu Ningning, 2013; Dingkui et al., 2022). Analysts, institutional investors, and state control organizations play vital roles in external supervision, and the digital revolution is expected to intensify their focus, particularly in offshore market supervision, thereby curtailing shadow banking in non-financial companies (Wang Zhuhai et al., 2022).

The financing structure of nonfinancial companies has evolved, indicated by an increasing share of debt in their financial structures and the growing influence of capital markets on the value of securities, affecting the credit ratio for financing business activities. Expanding financial obligations for derivatives is another aspect of this shift (Reattack, 2012, p. 291).

Finally, it is important to acknowledge the heterogeneity in the underlying definitions when discussing non-financial reporting or statements. The terms 'non-financial,' 'non-financial reporting,' 'non-financial disclosure,' and 'additional financial information' vary in usage frequency (Protein et al., 2014).

2. GREEN INNOVATION CAPABILITIES AND FIRM FINANCIAL PERFORMANCE

2.1. The Effects of Non-Financial Assessment on Financial Performance

The disclosure of non-financial statements, providing a more comprehensive and meaningful insight than financial statements alone, is gaining prominence in scientific and business circles. This shift reflects the growing importance of non-financial assets in determining a company's value. Non-financial reporting includes various types of external reporting that extend beyond traditional financial performance, offering stakeholders crucial insights and influencing investment decisions.

Kaplan and Norton (2005) developed a performance measurement system encompassing financial and non-financial perspectives, including customer satisfaction as a key non-financial indicator. This broad and adaptable approach is effective in general corporate metrics. Libby and Salterio (2000) found that such metrics significantly influence managers' performance evaluations. On the contrary, Libby, Saltire, and Webb (2004) observed that specialized measures in management performance assessment increased the demand for assurance reports.

Customer metrics, as identified by Kaplan and Norton (2005), are pivotal non-financial performance indicators. These metrics, which are difficult for many companies to measure, include customer satisfaction, market share and retention, and profitability. Niven (2002) emphasizes that understanding these metrics as performance motivators is essential.

The Global Reporting Initiative and the International Council provide comprehensive guidelines for non-financial disclosure reporting, making them a vital multi-stakeholder information source. Investors highly seek reports adhering to these global standards for their thorough insight into company operations (Hohmann, 2012; Greenpeace, 2013).

The impact of non-financial data disclosure on financial performance varies significantly across industries. While some sectors may experience a strong positive impact, others may not see any notable benefits. Investors consider various aspects of different industries when making decisions, reflecting the diverse impacts of non-financial data publication.

2.2. The Relationship between Green Innovation and Financial Performance

The relationship between green innovation and financial performance is complex. While innovation influences competitiveness and financial incentives (Ernst, 2001; Klein and Rosenberg, 2009), empirical evidence supporting performance improvement through innovation is not always conclusive (Bowen et al., 2010; Rosebush et al., 2011). The success of innovation depends on multiple factors, including innovation management style, timing of product market introduction (Van der Pan et al., 2003), and internationalization (Kufuor et al., 2008).

Studies examining green innovation's impact on competitiveness have yielded mixed results. Fernando et al. (2009) found no significant performance advantage for green companies over environmentally neutral ones, while Cordero and Sarkis (1997) identified a negative correlation between environmental activity and company performance.

However, numerous studies confirm the performance benefits of green innovation. Innovations aligned with environmental regulations can reduce costs or add value by enabling efficient resource use (Lindy and Porter, 1995). Green innovation, through recycling and waste reduction, not only cuts costs but also allows for premium pricing by appealing to environmentally conscious consumers. This dual strategy of cost leadership and market differentiation can enhance financial performance (Caracuel and Ortiz de Mando Jana, 2013).

Implementing green innovations has been shown to positively impact financial metrics. Companies with at least one type of green innovation have shown higher equity and profit retention returns than others (Przychodzen and Przychodzen, 2015). Both process and product innovations have been observed to improve financial indicators (several et al., 2017; Xie et al., 2016). Sustainable product development has also positively affected company profitability and value (Miroshnychenko, et al., 2017).

Green innovation performance can be categorized into direct, indirect, and cognitive outputs. Financial success from green innovation, though not always immediate, can manifest itself in green products, processes, knowledge accumulation, and other elements (Banerjee et al., 2003; Leonidou et al., 2017; Zameer et al., 2020; Panet et al., 2017).

A company's investment in green innovation research and development signifies its commitment to addressing environmental challenges. Digital transformation plays a crucial role in enhancing green innovation, especially in IT-listed companies, by facilitating data flow, improving information transparency, reducing internal and external information asymmetry, and lowering transaction costs. This, in turn, enables companies to become more financially capable, attract external investments, and overcome financing constraints.

2.3. Environmental, Social and Governance (ESG) Score and Its Importance

ESG, defined as environmental, social, and governance factors in investment processes, is used to assess a company's sustainability performance (Rebecca and Maci, 2021). According to Corporate Finance (2020), ESG investment, synonymous with socially responsible or sustainable investing, is gaining traction.

Investors increasingly rely on ESG ratings to evaluate companies based on their stakeholder treatment and environmental impact (Reutilize and Ruston, 2021). Consequently, ESG scores serve as a robust representation of stakeholder theory, which posits that a company should create value for all its stakeholders, not just shareholders (Freeman, R. E., 1984).

Practitioners use environmental, social, and governance ratings as tools to gauge the success of these dimensions in influencing equity performance (Dorf Leitner et al., 2015). However, the impact of a company's ESG performance on stock returns depends largely on the specific rating agency.

Other entities offer ESG scores as a novel way to assess company operations, focussing on the company's impact on key pillars rather than traditional financial reports. Recent studies highlight a growing understanding of the superiority of ESG in decision-making processes, indicating a shift in investor expectations towards ESG strategies (Felt 2017).

Felt (2017) also found that ESG scores influence financial performance. Studies show a positive relationship between ESG performance and corporate yield, although the impact may vary (Dalal and Thacker 2019).

Academic publications frequently refer to ESG scores (Reber et al., 2022; Shakil, 2021). These scores, ranging from 0 to 100, allow investors to compare a company's performance against its industry peers and across different industries. Companies with strong ESG scores can appeal more to investors who value the company’s commitment to ESG principles or seek mitigation of risk from environmental or poor governance issues.

ESG scores play several key roles: in guiding investment decisions, indicating a company’s commitment to sustainability and ethical standards; in risk mitigation, where high ESG scores suggest robust risk management and resilience to environmental and social challenges; in improving reputation and brand, as effective ESG practices can improve a company's image and attract customers; and in ensuring long-term sustainability, by addressing societal and environmental challenges.

Refinitiv provides ESG data for more than 9,000 companies, covering a significant portion of global market capitalization in 76 countries. This database, dating back to 2002, offers comprehensive ESG analyses and assigns a supplementary rating on a scale from 0 to 100 (Refinitiv, 2020). Widely used by academics and professional investors, Refinitiv's ESG source is recognized as one of the most comprehensive in the industry. ESG scores attempt to measure a company's environmental and governance performance, with scores scaled from 0 (lowest) to 100 (highest) based on relative performance within sectors and countries (Refinitiv, 2020). After its acquisition by Thomson Reuters in 2009 and subsequent renaming to Refinitiv in 2018, the company provides ESG subscores derived from data metrics across various categories. Major asset managers like BlackRock use Refinitiv ESG data to manage investment risks related to environmental, social, and governance factors.

2.4. Literature Review

Green innovation refers to the creation of new technologies and policies in product development, production, enterprise management, and marketing, focusing on environmental sustainability alongside financial goals. This concept is increasingly recognized as a key path to sustainable development in the business world.

The innovation capability index assesses the availability of innovation resources, new knowledge generation, enterprise innovation performance, and the innovation environment. Evaluating green innovation capacity is crucial for assessing investment correctness, resource allocation, and macro-policy effectiveness.

Academic efforts have enhanced the assessment of green innovation capability, with comprehensive and scientifically designed index methods. A popular research area is building assessment systems based on the green innovation process. For instance, Garcia Garner et al. use four criteria – product, process, organizational, and marketing innovation – to evaluate green innovation extent, focusing on the value chain principle.

Green innovation encompasses new or modified goods and actions, including administrative and organizational innovations that support sustainability. Growing consumer concerns about environmental protection make innovation management a strategic planning element. Financial performance benefits suggest a "win-win" situation, distinguishing green innovation from other strategies due to its positive externalities and indirect impacts.

Legal requirements establish green innovation fundamentals, but internal company factors like organizational cultures and resource availability also influence it. Companies must fulfill social obligations and invest significantly for long-term rewards, enabling a sustainable performance enhancement approach.

Green innovation improves financial performance by creating eco-friendly products and enhancing operational and management efficiency. It adheres to sustainability standards, creating a new business model and opportunity by mitigating harmful effects.

Green innovation meets diverse customer needs and enhances company image, increasing market share and profits. It offers competitive advantages, allowing companies to price products higher and use raw materials more efficiently by reducing waste.

The definition of green innovation varies, with terms like ecological innovation and sustainable innovation (Angelo et al., 2012). Varadarajan (2015) found limitations in literature definitions, but all aim to reduce environmental impact by improving resource efficiency (Tsai and Lee, 2018). Angelo et al. (2012) describe it as applications and organizational changes focusing on corporate products, manufacturing, and marketing.

Gopalakrishnan and Damanpour (1997) view green innovation as a multi-stage process involving research, development, invention, and patents. Green patents are the initial results of this process, requiring inputs like financial resources and R&D investments.

Xu et al. (2019) see green innovation as a strategy for achieving company goals, focusing on cost reduction and product differentiation (Sillito et al., 2020). Khan and Jull (2019) suggest holistic adoption of green innovation aids in reducing production costs and environmental impacts.

Studies like Gamier and Tarry (2009) find a positive correlation between green management and financial performance. Low-carbon marketing innovation mediates the relationship between organizational performance and green complex orientation. Duran and Ryan (2012), along with Azurin and Curtis (2009), emphasize the significance of environmental innovation in evaluating company performance.

3. THE ANALYSIS OF GREEN INNOVATION CAPABILITIES ON FIRM FINANCIAL PERFORMANCE

3.1. Data Collection and Sample

This section explains the data collection and samples for 2012-2021 collected through Green Innovation activities. Panel data is used to improve hypothesis testing. To enhance environmental management and corporate innovation initiatives, corporate managers are gradually becoming aware of the necessity of managing climate change, and data collected by Customs and Protection is increasingly being used in studies related to the environment and sustainability (Dawkins and Fras 2011b; Kim and Lyons 2011; Lu, Lan, and Tang 2012). Based on this information, we explain the criteria we used to select the data set in detail below.

Sample Selection Criteria of Research:

Criteria 1. Automobiles & Auto Parts Companies

Green innovation is of paramount importance for automobile and auto parts companies for several compelling reasons. Although sustainability and environmentally friendly practices are relevant in many industries, the automotive sector stands out due to its unique role in environmental impact, regulatory pressure, and consumer demands. Here are some reasons why green innovation is more critical for this sector:

Environmental Impact: The production of automobiles and automobile parts has significant environmental footprints. These industries are responsible for substantial global greenhouse gas emissions, resource consumption, and waste generation. Green innovation is essential to reduce these impacts and promote environmental stewardship.

Regulatory Pressure: Governments around the world are imposing stringent regulations to combat climate change and reduce air pollution. Auto companies face emissions standards, fuel efficiency requirements, and emissions testing, which require green innovation to comply.

Consumer Demand: Today's consumers are increasingly conscious of their environmental footprint and seek eco-friendly products. Green innovation can help auto companies meet consumer expectations, attract a more environmentally conscious customer base, and maintain market relevance.

Cost Reduction: Implementing green innovations such as lightweight materials, energy-efficient manufacturing processes, and electric powertrains can lead to cost savings through improved fuel efficiency, reduced waste, and lower operational expenses.

Competitive Advantage: Companies that invest in green innovation can gain a competitive edge. They are more likely to secure government incentives, access new markets with environmentally friendly regulations, and collaborate with partners and suppliers that prioritize sustainability.

Long-term Viability: The automotive industry is in a state of transformation. Internal combustion engines are gradually being replaced by electric vehicles and alternative propulsion systems. Companies that do not adapt to this shift risk obsolescence. Green innovation is essential to remain relevant in this evolving landscape.

Supply Chain Resilience: Green innovations in supply chains, such as sustainable sourcing, recycling, and waste reduction, contribute to a more resilient and reliable supply chain, reducing vulnerabilities to resource scarcity and price fluctuations.

Public Relations: Auto companies that engage in green innovation benefit from positive public relations and improved brand image. This can lead to greater customer loyalty and goodwill, which is vital for long-term success.

Innovation Ecosystems: The automotive sector is often at the forefront of innovation, and green innovation is a natural extension of this trend. Collaboration with start-ups, research institutions, and tech companies can lead to breakthroughs that benefit both the automotive industry and the broader sustainability agenda.

In conclusion, green innovation is more critical for automobile and auto parts companies than many other sectors due to the unique combination of environmental impact, regulatory pressures, consumer demands, and the industry's pivotal role in transportation. Companies that embrace green innovation can reduce their ecological footprint, improve their competitiveness, and position themselves for long-term success in an increasingly sustainable world.

Criteria 2. G20 countries

Green innovation is particularly important for G20 countries, which represent some of the world's largest and most economically influential nations, for several significant reasons:

Environmental Impact: G20 countries typically have higher levels of industrialization, energy consumption, and greenhouse gas emissions. Their economic activities have a substantial global environmental impact. Therefore, your commitment to green innovation is essential to mitigate these effects and address pressing global environmental challenges such as climate change.

Resource Consumption: The G20 countries are the main consumers of natural resources. Green innovation is crucial to reducing the strain on ecosystems and non-renewable resources, helping ensure the sustainability of these nations' economic growth.

Health and Air Quality: High levels of industrialization and urbanization in G20 countries can lead to air pollution, which has adverse effects on public health. Green innovation in sectors such as transportation and energy production is vital to reduce air pollutants and improve the well-being of their populations.

Energy Security: Many G20 countries rely heavily on fossil fuels for energy production. Embracing green innovation, such as transitioning to renewable energy sources and improving energy efficiency, helps reduce their dependence on fossil fuels and enhances energy security.

Economic Growth and Job Creation: Green innovation can drive economic growth by creating new markets, generating investment opportunities, and fostering innovation. It also leads to the creation of jobs in sectors such as renewable energy, sustainable agriculture, and the development of clean technology.

Technological Leadership: By leading in green innovation, the G20 nations can assert technological dominance and drive global standards. This not only strengthens their economies but also provides opportunities for exports and collaboration with other nations.

Global Responsibility: The G20 countries are seen as leaders in international politics and economics. Their commitment to green innovation sets a strong example for other nations, encouraging them to follow suit and work collectively to combat global environmental challenges.

Reducing Vulnerability to Climate Impacts: Many G20 countries are susceptible to the adverse effects of climate change, such as extreme weather events, rising sea levels, and water scarcity. Green innovation can help mitigate these impacts and improve resilience.

Mitigating Social Inequalities: The benefits of green innovation, such as cleaner air, energy access, and sustainable agriculture, can reduce social disparities within the G20 nations, ensuring that the advantages of a green economy are distributed more equitably.

International Agreements: The G20 countries are central to international climate negotiations and agreements. Demonstrating a solid commitment to green innovation is essential to meeting the goals in agreements such as the Paris Agreement and the United Nations Sustainable Development Goals.

In summary, green innovation is of greater importance for G20 countries than others due to its substantial economic influence, environmental impact, resource consumption, and role in shaping global policies. These nations have a unique opportunity and responsibility to lead the transition toward a more sustainable and environmentally responsible future, benefiting both their populations and the world at large.

Criteria 3. We selected companies from which we could get all the variables for 2012 – 2021.

Analyzing data with missing values can introduce several disadvantages and challenges that can affect the accuracy and reliability of the analysis. Here are some of the disadvantages of conducting analyses with missing values:

Biased Results: Missing data can lead to biased or inaccurate results, as missing values may not be completely missing at random (MCAR). If the missingness pattern is related to the variables studied, it can skew the conclusions.

Reduced Sample Size: Missing data reduces the effective sample size available for analysis. A smaller sample size may result in less statistical power and may reduce the ability to detect significant effects or relationships.

Loss of Information: Missing data can result in the loss of valuable information, reducing the richness of the dataset. This may limit the insights that can be gained from the analysis.

Selective Nonresponse: In some cases, individuals or data points with missing values may systematically differ from those with complete data. This can introduce selection bias, which can lead to incorrect conclusions.

Imputation Errors: To address missing values, imputation methods are often used to estimate or fill in missing data. However, imputation introduces uncertainty, and the chosen imputation method may not accurately represent the true values, leading to potential errors in the analysis.

Increased Complexity: The handling of missing data adds complexity to the analysis process. Researchers must choose appropriate imputation methods, consider the nature of the missing data (MCAR, MAR, or MNAR), and assess the impact of imputation on the results.

Misinterpretation of Results: Failure to account for missing values or improper handling can lead to a misinterpretation of the results. Analysts may draw conclusions based on incomplete or biased data, which can be misleading.

Difficulty in Replication: In research and scientific studies, the inability to replicate findings due to missing data can hinder the validation and credibility of the research.

Ethical Concerns: In some cases, missing data may be due to nonresponse or refusal to provide information. Handling this can raise ethical concerns, especially if sensitive or personal data is involved.

Time and Resource Intensive: Handling missing data requires additional time and resources for data cleaning, imputation, and sensitivity analyses. This can increase the overall cost and complexity of a research project.

To mitigate these disadvantages, it is crucial to handle missing data systematically and transparently. Researchers should carefully consider the nature of missing data, choose appropriate imputation methods, and report the strategies used to address missing values in their analyses to ensure the validity and reliability of their results.

Table 1: List of the Companies

No	Company Name	Country Origins
1	MAGNA INTERNATIONAL INC	Canada
2	BYD CO LTD	China
3	GUANGZHOU AUTOMOBILE GROUP CO LTD	China
4	FAURECIA SE	France
5	RENAULT SA	France
6	STELLANTIS NV	France
7	BAYERISCHE MOTOREN WERKE AG	Germany
8	CONTINENTAL AG	Germany
9	MERCEDES BENZ GROUP AG	Germany
10	VOLKSWAGEN AG	Germany
11	BAJAJ AUTO LTD	India
12	MAHINDRA AND MAHINDRA LTD	India
13	MARUTI SUZUKI INDIA LTD	India
14	TATA MOTORS LTD	India
15	TOYOTA BOSHOKU CORPORATİON	Japan
16	YOKOHAMA RUBBER CO LTD	Japan
17	BRİDGESTONE CORPORATİON	Japan
18	SUMİTOMO RUBBER INDUSTRİES, LTD.	Japan
19	NGK SPARK PLUG CO. LTD.	Japan
20	SUMITOMO ELECTRIC INDUSTRIES LTD	Japan
21	TOYOTA INDUSTRIES CORP	Japan
22	NSK LTD	Japan
23	JTEKT CORP	Japan
24	DENSO CORP	Japan
25	STANLEY ELECTRIC CO LTD	Japan
26	NISSAN MOTOR CO LTD	Japan
27	TOYOTA MOTOR CORP	Japan
28	NOK CORP	Japan
29	AISIN CORP	Japan
30	HONDA MOTOR CO LTD	Japan
31	SUZUKI MOTOR CORP	Japan
32	SUBARU CORP	Japan
33	KOITO MANUFACTURING CO LTD	Japan
34	TOYODA GOSEI CO LTD	Japan
35	KIA CORPORATION	South Korea
36	HYUNDAI MOTOR CO	South Korea
37	HYUNDAI MOBIS CO LTD	South Korea
38	HANKOOK TIRE & TECHNOLOGY CO LTD	South Korea
39	FORD OTOMOTIV SANAYI AS	Turkey
40	TOFAS TURK OTOMOBIL FABRIKASI AS	Turkey
41	BORGWARNER INC	USA
42	FORD MOTOR CO	USA
43	GENERAL MOTORS CO	USA
44	GENTEX CORP	USA
45	GOODYEAR TIRE & RUBBER CO	USA
46	LEAR CORP	USA
47	TESLA INC	USA

According to our sample selection criteria, we used data from 47 companies in 9 countries during the period 2012-2021. Table 1, shows the list of analyzed companies and their origins.

3.2. Variable Descriptions

In this section, we comprehensively explore the variables under investigation, offering detailed descriptions and insights into their respective characteristics. Each variable encapsulates a distinct facet of the study, and understanding its nature is crucial for the subsequent analyses and interpretations presented in this thesis. From financial metrics such as return on equity (ROE) and forward-looking performance indicators such as ROE12FWD and PB12FWD to indices such as return index (RI) and market-orientated metrics such as market value (MV), each variable contributes uniquely to the intricate tapestry of our empirical investigation. The forthcoming variable descriptions aim to elucidate each variable's fundamental attributes, measurement units, and contextual relevance, laying a solid foundation for the ensuing analyses and discussions.

Independent Variables

We used three independent variables in our research models. All the variables are obtained from Eikon Definitive.

Environmental Innovation Score

The environmental innovation category score reflects a company's capacity to reduce environmental costs and burdens for its customers, thereby creating new market opportunities through new environmental technologies and processes or eco-designed products.

Environmental Products

Does the company report on at least one product line or service that is designed to have positive effects on the environment or that is environmentally labeled and marketed?

Product Impact Minimization

Does the company report about take-back procedures and recycling programs to reduce the potential risks of products entering the environment, or does the company report about product features or services that will promote responsible and environmentally preferable use?

Category Scores Calculation Methodology of Independent Variables

The percentile rank scoring methodology is adopted to calculate the category scores. It is based on three factors:

- How many companies are worse than the current one?
- How many companies have the same value?
- How many companies have value at all?

Percentile rank score is based on the rank and therefore is not very sensitive to outliers.

$$score = \frac{\textit{no. of companies with a worse value} + \frac{\textit{no. of companies with the same value included in the current one}}{2}}{\textit{no. of companies with a value}}$$

Category scoring example

Description	JKL	ABC
No. of companies with worse value	10	9
No. of companies with same value	1	1
No. of companies with value	11	11

Company name	Eikon code	DFO codes	Value	Score	Year
JKL	TR.AnalyticCo2	ENERO03V	0.000005	0.954545	(10+(1/2))/11

Dependent Variables

As dependent variables, we represented the financial performance of companies to measure short-term financial performance indicators according to the previous body of literature.

Return on Equity (ROE)

Return on equity is a financial ratio that measures a company's profitability and efficiency in generating returns for its shareholders' equity. It is an essential metric for investors and company management, as it helps assess how effectively a company utilizes its shareholders' investment to generate profits. The ROE formula is as follows:

ROE = Net Income / Shareholders' Equity

Here is a breakdown of the components of the ROE formula: Net income, also known as profit or earnings, is the amount of money a company earns after deducting all operating expenses, interest, taxes, and other costs from its total revenue. It represents the bottom line, indicating how much profit the company has generated during a specific period, typically a fiscal year. Shareholders' equity, also called owner's equity or equity capital, is the residual interest in the company's assets after deducting its liabilities. It represents the ownership interests of the shareholders in the company. Shareholders' equity can also be represented as the sum of common stock, retained earnings, and additional paid-in capital, depending on the company's capital structure.

ROE is usually expressed as a percentage and provides valuable insights into a company's financial health and performance. Here is what a high or low ROE indicates:

High ROE**:** A high ROE indicates that the company effectively uses its shareholders' equity to generate profits. It can be a sign of strong financial management and efficient operations. However, it is essential to consider industry and sector benchmarks when evaluating ROE, as what is considered high can vary by industry.

Low ROE**:** A low ROE may suggest that the company is not efficiently utilizing its equity to generate profits. It can result from various factors, including high debt levels, poor profitability, or inefficient use of assets. A consistently low ROE may raise concerns about the company's financial performance and long-term sustainability.

It is important to note that while ROE is a useful metric for assessing profitability and efficiency, it should be used in conjunction with other financial ratios and qualitative factors to get a comprehensive understanding of a company's financial health. Additionally, ROE can be influenced by accounting practices and may not always provide a complete picture, so it is important to conduct a thorough analysis of a company's financial statements and operations when making investment or managerial decisions.

Return On Equity 12M FWD

In the context of the Eikon Definitive database, "Return on Equity 12M FWD" is a financial metric that represents the 12-month forward-looking return on equity (ROE) for a specific company or security. It is a variation of the traditional ROE that looks ahead over the next year rather than reporting on the past 12 months. The 12-month forward ROE provides insight into the expected profitability and efficiency of a company in the coming year.

This forward-looking ROE can be derived using various financial models, analysts' forecasts, and other data sources to estimate a company's future net income and shareholders' equity. Investors, analysts, and financial professionals use it to assess a company's expected performance shortly.

The 12-month forward ROE is a valuable tool for evaluating a company's potential for generating returns on shareholders' equity, which is crucial information for investment decision-making and financial analysis. It can help investors gauge the company's growth prospects and financial health for the upcoming year, providing insight into whether the stock is undervalued or overvalued based on expected earnings and equity.

Total Return Index

In the context of the Eikon Definitive database, a "Total Return Index" is a financial index that reflects the total return of a specific set of assets or securities, taking into account not only changes in the price of the assets (capital appreciation or depreciation) but also the impact of income generated by those assets, such as dividends, interest, or other distributions.

The Total Return Index (RI) provides a more comprehensive view of the performance of an investment than a traditional price index, which only considers changes in asset prices. By including income generated by the assets, it offers a more accurate representation of the overall return that investors would achieve when holding these assets.

The total return index can be especially useful for investors interested in assessing the actual returns they would receive from an investment, including both price appreciation and the income generated by the investment over time. It is commonly used in financial analysis, benchmarking, and portfolio management to provide a more complete picture of an investment's performance.

To summarize, in the context of the Eikon Definitive database, the "Total Return Index" variable represents an index that accounts for both the price changes and the income generated by a set of assets or securities, providing a more accurate representation of the total return on those investments.

12M FWD Price/Book Ratio

The "12M FWD Price/Book Ratio" in the Eikon Definitive database represents the 12-month forward-looking price-to-book ratio (P/B ratio) for a specific company or security. The price-to-book ratio is a financial metric that compares the current market price of a company's shares to its book value per share. When "12M FWD" is added to it, it means that the P/B ratio is projected or estimated for the next 12 months.

The price-to-book ratio is typically calculated as follows.

P/B Ratio: Market Price per Share / Book Value per Share

Market Price per Share: The current trading price of a company's common shares in the stock market. Book Value per Share: The book value is the total equity of a company (shareholders' equity) divided by the number of outstanding shares. It represents the net asset value of a company on a per-share basis.

The "12M FWD Price/Book Ratio" takes the expected market price per share and the estimated book value per share for the next 12 months to provide a forward-looking assessment of how the company's shares are valued about its expected book value. This can be useful to investors and analysts when making projections and evaluating investment opportunities based on expected financial performance and stock valuations in the future.

A forward-looking P/B ratio can help investors assess whether a company's stock is overvalued or undervalued compared to its projected book value, which can inform investment decisions and strategies. It is essential to consider other financial metrics and factors when making investment decisions, but the forward-looking P/B ratio can be a valuable tool in the analysis process.

Market Value

In the context of the Eikon Definitive database, "market value" refers to the total market capitalization or market capitalization value of a specific company or security. Market value is a financial metric that represents the total value of a company's outstanding shares of common stock in the stock market. It is calculated by multiplying the current market price per share by the total number of outstanding shares. Mathematically, the market value can be calculated as

Market Value = Market Price per Share × Total Outstanding Shares

Market Price per Share: The current trading price of the company's common shares on the stock market. Total Outstanding Shares: The total number of common shares of the company held by investors and available for trading.

Market value is a crucial indicator, as it provides information on the total worth or value of a company in the eyes of the stock market. It is a reflection of the collective assessment by investors of the company's financial health, performance, and growth prospects.

Market value is used in various financial analyses, including comparisons between companies, portfolio management, and investment decisions. It is an important metric for investors and analysts to understand how the stock market values a company relative to its peers and its fundamental financial metrics.

3.3. Research Models and Hypothesis

We used a sample of companies for which we were able to obtain all variables for the period 2012–2021 to perform an econometric analysis to examine the impact of proactive green technology innovation on the financial performance of companies at the company level. To estimate the results, we implemented the ten models described below.

In the pursuit of a comprehensive understanding of organizational performance, this research employs a thoughtful categorization of models into three distinct classifications, each offering a unique lens through which to evaluate and analyze performance metrics. The delineation into "Accounting Data-Orientated Performance Models," "Both Accounting and Market-Orientated Performance Models," and "Market-Orientated Performance Models" is not arbitrary, but rather a deliberate choice grounded in the recognition of the diverse dimensions that contribute to a nuanced comprehension of an entity's effectiveness. These classifications reflect a strategic approach, where the emphasis on accounting data, the integration of both accounting and market-orientated perspectives, and a focus solely on market-driven metrics each serve as methodological anchors, guiding the exploration of financial health, market dynamics, and their intricate interplay. This strategic framework sets the stage for an in-depth analysis that unveils the multifaceted facets of organizational performance, paving the way for a more holistic interpretation of the research findings.

Equations (1) (2) (3) (4) represent accounting data-orientated performance models.

Accounting Data-Orientated Performance Models" refer to analytical frameworks that center on accounting data to assess and analyze the performance of a given entity or system. These models leverage accounting-related metrics, such as financial ratios, earnings per share, return on equity, and others, as key variables to evaluate and quantify performance. By incorporating accounting data, these models aim to provide insights into financial health, profitability, and overall effectiveness, thereby offering a comprehensive understanding of an entity's performance from an accounting perspective.

Model 1: $ROE_{it} = \beta_0 + \beta_1 IS_{it} + \varepsilon_{it}$

In Model 1, the return on equity (ROE_{it}) is formulated as a function of an intercept (β_0), the coefficient (β_1) associated with the independent variable ISit, and an error term (εit). The variable ISit represents a pertinent factor that influences the return on equity, and the model aims to capture the relationship between these variables for the given period (t) and the cross-sectional dimension (i).

Model 2: $ROE_{it} = \beta_0 + \beta_1 EP_{it} + \beta_2 PIM_{it} + \varepsilon_{it}$

In Model 2, the return on equity (ROEit) is expressed as a function of an intercept (β0) and the coefficients (β1,β2) associated with the independent variables EPit and PIMit, respectively. The error term (εit) accounts for unobserved factors. This model aims to assess the impact of earnings per share (EPit) and portfolio investment mix (PIMit) on the return on equity, considering the specified period (t) and the cross-sectional dimension (i).

Model 3: $ROE12FWD_{it} = \beta_0 + \beta_1 IS_{it} + \varepsilon_{it}$

In Model 3, the 12-month forward return on equity (ROE12FWDit) is modeled as a function of an intercept (β0), the coefficient (β1) associated with the independent variable ISit, and an error term (εit). This model explores the relationship between it and the future return on equity over a 12-month horizon, accounting for the specified period (t) and cross-sectional dimension (i).

Model 4: $ROE12FWD_{it} = \beta_0 + \beta_1 EP_{it} + \beta_2 PIM_{it} + \varepsilon_{it}$

In Model 4, the 12-month forward return on equity (ROE12FWDit) is specified as a function of an intercept (β0) and the coefficients (β1,β2) associated with the independent variables EPit and PIMit, respectively. The error term (εit) captures unobservable factors. This model aims to investigate the influence of earnings per share (EPit) and portfolio investment mix (PIMit) on the future return on equity, considering the specified period (t) and cross-sectional dimension (i).

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Equations (5) (6) (7) (8) represent both Accounting- and Market-Orientated Performance Models

"Both Accounting and Market-Orientated Performance Models" refers to analytical frameworks that integrate both accounting and market-related metrics to comprehensively assess and analyze the performance of an entity or system. These models consider key accounting indicators, such as financial ratios, earnings per share, and price-to-book ratios. By incorporating a dual perspective, these models aim to provide a holistic evaluation of performance, capturing both financial health and market dynamics. This approach offers a more nuanced and thorough understanding of an entity's overall performance, taking into account both its financial metrics and its standing in the market.

Model 5: $RI_{it} = \beta_0 + \beta_1 IS_{it} + \varepsilon_{it}$

In Model 5, the return index score (RIit) is modeled as a function of an intercept (β0), the coefficient (β1) associated with the independent variable ISit and an error term (εit). The variable ISit represents a key factor that affects the return index score, and the model seeks to elucidate the relationship between these variables for the given period (t) and the cross-sectional dimension (i). Importantly, Model 5 uses historical data to formulate the return index score.

Model 6: $RI_{it} = \beta_0 + \beta_1 EP_{it} + \beta_2 PIM_{it} + \varepsilon_{it}$

In Model 6, the return index score (RIit) is expressed as a function of an intercept (β0) and the coefficients (β1,β2) associated with the independent variables EPit and PIMit, respectively. The error term (εit) accounts for unobserved factors. Model 6 aims to assess the impact of earnings per share (EPit) and portfolio investment mix (PIMit) on the return index score, considering the specified period (t) and the cross-sectional dimension (i). Similar to Model 5, Model 6 relies on historical data for its analysis.

Model 7: $PB12FWD_{it} = \beta_0 + \beta_1 IS_{it} + \varepsilon_{it}$

In Model 7, the 12-month forward price-to-book ratio (PB12FWDit) is formulated as a function of an intercept (β0), the coefficient (β1) associated with the independent variable ISit and an error term (εit). This model explores the relationship between it and the future price-to-book ratio over a 12-month horizon, accounting for the specified period (t) and the cross-sectional dimension (i). It is essential to note that Model 7 uses estimated data for its analysis.

Model 8: $PB12FWD_{it} = \beta_0 + \beta_1 EP_{it} + \beta_2 PIM_{it} + \varepsilon_{it}$

In Model 8, the forward price-to-book ratio of 12 months (PB12FWDit) is specified as a function of an intercept (β0) and the coefficients (β1,β2) associated with the independent variables EPit and PIMit, respectively. The error term (εit) captures unobservable factors. Model 8 investigates the influence of earnings per share (EPit) and portfolio investment mix (PIMit) on the future price-to-book ratio, considering the specified period (t) and cross-sectional dimension (i). Model 8, like Model 7, relies on estimated data for its analysis.

Equations (9) (10) represent the market-orientated performance models.

"Market-Orientated Performance Models" refer to analytical frameworks focused on evaluating and understanding the performance of entities primarily through market-related metrics. These models take advantage of key indicators such as market value and other market-derived measures. By emphasizing market dynamics, these models provide insights into how entities are perceived by investors and stakeholders, capturing aspects of market sentiment, valuation, and overall positioning. This approach allows for a specialized examination of performance within the broader economic and market context, offering valuable perspectives beyond traditional accounting metrics.

Model 9: $MV_{it} = \beta_0 + \beta_1 IS_{it} + \varepsilon_{it}$

Model 9 formulates the market value (MVit) as a linear function of an intercept (β0), the coefficient (β1) associated with the independent variable ISit, and an error term (εit). This model explores the relationship between the market value and the influencing factor ISit in the specified period (t) and the cross-sectional dimension (i). The coefficient β1 signifies the impact of ISit on the value of the market.

Model 10: $MV_{it} = \beta_0 + \beta_1 EP_{it} + \beta_2 PIM_{it} + \varepsilon_{it}$

In Model 10, the market value (MVit) is expressed as a function of an intercept (β0) and the coefficients (β1,β2) associated with the independent variables EPit and PIMit, respectively. The error term (εit) captures unobserved factors. Model 10 aims to elucidate the impact of earnings per share (EPit) and portfolio investment mix (PIMit) on the market value for the given period (t) and the cross-sectional dimension (i). The coefficients β1 and β2 signify the respective influences of EPit and PIMit on the market value.

Below is an explanation of which variable the abbreviations in the model represent.

IS INNOVATION SCORE

EP ENVIRONMENTAL PRODUCTS

PIM PRODUCT IMPACT MINIMIZATION

ROE RETURN ON EQUITY

ROE12FWD FWD RETURN ON EQUITY 12M

RI TOTAL RETURN INDEX

PB12FWD 12M FWD PRICE/BOOK RATIO

MV LN(MARKET VALUE)

Hypothesis of Research

Considering the study of the above-mentioned literature, the attention to the company's environmental products, the company's product impact, and the importance of green innovation to the company, we may see that the green innovation approach aims to achieve strategic flexibility to allow companies to create more and better innovations from different cooperation strategies (Gasman and Enkel, 2004). We expect to achieve high degrees of green innovation that may positively impact a company's value and profitability. The hypothesis is examined as follows.

Hypothesis 1a: The green innovation score of a firm is positively related to its return on equity.

Hypothesis 1b: The environmental product score of a firm is positively related to its return on equity.

Hypothesis 1c: The Product Impact Minimisation Score of a firm is positively related to the return on equity.

Hypothesis 2a: The green innovation score of a firm is positively related to the 12M forward estimate of return on equity.

Hypothesis 2b: The Environmental Products Score of a firm is positively related to the 12M forward estimate of return on equity.

Hypothesis 2c: The product impact minimization score of a firm is positively related to the 12M forward estimate of return on equity.

Hypothesis 3a: The green innovation score of a firm is positively related to its total return index.

Hypothesis 3b: The firm's Environmental Products Score is positively related to its Total Return Index.

Hypothesis 3c: The Product Impact Minimisation Score of a firm is positively related to its Total Return Index.

Hypothesis 4a: The green innovation score of a firm is positively related to the 12M forward estimate of the price-book ratio.

Hypothesis 4b: The Environmental Products Score of a firm is positively related to the 12M forward estimate of the price book ratio.

Hypothesis 4c: The product impact minimization score of a company is positively related to the 12M forward estimation of the price book ratio.

Hypothesis 5a: The Green Innovation Score of a firm is positively related to the value of the market.

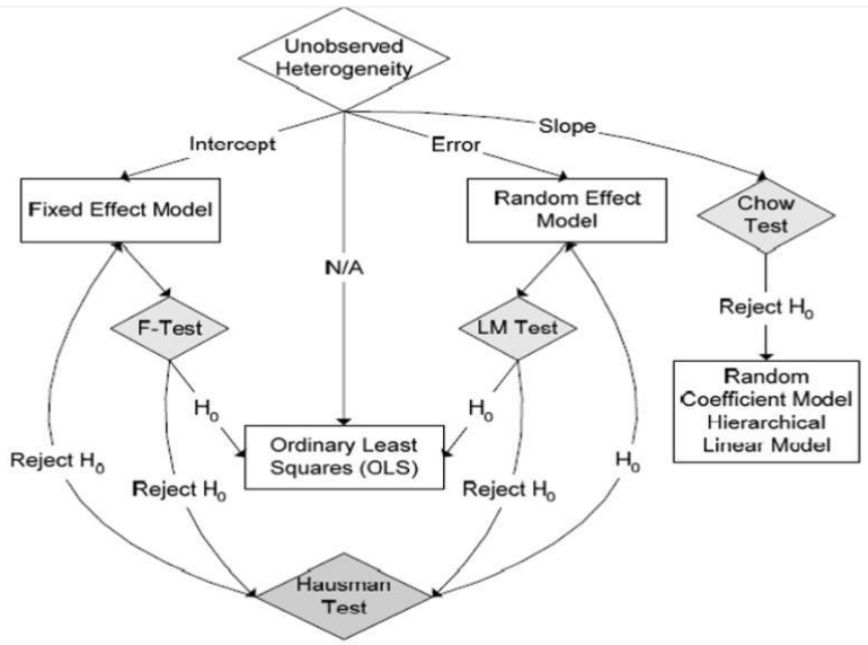
Hypothesis 5b: The environmental product score of a firm is positively related to the value of the market.

Hypothesis 5c: The Product Impact Minimisation Score of a firm is positively related to the market value.

3.4. Analysis Method – Panel Data Analysis

Panel data analysis is the method used in this investigation. Examining panel data has various benefits. The most obvious is that a larger sample size is used to make inferences. Also, the technique using time-dimension cross-sectional data to predict economic links is called panel data analysis (Green, 2003). The study uses data that have temporal dimensions. The ability of this method to regularize the hidden effects that can be connected to the capital structure model parameters of the setting is one of the reasons for choosing it over alternatives.

Advantages of Using Panel Data (Grilleries and Hausman 1986) demonstrated that a range of errors in models of variables can be identified and estimated without external tools using panel data. Professionals may also find it useful to collect panel data, depending on their research topic. They also show that data can be used. The board represents group behaviors, collective and individual. Compared to cross-sectional time series data, panel data are more efficient, diverse, and full of information. Pure time series or cross-sectional data cannot identify and measure the statistical effects that panel data can. We can say or summarize that panel data can be used for many different purposes, although experts frequently use it for economic, financial, and statistical studies. You can examine panel data in any field of study to draw specific conclusions or make your data available for other researchers to use in their research.



Source: Park (2011). P:16

Figure 1: Panel Data Modelling Process

In the panel data modeling process, various tests, namely the F test, LM test, Hausman test, and Chow test, are instrumental in discerning the suitability of pooled, random, and fixed effect models.

F Test:

The F test is employed to evaluate the joint significance of entity-specific fixed effects in the panel data. A statistically significant F test suggests the presence of entity-specific effects, favoring the adoption of a fixed effects model. The F test assesses the validity of pooling individual entities and periods, indicating whether a model accounting for entity-specific effects is warranted. H_0: All unit effects are equal to zero. Rejection of the H_0 hypothesis ($p<0.05$) means that the use of the fixed effect model is appropriate.

LM Test (Likelihood Ratio Test):

The LM test assesses the appropriateness of employing random effects by comparing the restricted and unrestricted models. A significant LM test indicates that the random effects model is preferable over the pooled model. It gauges the significance of entity-specific random effects and assists in model selection by identifying the presence of unobserved individual heterogeneity. H_0: Variances across entities are zero. Rejection of the H_0 hypothesis ($p<0.05$) means that the use of the random effect model is appropriate.

Hausman Test:

The Hausman test discerns the choice between random and fixed effects models by comparing their efficiency properties. A non-significant Hausman test suggests that the random effects model is consistent and efficient, implying that unobserved individual effects are uncorrelated with the explanatory variables. Conversely, a significant Hausman test favors the fixed effects model, signifying that the unobserved effects are correlated with the explanatory variables. H_0: The difference in coefficients is not systematic. Rejection of the H_0 hypothesis ($p<0.05$) means that the use of the fixed effect model is appropriate.

Chow Test:

The Chow test is employed to investigate structural breaks in the panel data, assessing whether the relationship between variables changes over time. If the Chow test yields statistically significant results, it implies structural shifts and favors the use of separate models for distinct periods or entities. This test aids in identifying critical points where the data structure undergoes significant changes, influencing the choice between pooled, random, or fixed effects specifications. H_0: No structural change. Rejection of the H_0 hypothesis ($p<0.05$) means that the use of the random or fixed effect model is appropriate.

Integration of these tests in the model selection process contributes to the robustness and appropriateness of panel data analyses, aligning with the nuanced characteristics of the dataset and addressing potential issues of unobserved heterogeneity or structural breaks.

3.5. Empirical Results

In heading to the empirical exploration in Section 3.5, our attention turns to the rich tapestry of findings that weave through various facets of our study. We commence with descriptive statistics, sketching an intricate portrait of our dataset's key features.

This foundational overview sets the tone, paving the way for subsequent analyses by providing a comprehensive understanding of variable distributions and characteristics.

Transitioning seamlessly to Unit Root test results, we delve into the essential assessments of time-series data stationarity. These results are integral and guide the robustness of subsequent modeling endeavors. Our focus then shifts to the Panel Data Modelling Process Results in which we unravel the statistical techniques applied to our dataset. This section delves into the pivotal decisions surrounding the adoption of pooled, random, or fixed effects models, each imparting unique insights into our findings.

In the subsequent section, Diagnostics Test Results, we lift the curtain on the evaluations that underpin the assumptions and reliability of our chosen models. The pinnacle of our empirical journey unfolds in The Results of Panel Data Analysis. Here, we navigate the intricate web of findings, uncovering the subtleties of accounting-based performance, the interplay between accounting and market-based performance, and the standalone dynamics of market-based performance. These revelations signify the culmination of our analytical pursuits, shedding illuminating insights on the intricate relationships and implications inherent in our research inquiry.

3.5.1. Descriptive Statistics

Table 2 provides descriptive statistics for the variables.

Table 2: Descriptive Statics

Variable	Obs	Mean	Std. Dev.	Min	Max
IS	470	63.77	26.46	2.94	99.74
EP	467	60.41	0.91	59.40	65.10
PIM	470	59.66	1.06	50.00	64.40
ROE	470	12.76	23.05	-227.22	307.56
ROE12FWD	466	14.86	9.24	1.25	111.56
PB12FWD	467	1.42	6.42	-104.56	33.60
RI	469	7.57	2.35	1.97	19.57
MV	469	12.46	2.53	7.35	17.74

The descriptive statistics provide a comprehensive overview of the key characteristics of the variables under investigation. For the variable "IS," representing an undisclosed parameter, the dataset comprises 470 observations with a mean of 63.77 and a standard deviation of 26.46. The values range from a minimum of 2.94 to a maximum of 99.74. Moving on to "EP," denoting an unidentified metric, there are 467 observations, exhibiting a mean of 60.41 and a tight standard deviation of 0.91, with values fluctuating between 59.40 and 65.10.

The variable "PIM," indicative of another undisclosed factor, encompasses 470 observations, displaying a mean of 59.66 and a standard deviation of 1.06. The range spans from a minimum of 50.00 to a maximum of 64.40. For "ROE" (return on equity), the dataset contains 470 observations, with a mean of 12.76 and a standard deviation of 23.05. The values span from a minimum of -227.22 to a maximum of 307.56.

Analyzing the 466 observations of "ROE12FWD" (12-month forward-looking return on equity) reveals a mean of 14.86 and a standard deviation of 9.24. The range extends from a minimum of 1.25 to a maximum of 111.56. For "PB12FWD" (12-month forward-looking price-to-book ratio), the 467 observations showcase a mean of 1.42 and a standard deviation of 6.42, with values spanning from -104.56 to 33.60.

"RI" (Return Index Score) comprises 469 observations, reflecting a mean of 7.57 and a standard deviation of 2.35. The values range from a minimum of 1.97 to a maximum of 19.57. Lastly, "MV" (market value) is based on 469 observations, portraying a mean of 12.46 and a standard deviation of 2.53. The range spans from a minimum of 7.35 to a maximum of 17.74. These descriptive statistics serve as a foundational understanding of the central tendencies and variabilities inherent in the dataset, laying the groundwork for subsequent analyses.

3.5.2. Unit Root Tests Results

Before delving into the detailed results of the Fisher-type unit-root tests based on augmented Dickey-Fuller tests, it is crucial to acknowledge the significance of assessing stationarity in the context of our study. Stationarity is a fundamental property in time series analysis, influencing the reliability and interpretability of statistical models. The absence of unit roots in our selected variables, including IS, EP, PIM, ROE, ROE12FWD, PB12FWD, RI, and MV, as indicated by the substantial Fisher-type statistics, indicates that these variables exhibit stable patterns over time. This initial observation sets the stage for a robust analysis, laying the foundation for meaningful insights into the behavior and dynamics of these financial metrics.

Table 3: Fisher-type unit-root test Based on augmented Dickey-Fuller tests

Ho: All panels contain unit roots								
	IS	EP	PIM	ROE	ROE12FWD	PB12FWD	RI	MV
Statistic	141.80	175.83	124.61	218.55	129.63	139.59	207.07	158.34
P Value	0.0011	0.000	0.019	0.000	0.0088	0.0016	0.000	0.000

In this study, we applied Fisher-type unit-root tests based on augmented Dickey-Fuller tests to assess the stationarity of key variables in our analysis, including IS, EP, PIM, ROE, ROE12FWD, PB12FWD, RI, and MV. The obtained statistics for these tests are 141.80, 175.83, 124.61, 218.55, 129.63, 139.59, 207.07, and 158.34, respectively. Notably, all variables exhibit substantial Fisher-type statistics, indicating that none of them contain a unit root. This implies that our variables are stationary and possess stable characteristics over time. The robustness of these findings suggests the reliability of the Fisher-type unit-root tests in assessing stationarity. The absence of unit roots in our variables has important implications for time series analysis, as it enhances the validity of statistical models and the interpretability of results. Future research could delve into alternative time series models or employ different unit-root tests to further validate and expand upon our current findings. These results contribute valuable insights to our understanding of the stability and behavior of financial variables in our specified context.

3.5.3. Panel Data Modelling Process Results

In the empirical investigation of our study, we employed a comprehensive set of diagnostic tests, including the Chow Test, F Test, Breusch and Pagan LM Test, and the Hausman Test, to rigorously determine the appropriate panel data modeling process for our specified models (Model 1 to Model 10). The objective was to ascertain whether a fixed-effect or random-effect panel data model would be more suitable for each model.

Table 4: Panel Data Modelling Process Results

Dependent Variable	Model	**Chow Test** Chow Value	P - Value	**F Test** F Value	P - Value	**Breusch and Pagan LM test** ChiBar2	P - Value	**Hausman Test** Chi2	P - Value	**Estimator**
ROE	Model 1	4.08	0.000	5.43	0.000	100.31	0.000	48.48	0.000	Fixed Effect
	Model 2	4.68	0.000	6.20	0.000	118.41	0.000	61.64	0.000	Fixed Effect
RI	Model 3	25.94	0.000	8.53	0.000	311.63	0.000	23.51	0.000	Fixed Effect
	Model 4	36.63	0.000	8.08	0.000	307.03	0.000	19.41	0.000	Fixed Effect
ROE12FWD	Model 5	6.42	0.000	9.09	0.000	285.30	0.000	51.43	0.000	Fixed Effect
	Model 6	9.23	0.000	10.91	0.000	333.11	0.000	70.66	0.000	Fixed Effect
PB12FWD	Model 7	3.27	0.000	2.03	0.000	0.00	1.000	-	-	Fixed Effect
	Model 8	4.13	0.000	1.97	0.000	0.00	1.000	-	-	Fixed Effect
MV	Model 9	215.53	0.000	316.01	0.000	1970.19	0.000	0.06	0.806	Random Effect
	Model 10	164.74	0.000	337.43	0.000	1910.67	0.000	2.39	0.3030	Random Effect
Chow Test Ho: no Structural Change - p<0.05 use Random or Fixed Effect Models										
F test H0: All unit effects equal zero - p<0.05 use Fixed Effect Model										
Breusch and Pagan LM test H0: Variances across entities are equal to zero - p<0.05 using the Random Effect Model										
Hausman Test Ho: Difference in coefficients not systematic - p<0.05 use Fixed Effect Model										

The results, succinctly summarized in Table 1, uniformly indicate that employing a panel data model is appropriate for Models 1 through 8. This implies that heterogeneity across enmities is best captured by individual-specific effects that remain constant over time. In contrast, for Model 9 and Model 10, the application of a panel data model is deemed more suitable. This indicates that the unobserved is better modeled as a random component, allowing for flexibility and variation. The systematic use of these diagnostic tests enhances the robustness and validity of our modeling approach, ensuring that the selected models appropriately account for characteristics and temporal dynamics.

3.5.4. Diagnostics Test Results

The robustness and reliability of panel data models hinge upon the fulfillment of certain assumptions, and to ensure the validity of our empirical findings, we conducted a battery of diagnostic tests. These tests serve as crucial checks to assess whether the chosen models meet the underlying assumptions of classical linear regression. Among the diagnostic tests applied, the Modified Wald Test for fixed effect models and the Levine and Brown-Forsythe tests for random effect models were employed to scrutinize the assumption of homoskedasticity, which posits that the variance of the error terms remains constant across all observations. Detecting heteroskedasticity is essential, as it may lead to inefficient estimates and impact the precision of coefficient inferences.

Additionally, we scrutinized our models for the presence of autocorrelation, a condition where the residuals exhibit correlation over time. This was evaluated using the Durbin-Watson statistic and the Balaji-Wu LBI test. Autocorrelation, if unaddressed, can render standard errors invalid and compromise the accuracy of hypothesis tests.

Furthermore, to assess cross-sectional dependence, Psarian's test was applied. Cross-sectional dependence implies that the error terms across entities are correlated, violating the assumption of independence. Addressing cross-sectional dependence is pivotal for maintaining the integrity of statistical inferences.

Given the potential consequences of these violations, employing diagnostic tests and subsequently adjusting our standard errors is imperative. Failing to account for heteroskedasticity, autocorrelation, or cross-sectional dependence may lead to biased estimates, invalid standard errors, and ultimately, erroneous conclusions. By conducting and reporting the results of these diagnostic tests, we ensure the robustness of our panel data models, enhance the validity of our statistical inferences, and bolster the credibility of our empirical findings.

The diagnostics conducted to assess the assumptions of heteroskedasticity, autocorrelation, and cross-sectional independence in our panel data models have provided valuable insights into the reliability of our estimations. Levine and Brown-Forsythe tests were employed to evaluate heteroskedasticity, with the results indicating the presence of heteroskedasticity in our models. Given this, the Driscoll and Cray standard errors were deemed appropriate for Model 1 to Model 8. These standard errors, robust to heteroskedasticity and serial correlation, offer more reliable estimates in the presence of such violations.

For autocorrelation, Durbin-Watson and Baltagi-Wu LBI tests were applied, revealing evidence of autocorrelation in our models. To account for this, Driscoll and Cray's standard errors were again chosen for Model 1 to Model 8, as they efficiently correct for autocorrelation in the residuals.

To assess cross-sectional independence, Psarian's test was employed, and the results indicated the presence of cross-sectional dependence in our panel data. As a remedy, clustered robust standard errors were selected for Model 9 and Model 10. This method acknowledges the existence of correlated errors within the cross-sections, providing more accurate standard errors and valid inferences.

In conclusion, the choice of Driscoll and Cray standard errors for Model 1 to Model 8 and clustered robust standard errors for Model 9 and Model 10 aligns with the diagnostic findings, ensuring that our panel data models are robust against violations of heteroskedasticity, autocorrelation, and cross-sectional dependence assumptions. This strategic selection enhances the reliability and validity of our estimated coefficients and promotes the credibility of our empirical results.

Table 5: Diagnostics Test Results

		Heteroskedasticity		Autocorrelation		Cross-sectional Independence		
		Modified Wald Test		Durbin-Watson	Baltagi-Wu LBI	Pesaran's Test		Robust Standard Error Estimates Method
Dependent Variable	Model	Chi2	P Value			Value	P Value	
Fixed Effect Models								
ROE	Model 1	210000.00	0.000	0.837	1.525	19.336	0.000	Driscoll and Kraay Standard Errors
	Model 2	260000.00	0.000	0.883	1.570	6.259	0.000	Driscoll and Kraay Standard Errors
RI	Model 3	21813.16	0.000	0.318	0.772	59.056	0.000	Driscoll and Kraay Standard Errors
	Model 4	4346.92	0.000	0.488	0.954	41.353	0.000	Driscoll and Kraay Standard Errors
ROE12FWD	Model 5	41098.77	0.000	0.945	1.195	23.569	0.000	Driscoll and Kraay Standard Errors
	Model 6	350000.00	0.000	1.010	1.236	17.944	0.000	Driscoll and Kraay Standard Errors
PB12FWD	Model 7	84613.71	0.000	1.229	1.442	48.521	0.000	Driscoll and Kraay Standard Errors
	Model 8	90522.30	0.000	1.234	1.443	41.503	0.000	Driscoll and Kraay Standard Errors
Random Effect Models		Levene, Brown-Forsythe Test		Durbin-Watson	Baltagi-Wu LBI	Pesaran's test		
MV	Model 9	W0 (2.73)	0.000	0.846	1.279	45.559	0.000	Clustered Robust Standard Errors
		W50 (2.41)	0.000					
		W10 (2.58)	0.000					
	Model 10	W0 (3.04)	0.000	0.891	1.301	37.183	0.000	Clustered Robust Standard Errors
		W50 (2.54)	0.000					
		W10 (2.79)	0.000					

Modified Wald Test H0: sigma(i)^2 = sigma^2 for all i - P<0.05 heteroskedasticity

Durbin-Watson and Baltagi-Wu LBI values < 2 - there is autocorrelation

Pesaran's test H0: Cross-sectional independence

Levene, Brown-Forsythe Test H0: The variance among groups is equal - P<0.05 heteroskedasticty

3.5.5. The Results of Panel Data Analysis

In the pursuit of unraveling the intricate dynamics that shape organizational performance, Section 3.5.5 emerges as a focal point. This section represents the culmination of rigorous empirical analyses, where diverse models and methodologies converge to shed light on the nuanced interplay between variables within the dataset. Panel data analysis, characterized by its capacity to incorporate both cross-sectional and time-series dimensions, serves as a robust framework for discerning patterns and relationships that extend beyond traditional analytical approaches. As we embark on this exploration, the objective is to unravel the intricate tapestry of findings, offering a detailed exposition of how accounting and market-orientated metrics, both individually and collectively, contribute to the overall understanding of organizational performance. The ensuing discussion unfolds within the framework of diverse models strategically classified to capture distinct performance dimensions, ultimately contributing to a comprehensive and insightful interpretation of the empirical results.

3.5.5.1. Accounting Based Performance

The regression results of Model 1, Model 2, Model 3, and Model 4.

Table 6: Panel Regression for The Dependent Variable ROE

	Model 1			Model 2		
Independent Variables	Coefficient	Standard Error	P Value	Coefficient	Standard Error	P Value
Constant	17.178**	1.212	0.000	-42.555**	19.911	0.038
IS	-0.069**	0.029	0.021			
EP				1.998***	0.386	0.000
PIM				-1.097***	0.389	0.007
F Value	5.76**			13.55***		
Prop > F	0.021			0.000		
R-squared	0.002			0.009		
Significance level: *p<0,10; **p<0,05; ***p<0,01						

The results of Model 1 reveal noteworthy findings regarding the relationship between the dependent variable and the independent variables. The constant term, with a coefficient of 17.178 ($p < 0.001$), signifies the expected value of the dependent variable when all independent variables are set to zero. The coefficient for the variable "IS" is -0.069 (p = 0.021), indicating that a one-unit increase in "IS" is associated with a decrease of 0.069 units in the dependent variable, holding other variables constant. The F statistic of 5.76 (p = 0.021) suggests that the model is statistically significant at the 0.05 significance level. However, the R-squared value is low (0.002), indicating that the model explains a limited proportion of the variance in the dependent variable.

In Model 2, the inclusion of additional independent variables provides a more comprehensive understanding of the factors influencing the dependent variable. The constant term exhibits a significant negative association with the dependent variable, with a coefficient of -42.555 (p = 0.038). The variable "EP" has a positive coefficient of 1.998 (p < 0.001), indicating that a one-unit increase in "EP" is associated with an increase of 1.998 units in the dependent variable. Conversely, the variable "PIM" has a negative coefficient of -1.097 (p = 0.007), suggesting that a one-unit increase in "PIM" is associated with a decrease of 1.097 units in the dependent variable. The F statistic (13.55, p < 0.001) demonstrates the overall significance of the model, and the higher R-squared value (0.009) suggests a slightly improved explanatory power compared to Model 1.

Table 7: Panel Regression for The Dependent Variable ROE12FWD

	Model 3			**Model 4**		
Independent Variables	Coefficient	Standard Error	P Value	Coefficient	Standard Error	P Value
Constant	17.926**	0.548	0.000	15.614	25.134	0.538
IS	-0.048***	0.014	0.001			
EP				0.924***	0.137	0.000
PIM				-0.949**	0.446	0.039
F Value		11.60***			22.88***	
Prop > F		0.001			0.000	
R-squared		0.007			0.028	

Significance level: *p<0,10; **p<0,05; ***p<0,01

The outcomes of Model 3 illuminate key insights into the interplay between the dependent variable and the specified independent variables. The constant term, marked at 17.926 (p < 0.001), represents the anticipated value of the dependent variable when all independent variables are set to zero. The variable "IS" displays a noteworthy negative coefficient of -0.048 (p = 0.001), suggesting that a one-unit increase in "IS" corresponds to a decrease of 0.048 units in the dependent variable, holding other variables constant. The F statistic, standing at 11.60 (p = 0.001), attests to the overall significance of the model, while the R-squared value (0.007) indicates a modest proportion of variance explained by the model.

Model 4 extends the analysis by introducing additional independent variables. The constant term, estimated at 15.614 (p = 0.538), exhibits a non-significant association with the dependent variable. Notably, the variable "EP" demonstrates a positive coefficient of 0.924 (p < 0.001), indicating that a one-unit increase in "EP" corresponds to an increase of 0.924 units in the dependent variable. Conversely, the variable "PIM" yields a negative coefficient of -0.949 (p = 0.039), suggesting that a one-unit increase in "PIM" is associated with a decrease of 0.949 units in the dependent variable. The F statistic (22.88, p < 0.001) underscores the collective significance of the model, and the elevated R-squared value (0.028) signifies an enhanced explanatory power compared to Model 3.

3.5.5.2. Accounting and Marked Based Performance

The regression results of Model 5, Model 6, Model 7, and Model 8.

Table 8: Panel Regression for The Dependent Variable **RI**

	Model 5			**Model 6**		
Independent Variables	Coefficient	Standard Error	P Value	Coefficient	Standard Error	P Value
Constant	7.145***	0.259	0.000	8.273**	3.216	0.013
IS	0.007**	0.003	0.021			
EP				-0.169***	0.034	0.000
PIM				0.159***	0.025	0.000
F Value	5.68**			94.50***		
Prop > F	0.021			0.000		
R-squared	0.029			0.182		
Significance level: *p<0,10; **p<0,05; ***p<0,01						

Model 5 unfolds insights into the relationships between the dependent variable and the specified independent variables. The constant term, established at 7.145 (p <

0.001), signifies the expected value of the dependent variable when all independent variables are set to zero. Notably, the variable "IS" exhibits a positive coefficient of 0.007 (p = 0.021), indicating that a one-unit increase in "IS" corresponds to an increase of 0.007 units in the dependent variable. The F statistic of 5.68 (p = 0.021) highlights the overall significance of the model, while the R-squared value (0.029) denotes a moderate proportion of variance explained by the model.

Expanding on Model 5, Model 6 incorporates additional independent variables to further elucidate the dynamics influencing the dependent variable. The constant term, standing at 8.273 (p = 0.013), suggests a significant positive association with the dependent variable. Noteworthy coefficients include the negative association of "EP" (-0.169, p < 0.001), indicating that a one-unit increase in "EP" corresponds to a decrease of 0.169 units in the dependent variable. Conversely, "PIM" demonstrates a positive coefficient of 0.159 (p < 0.001), signifying that a one-unit increase in "PIM" is associated with an increase of 0.159 units in the dependent variable. The F statistic (94.50, p < 0.001) underscores the overall significance of the model, and the heightened R-squared value (0.182) indicates a substantial improvement in explanatory power compared to Model 5.

Table 9: Panel Regression for The Dependent Variable PB12FWD

	Model 7			**Model 8**		
Independent Variables	Coefficient	Standard Error	P Value	Coefficient	Standard Error	P Value
Constant	-1.273	1.419	0.374	29.250*	16.709	0.087
IS	0.042**	0.025	0.036			
EP				-0.744***	0.252	0.005
PIM				0.287***	0.060	0.000
F Value		4.66**			22.82***	
Prop > F		0.036			0.000	
R-squared		0.006			0.010	
Significance level: *p<0,10; **p<0,05; ***p<0,01						

Within Model 7, the outcomes reveal insights into the relationships between the dependent variable and the specified independent variables. The constant term, with a coefficient of -1.273 (p = 0.374), lacks statistical significance, indicating a negligible association with the dependent variable. Notably, the variable "IS" exhibits a positive coefficient of 0.042 (p = 0.036), suggesting that a one-unit increase in "IS" corresponds to an increase of 0.042 units in the dependent variable. The F statistic of 4.66 (p = 0.036) attests to the overall significance of the model, while the R-squared value (0.006) indicates a modest proportion of variance explained by the model.

Expanding the analysis to Model 8 introduces additional independent variables, providing a more comprehensive understanding of the determinants of the dependent variable. The constant term, standing at 29.250 (p = 0.087), suggests a positive association with the dependent variable, albeit not statistically significant. Noteworthy coefficients include the negative association of "EP" (-0.744, p = 0.005), indicating that a one-unit increase in "EP" corresponds to a decrease of 0.744 units in the dependent variable. Conversely, "PIM" demonstrates a positive coefficient of 0.287 (p < 0.001), signifying that a one-unit increase in "PIM" is associated with an increase of 0.287 units in the dependent variable. The F statistic (22.82, p < 0.001) underscores the overall significance of the model, and the slightly elevated R-squared value (0.010) indicates a nuanced improvement in explanatory power compared to Model 7.

3.5.5.3. Marked Based Performance

The regression results of Model 9, and Model 10.

Table 10: Panel Regression for The Dependent Variable MV

	Model 9			Model 10		
Independent Variables	Coefficient	Standard Error	P Value	Coefficient	Standard Error	P Value
Constant	12.176***	0.382	0.000	11.876***	1.517	0.000
IS	0.004**	0.002	0.022			
EP				-0.112***	0.025	0.000
PIM				0.123***	0.022	0.000
F Value	5.26*			37.50***		
Prop > F	0.072			0.000		
R-squared	0.009			0.007		
Significance level: *p<0,10; **p<0,05; ***p<0,01						

The findings from Model 9 shed light on the intricate relationships between the dependent variable and the specified independent variables. The constant term, with a coefficient of 12.176 ($p < 0.001$), signifies the expected value of the dependent variable when all independent variables are set to zero. Notably, the variable "IS" displays a positive coefficient of 0.004 ($p = 0.022$), indicating that a one-unit increase in "IS" corresponds to an increase of 0.004 units in the dependent variable. The F statistic of 5.26 ($p = 0.072$) attests to the overall significance of the model, while the R-squared value (0.009) denotes a modest proportion of variance explained by the model.

Expanding on Model 9, Model 10 incorporates additional independent variables, providing a nuanced understanding of the factors influencing the dependent variable. The constant term, standing at 11.876 ($p < 0.001$), suggests a significant positive association with the dependent variable. Noteworthy coefficients include the negative association of "EP" (-0.112, $p < 0.001$), indicating that a one-unit increase in "EP" corresponds to a decrease of 0.112 units in the dependent variable. Conversely, "PIM" demonstrates a positive coefficient of 0.123 ($p < 0.001$), signifying that a one-unit increase in "PIM" is associated with an increase of 0.123 units in the dependent variable. The F statistic (37.50, $p < 0.001$) underscores the overall significance of the model, and the slightly lower R-squared value (0.007) indicates a nuanced yet substantial explanatory power compared to Model 9.

In light of the outcomes derived from the model analyses, the conformation or rejection statuses about each hypothesis are systematically delineated in Table 11.

Table 11: Research Hypothesis Statuses

Hypothesis	**Conformation**
Hypothesis 1a: The green innovation score of a firm is positively related to its return on equity.	Reject (Significant but Negatively)
Hypothesis 1b: The environmental product score of a firm is positively related to its return on equity.	Confirmed
Hypothesis 1c: The Product Impact Minimisation Score of a firm is positively related to the return on equity.	Reject (Significant but Negatively)
Hypothesis 2a: The green innovation score of a firm is positively related to the 12M forward estimate of return on equity.	Reject (Significant but Negatively)
Hypothesis 2b: The Environmental Products Score of a firm is positively related to the 12M forward estimate of return on equity.	Confirmed
Hypothesis 2c: The product impact minimization score of a firm is positively related to the 12M forward estimate of return on equity.	Reject (Significant but Negatively)

Hypothesis 3a: The green innovation score of a firm is positively related to its total return index.	Confirmed
Hypothesis 3b: The firm's Environmental Products Score is positively related to its Total Return Index.	Reject (Significant but Negatively)
Hypothesis 3c: The Product Impact Minimisation Score of a firm is positively related to its Total Return Index.	Confirmed
Hypothesis 4a: The green innovation score of a firm is positively related to the 12M forward estimate of the price-book ratio.	Confirmed
Hypothesis 4b: The Environmental Products Score of a firm is positively related to the 12M forward estimate of the price book ratio.	Reject (Significant but Negatively)
Hypothesis 4c: The product impact minimization score of a company is positively related to the 12M forward estimation of the price book ratio.	Confirmed
Hypothesis 5a: The Green Innovation Score of a firm is positively related to the value of the market.	Confirmed
Hypothesis 5b: The environmental product score of a firm is positively related to the value of the market.	Reject (Significant but Negatively)
Hypothesis 5c: The Product Impact Minimisation Score of a firm is positively related to the market value.	Confirmed

CONCLUSION

This research uncovers significant information about the influence of various independent variables on a dependent variable. Model 1's findings indicate that the variable "innovation score" negatively impacts the dependent variable, a revelation that underscores the complex nature of these relationships. Although the model's R-squared value suggests limited explanatory power, the significant F statistic confirms the overall validity of the model. Model 2 improves our understanding by introducing additional variables that reveal positive and negative associations. The positive effect of "innovation score" and the negative impact of "product impact minimization" on the dependent variable, along with an improved R-squared value, suggest a more comprehensive understanding of the factors at play.

The analysis of Model 3 reveals a significant negative relationship between the variable "innovation score" and the dependent variable, further elucidating the intricacies of these associations. The moderate R-squared value of the model, coupled with a substantial F statistic, suggests a significant yet partial explanation of the variance of the dependent variable. In Model 4, the introduction of additional variables provides a deeper understanding. The positive impact of "environmental products " and the negative influence of "product impact minimization" on the dependent variable, along with a higher R-squared value, demonstrate a more comprehensive model, enhancing our grasp of the factors driving organizational performance.

Model 5 introduces a novel perspective, indicating a positive relationship between the variable " innovation score" and the dependent variable. The moderate R-square value, along with a significant F statistic, reflects a meaningful but partial explanation of the variance in the dependent variable. Model 6, with its additional variables, offers a more complex view. The negative association of "environmental products" and the positive impact of "product impact minimization" on the dependent variable, together with a significantly higher R-squared value, provide a deeper understanding of the factors influencing organizational performance.

Model 7 introduces a positive relationship between the variable "innovation score" and the dependent variable, although the constant term lacks statistical significance. The modest R-squared value, coupled with a significant F statistic, suggests that the model captures a certain degree of variance in the dependent variable.

Model 8, with its additional variables, deepens our understanding. The negative impact of "environmental products "and the positive influence of "product impact minimization" on the dependent variable, along with a slightly higher R-squared value, provide a more nuanced understanding of the determinants of organizational performance.

Model 9's findings reveal a positive correlation between the variable " innovation score" and the dependent variable, further enriching our understanding of these complex relationships. The modest R-squared value of the model, in conjunction with a significant constant term and an F statistic indicative of general significance, highlights the multifaceted nature of the financial metrics under study. Model 10 improves this understanding by introducing additional variables. The negative impact of "environmental products" and the positive influence of "product impact minimization" on the dependent variable, combined with a nuanced R-squared value, offer a more detailed view of the factors influencing organizational performance.

Theoretical Contributions and Discussion

This study embarked on an exploration of the relationship between a firm's green innovation score and various financial performance indicators. The findings present a multifaceted picture, revealing both positive and negative correlations that contribute to an enriched understanding of the economic implications of green innovation.

Initially, a negative relationship was observed between a firm's green innovation score and its return on equity. This contradicts the theoretical expectation of a positive correlation. This discrepancy can be attributed to factors such as initial high investment costs in green technologies, which can temporarily reduce profitability (Xie et.al, 2022), and the possibility of a time-lag effect where the financial benefits of green innovations are realized over a longer term (Rezende et al., 2019). Industry-specific factors could also contribute where the immediate financial benefits of green initiatives are not recognized by the market (Ekins & Zenghelis, 2021).

In contrast, the study found that a firm's green innovation score is positively correlated with the total return index, the 12-month forward estimate of the price-book ratio, and the market value. These findings align with the view that green innovation improves the long-term value and attractiveness of a firm to investors. The positive relationship with the total return index suggests that investors may perceive green innovation favorably, considering it a marker of sustainable growth and long-term profitability (Aguilera-Caracuel and Ortiz-de-Mandojana, 2013). Similarly, the positive association with the 12M forward estimate of the price-book ratio and market value implies that green innovation may enhance the perceived future value and growth potential of the firm (Shamsuzzoha et.al, 2023).

Theoretical expectations posited a positive relationship between a firm's Environmental Product Score and several key financial metrics, including return on equity, 12-month forward estimate of return on equity, Total Return Index, price-book ratio, and market value. Contrary to these expectations, the empirical findings of this study indicate a negative relationship between the Environmental Product Score and the Total Return Index, the price book ratio, and the market value, while the findings are consistent with the expectations for the return on equity and its future estimate.

The negative association observed with the total return index, the price-book ratio, and the market value can be attributed to several factors. A plausible explanation is the perception of increased risk and uncertainty associated with environmental products (Aguilera-Caracuel and Ortiz-de-Mandojana, 2013). Investors may perceive these products as less profitable in the short term, thereby negatively impacting these financial metrics. Another factor could be the initial high costs and investment associated with developing and marketing environmental products, which might not immediately translate into increased market value or favorable price-book ratios (Xie et.al, 2022).

The positive relationships with the return on equity and its forward estimate align with the theoretical framework. These findings could be explained by the long-term creation of value and the improved reputation resulting from environmental product initiatives, leading to improved profitability and investor confidence (Shamsuzzoha et al., 2023).

The theoretical framework of this study anticipated a positive relationship between a firm's Product Impact Minimisation Score and several key financial metrics, including the return on equity (return on equity), the 12-month forward estimate of return on equity, the Total Return Index, the price-book ratio, and market value. On the contrary, the empirical analysis revealed a negative relationship between the Product

Impact Minimisation Score and both the return on equity and its 12-month forward estimate, while the findings for other metrics aligned with expectations.

The negative correlation observed with return on equity and its forward estimate may be attributed to several factors. Initial investment costs in product impact minimization could be substantial, potentially reducing short-term profitability and thus affecting return on equity (Rezende et al., 2019; Ekins & Zenghelis, 2021). Furthermore, the market might not immediately recognize the long-term financial benefits of such initiatives, leading to a lower forward estimate of return on equity. This could reflect market skepticism about the immediate profitability of environmental initiatives.

The positive relationships observed with the total return index, the price book ratio, and the market value align with the theoretical framework, suggesting that investors and the market may view product impact minimization favorably in terms of long-term growth and sustainability (Xie et al., 2022). These findings could be attributed to the improved reputation and customer loyalty associated with environmentally conscious practices, which are often reflected in these broader market metrics.

The contrasting nature of these findings underscores the complexity of the financial impact of green innovation. It suggests that while green innovation might initially burden short-term profitability (as reflected in return on equity), it positively influences market perceptions and long-term financial prospects. This dual impact highlights the need for a balanced view of green innovation, recognizing its potential for short-term challenges and long-term financial benefits.

Theoretically, these findings contribute to the nuanced understanding of green innovation's impact on financial performance. Practically, they suggest that firms should strategically manage the balance between the short-term financial implications of adopting green innovations and their potential for long-term value creation.

Recommendations for Future Research

Given the discrepancies observed in the short-term (negative relationship with ROE and its forward estimate) versus long-term financial metrics (positive relationships with the total return index, price-book ratio, and market value), future studies should investigate the temporal aspects of these relationships. Longitudinal studies could provide more information on how the impacts of Product Impact Minimisation and similar environmental initiatives evolve.

The impact of environmental initiatives can vary between different industries. Future research should consider conducting industry-specific analyses to determine how sectoral dynamics influence the relationship between environmental scores and financial performance metrics.

To better understand the underlying mechanisms, future studies should consider including additional variables that may mediate or moderate the relationship between environmental initiatives and financial outcomes. This could include factors such as consumer perception, regulatory changes, or technological advancements.

Expanding research to include diverse geographical and cultural contexts can provide a more global perspective on the financial implications of environmental initiatives. This is particularly relevant given the varying environmental regulations and market conditions in different regions.

Incorporating qualitative research methods, such as case studies or interviews with industry experts, can complement quantitative findings and offer richer context-specific insights into the observed relationships. Future research could explore how investors and the market perceive and respond to firms' environmental initiatives. This would help to understand the observed discrepancies between different financial metrics.

A detailed cost-benefit analysis of the implementation of environmental initiatives could provide practical insights for companies. This analysis should consider both direct and indirect costs and benefits, including potential impacts on brand reputation and customer loyalty. Research on the policy implications of these findings could be beneficial. Understanding how government policies and incentives might influence the economic impacts of environmental practices could inform more effective policy-making.

By following these research directions, future studies can build on the current findings, offering a more comprehensive understanding of the complex interplay between environmental initiatives and various financial performance metrics.

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