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THE RELATIONSHIP BETWEEN GREEN INNOVATION AND FINANCIAL PERFORMANCE: A STUDY ON EU FIRMS

Yüksek Lisans Tezi

KUBİLAY DÜZGİT

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Danışman: PROF. DR. ASLI AYBARS

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ÖZET

YEŞİL İNOVASYON VE FİNANSAL PERFORMANS İLİŞKİSİ: AB FİRMALARI ÜZERİNE BİR ARAŞTIRMA

Son yıllarda hem akademik alanda hem de özel sektörde yeşil inovasyon ile finansal performans arasındaki ilişkiye olan ilgi artmaktadır. Yeşil inovasyonun finansal performans üzerindeki etkilerini kavramak için çeşitli türlerde çalışmalar yapılmıştır, ancak sonuçlar üzerinde henüz bir fikir birliğine varılamamıştır. Bazı çalışmalar yüksek yeşil inovasyon değerlerinin finansal performansı artırıcı etkisi olduğunu savunmakta, bazı çalışmalar ise finansal performansı düşürücü etkisi olduğunu savunmaktadır. Bu çalışmada Avrupa Birliği'nde faaliyet gösteren 105 şirketin 2016 ve 2022 yılları arasındaki finansal verileri Eikon veri tabanından elde edilmiştir. Patent verilerinin toplanmasında Avrupa Patent Ofisi tarafından oluşturulmuş küresel bir patent veri tabanı olan PATSTAT kullanılmıştır. Bu patent verileri, analiz edilen firmaların yeşil inovasyon yoğunluğunun değerlendirilebilmesi için Dünya Fikri Mülkiyet Örgütü'nün IPC (Uluslararası Patent Sınıflandırma) Kodlarına göre yayınladığı "IPC Yeşil Envanteri" kullanılarak sınıflandırılmıştır. Yeşil inovasyon yoğunluğu, yeşil inovasyonu ölçümlemek için çalışmamızda bağımsız değişken olarak kullanılmıştır. Finansal performansın değerlendirilmesinde, yaygın olarak kullanılan aktif karlılığı ve öz kaynak karlılığı oranları seçilmiştir. Kullanılan bu oranlar çalışmamızda bağımlı değişken olarak nitelendirilen finansal performansı temsil etmektedir. Bu şirketlerin finansal performansları ile yeşil inovasyon yoğunlukları arasındaki ilişkiyi incelemek için panel veri analizi kullanılmıştır. Analiz sonuçları, yeşil inovasyon ile finansal performans arasında istatistiksel olarak anlamlı ve pozitif bir ilişki olduğunu göstermektedir.

Anahtar Kelimeler: Yeşil İnovasyon, Finansal Performans, Avrupa Birliği, Panel Veri Analizi

ABSTRACT

THE RELATIONSHIP BETWEEN GREEN INNOVATION AND FINANCIAL PERFORMANCE: A STUDY ON EU FIRMS

In recent years, interest towards the relationship between green innovation and financial performance has been increasing, both in the academic field and the private sector. Various types of studies have been conducted to grasp the effects of green innovation on financial performance, but a consensus as to the results has not yet been reached. While some studies argue that high green innovation values result in an increase in financial performance, other studies report the reverse relationship. In this study, the financial data of 105 companies, which operate in the European Union, have been collected from Eikon database between the years 2016 and 2022. PATSTAT, which is a global database of patents formed by the European Patent Office was used to gather the patent data of these companies for the same period. This patent data is classified using the "IPC Green Inventory" published by the World Intellectual Property Organization by their IPC (International Patent Classification) Codes in order to evaluate the green innovation intensity of the analyzed firms. Green innovation intensity is used as our explanatory variable to measure green innovation. For the assessment of financial performance, commonly used ratios; namely, return on assets (ROA) and return on equity (ROE), are used as dependent variables. Panel data analysis is utilized in order to reveal the relationship between financial performance and green innovation intensity. The results show that there is a statistically significant and positive relationship between green innovation and financial performance.

Keywords: Green Innovation, Financial Performance, European Union, Panel Data Analysis

ACKNOWLEDGEMENT

First and foremost, I would like to thank my supervisor Prof. Dr. Aslı Aybars for her valuable insights, contributions, and guidance throughout my graduate studies. I would like to express my sincerest gratitude to my colleague Ceren Bulundu for the limitless support she had for me in managing work, school, and life balance. For the assistance they gave me in my data collection phase I would like to thank my dear friends Ender Barış İmamoğlu and Faik Derya İnce. For all the selfless acts she has done in order for me to be successful, for her endless love, support and care I would like to thank my girlfriend Cansu Bıdıklı. And my family; for everything they have sacrificed for me, for always being by my side and always believing in me, I am extremely grateful.

Kubilay DÜZGİT

İstanbul, 2023

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ABBREVIATIONS

ASEAN	Association of Southeast Asian Nations
CIS	Community Innovation Survey
CSR	Corporate Social Responsibility
EPO	European Patent Office
ESG	Environmental Social and Governance
EU	European Union
FP	Financial Performance
GDP	Gross Domestic Product
GI	Green Innovation
GII	Green Innovation Intensity
GMM	Generalized Method of Moments
GRI	Global Reporting Initiative
IP	Intellectual Property
IPC	International Patent Classification
MNC	Multinational Company
OECD	Organization for Economic Cooperation and Development
PCT	Patent Cooperation Treaty
PRI	Principles for Responsible Investment
R&D	Research and Development
RBV	Resource Based View
ROA	Return on Assets
ROE	Return on Equity
ROI	Return on Investment
ROS	Return on Sales
SASB	Sustainability Accounting Standards Board
SDG	Sustainable Development Goal
SME	Small and Medium-Sized Enterprise
SRI	Socially Responsible Investing
UK	United Kingdom
US	United States
WIPO	World Intellectual Property Organization
VIF	Variance Inflation Factor

1. INTRODUCTION

1.1. What Is the Aim of Green Innovation?

In the effort to achieve sustainable development, green innovation is essential. In order to reduce the negative consequences of economic activities, the development of innovative goods, processes, and services that prioritize the environment are required. Green innovation seeks to reduce pollution, protect important resources, and encourage the use of renewable energy sources through promoting novel technology and practices (Fussler & James, 1996).

Numerous factors propel the adoption of green innovation. Companies are compelled to adhere to eco-friendly standards and reduce their environmental impact due to stringent environmental regulations. Furthermore, the increasing demand from consumers for sustainable products acts as a driving force. The availability of financial support for green innovation projects, the desire to enhance corporate social responsibility (CSR), and the acknowledgment of the economic benefits linked to sustainability also contribute to its promotion. Despite these driving factors, challenges persist in the realm of green innovation. High development and implementation costs of sustainable technologies pose a significant obstacle. Furthermore, limited awareness and understanding, particularly among small and medium-sized enterprises, hinder the adoption of green practices. Cultural, social, and institutional barriers can also impede the transition to sustainable practices (Liu, Wang & Wu, 2021).

The benefits derived from green innovation are extensive. They encompass reduced environmental impact, improved resource efficiency, and enhanced competitiveness. Green innovation fosters the creation of new markets and business opportunities, particularly in renewable energy and sustainable products. Moreover, it enhances the reputation of companies and strengthens their relationships with stakeholders, such as customers, employees, and investors (Takalo & Tooranloo, 2021).

For organizations and communities, green innovation is of utmost importance in environmental management (Yang et al., 2016). In recent years, the number of studies conducted in this area have witnessed an upward trend. Because of the serious threat that environmental deterioration poses to human life, many organizations and communities have embraced green innovation as a way to advance both environmental preservation and economic growth. According to Hur, Kim & Park (2013), green innovation helps businesses achieve sustainable competitive advantages when both environmental sustainability and economic profitability are valued equally.

Green innovation is now a vital instrument used by businesses to increase their market share and guarantee long-term profitability. Successful green innovation initiatives improve market standing,

increase customer loyalty, provide eco-friendly services, and grant a competitive edge. These advantages have sparked considerable interest among researchers and managers across diverse enterprises. Most innovation studies draw upon the Schumpeterian theory, which posits that green innovation addresses customer expectations to preserve the environment. In green innovation, new goods and technologies are created with the intention of lowering environmental hazards including pollution and resource depletion (Castellacci & Lie, 2017).

Process or product design and service development are two subcategories of innovation. Enhancing how goods and services serve customers and clients is the ultimate purpose of product and service innovation. This innovation process improves cost-effectiveness and organizational flexibility; thereby, reducing environmental risks, enhancing resource efficiency, creating opportunities for eco-conscious behaviors, reducing pollution, promoting recycling, and conserving energy. It also aids in gaining competitive advantages, improving environmental performance, alignment with strategic goals, and enhancing overall company performance.

Therefore, green innovation serves as a crucial tool for achieving environmental sustainability for the society, organizations, and businesses. It also plays a significant role in gaining a competitive edge (Chu, Wang & Lai, 2019), boosting economic performance, and addressing environmental concerns. Importantly, green innovation hampers imitation. Highlighting these aspects amplifies its influence on groups, businesses, and the wider community. However, implementing these factors comes with challenges, including environmental issues associated with green technologies, the risk of implementation failure, high research and development costs, data collection challenges, increased workload and job dissatisfaction for employees, insufficient funding for green projects, negative effects of external information, organizational aversion to risk, limited understanding of green projects, and ineffective government assistance. Overcoming these obstacles can facilitate the adoption of green innovation by organizations and communities (Taklo, Tooranloo & Shahabaldini Parizi, 2020).

1.2. Recent European Environmental, Economic and Social Setting

Europe has played a leading role in environmental, economic, and social policies for an extended period, and recent developments have further solidified this position. In this section, the current state of the European environment, economy, and society, as well as the policies and initiatives undertaken to foster sustainability and well-being will be reviewed.

The European Union (EU) has established challenging environmental goals, such as lowering greenhouse gas emissions, improving air and water quality, and protecting biodiversity. By setting a goal to achieve net-zero greenhouse gas emissions by 2050, the EU acknowledged the climate emergency in 2019 (Bouckaert et al., 2021). The EU, which has implemented stringent environmental

regulations, has pushed a range of industries to adopt sustainable methods, including agriculture, transportation, and energy. The main goals of these projects are to protect biodiversity and reduce air and water pollution.

Even yet, issues persist, notably with the circular economy and the decline of biodiversity. Recent research indicates that the EU's 2030 goal of reversing biodiversity loss is not progressing very significantly (Seto, Güneralp, & Hutyra, 2012). The EU's circular economy action plan, which aims to decrease waste and increase resource efficiency, is challenging to implement because of the complexity of the circular economy.

The digital revolution and growing economic inequality are issues for Europe's economy, notwithstanding their strength and variety. These problems have gotten worse as a result of the COVID-19 pandemic, which has sparked a recession and raised unemployment rates throughout Europe.

To address these concerns, the EU has launched a variety of economic initiatives, including the Digital Single Market and the European Green Deal. The European Green Deal seeks to advance sustainability and resource efficiency with the ultimate goal of transforming the EU into a climate-neutral economy. This comprises advocating for ecologically sustainable practices in several sectors, such as transportation, energy, and agriculture (Siddi, 2020). On the other side, the Digital Single Market prioritizes data protection and privacy while fostering digital innovation and economic progress (Cini & Czulno, 2022).

Even while Europe has made great strides in promoting social inclusion and wellbeing, issues like migration, inequality, and social cohesion still need to be addressed. The COVID-19 pandemic has further exacerbated these challenges, disrupting education (Hoofman & Secord, 2021), employment (Fana, Torrejón Pérez & Fernández-Macías, 2020), and social services (Fisher, 2020) across Europe.

The NextGenerationEU program and the European Pillar of Social Rights are only two of the many social initiatives the EU has put in place to address these problems. The European Pillar of Social Rights aims to promote equality of opportunity and access to essential social services, such as social assistance, healthcare, and education (Garben, 2019). Through targeted investments in industries including education, healthcare, and renewable energy, the NextGenerationEU program aims to enhance economic recovery, social well-being, and environmental sustainability (De la Porte & Jensen, 2021).

1.3. Structure of the Research

Five chapters make up this thesis: Introduction; Environmental, Social and Governance Criteria, Sustainable Development and Green Innovation: The Theoretical Background; Green Innovation and Financial Performance Relationship; Empirical Analysis; Conclusions and Recommendations.

The Introduction section defines the goal of green innovation as well as the recent environmental, economic, and social context in Europe. The definition of "green innovation" is addressed under "Introduction." The overall setting for Europe is given next. Finally, the thesis's framework and constraints are explained.

The definitions of environmental, social, and governance criteria, sustainable development, and green innovation are provided in the Environmental, Social, and Governance Criteria, Sustainable Development, and Green Innovation: Theoretical Background section of the thesis. The historical developments of these subjects are made clear. An overview of international patent classification is included in the description of the patent grant procedure, along with information regarding the World Intellectual Property Organization and the European Patent Office.

The link between green innovation and financial performance is discussed in the third section. In this part, the factors and the ratios that have been used to evaluate these variables in the literature are provided.

The empirical analysis is the focus of the thesis' fourth section. Studies on the link between green innovation and financial performance are provided with respect to this context. Next, a description of the data utilized in the empirical analysis is described. The analytical approach is explained in the methodology section. The final component of the fourth segment provides an interpretation of the study findings.

The conclusion of the thesis is evaluated overall in the last section, which also summarize the analysis' key results. Additional suggestions for the researchers in the green innovation literature are made at the conclusion of this thesis.

1.4. Limitations of the Research

The impact of green innovation on financial performance is the main topic of this thesis. Researching the effects of green innovation on financial performance is a paramount undertaking in the current global context, where sustainability and economic growth converge. As the world grapples with pressing environmental challenges, businesses are increasingly under scrutiny to adopt sustainable practices and develop green innovations. This study holds immense significance due to its potential to shed light on the interplay between environmentally conscious strategies and financial outcomes for companies.

By investigating how green innovation initiatives impact the financial performance of organizations, we can gain valuable insights into the feasibility of integrating sustainability into core business practices, its implications for profitability, cost efficiency, and long-term resilience.

Understanding this relationship can empower businesses, investors, policymakers, and other stakeholders to make informed decisions that not only benefit their bottom lines but also contribute to a more sustainable and ecologically responsible global economy.

The scope of this study is restricted to the period of analysis, which is 2016–2022, and the conclusions can only be a representation to the European Union enterprises that are the focus of this study. In order to evaluate financial performance, green innovation, and other control variables, many variables have been utilized in the literature. The variables used in the empirical analysis section are determined after the in-depth research of the related literature.

2. ENVIRONMENTAL, SOCIAL AND GOVERNANCE CRITERIA, SUSTAINABLE DEVELOPMENT AND GREEN INNOVATION: THE THEORETICAL BACKGROUND

2.1. Definition of ESG Criteria, Sustainable Development, and Green Innovation

ESG (Environmental, Social, and Governance) criteria and Green Innovation are closely interconnected concepts vital for sustainability. ESG criteria serve as benchmarks to evaluate the environmental, social, and governance performance of companies or organizations. Environmental standards measure how much influence businesses have on the environment, taking into account things like greenhouse gas emissions, trash production, and resource usage. Social factors take into account a company's impact on society, including labor standards, human rights laws, and volunteerism. According to Friede, Busch & Bassen (2015), governance criteria evaluate a company's management procedures, including the composition of the board, executive remuneration, and transparency.

Investors are adopting ESG criteria more frequently to find businesses that are dedicated to sustainability and making positive contributions to the environment and society. Investors can evaluate a company's long-term sustainability as well as possible risks and opportunities by using ESG criteria (Park & Jang, 2021).

The development of ecologically sound, socially conscious, and commercially successful goods, services, and technology is the emphasis of green innovation. On the other hand, its objective is to lessen the negative effects of economic activity on the environment while promoting economic development and social welfare (Takalo & Tooranloo, 2021).

Energy, transportation, agriculture, construction, and manufacturing are just a few of the industries that have adopted green innovation. Green innovation, for instance, advances clean energy technologies like solar and wind power to reduce greenhouse gas emissions and advance energy independence. In transportation, it entails the development of electric vehicles and fuel-efficient engines to mitigate air pollution and enhance energy efficiency. In agriculture, green innovation encompasses sustainable farming practices like organic farming and crop rotation to minimize the use of pesticides and fertilizers while promoting soil health.

Both ESG criteria and green innovation play pivotal roles in promoting sustainability. ESG criteria enable investors to evaluate a company's long-term sustainability, identify risks and opportunities, and incentivize sustainable practices that reduce environmental impact while promoting social and economic welfare.

Green innovation is equally essential as it drives the creation of novel products, services, and technologies that are environmentally sustainable, socially responsible, and economically viable. It spurs economic growth, job creation, and environmental protection (Asadi et al., 2020).

The International Union for Conservation of Nature and Natural Resources is credited for coining the term "sustainable development" in its 1980 World Conservation Strategy report, according to Church et al. (2008). This concept states that to guarantee that any changes to the environment safeguard everyone's right to exist and live in peace, sustainable development integrates conservation with development. The concept was further popularized by the Brundtland Report of the United Nations, which defined sustainable development as meeting present demands without compromising the capacity of future generations to meet their own needs. According to Brundtland (1987), sustainable development recognizes the constraints that withstand the effects of human activities as technology, social structure, and the capacity of natural resources.

"Green innovation" has many different connotations. The definition of green innovation "new products and processes that deliver customer and business value while significantly reducing environmental impacts" was originally used by Fussler & James in 1996. According to Kemp & Pearson (2007), "green innovation" is the development, adoption, or use of innovative goods, services, processes, or management techniques that, when compared to alternatives, have less hazards to the environment, produce less pollution, and have negative effects on society less often.

Green innovation is defined by the Europe INNOVA panel as the development of novel, competitively priced products, systems, processes, and procedures that meet human needs and improve quality of life while releasing the fewest number of toxic substances possible (Schiederig, Tietze, & Herstatt, 2012). This is in line with the definition offered by the Organization for Economic Cooperation and Development (OECD, 2009), which characterizes green innovation as the development or application of novel or significantly enhanced procedures, marketing strategies, organizational designs, and institutional arrangements that result in environmental enhancements in comparison to relevant alternatives.

Driessen & Hillebrand (2002) offer a more practical definition of green innovation, arguing that it does not always seek to lessen environmental burden but nonetheless produces significant environmental advantages. Technology breakthroughs in energy conservation, pollution avoidance, trash recycling, green product designs (hardware or software), or corporate environmental management are all examples of what Chen et al. (2006) refer to as "green innovation".

2.2. History of ESG Criteria and Green Innovation

ESG criteria and green innovation play vital roles in the investment world and the pursuit of sustainability. Investors now place greater emphasis on companies that prioritize ethical practices and sustainability. The development of innovative technologies and procedures to address resource depletion and mitigate climate change are referred to as green innovation.

ESG standards were first developed in the 1960s and 1970s in response to environmental disasters and social justice issues. Socially responsible investing (SRI) funds first appeared in the United States in the 1970s, first focusing on excluding businesses engaged in contentious industries including cigarettes, weapons, and gambling (Townsend, 2020).

In the 1980s and 1990s, ESG criteria grew to include a wider variety of social and environmental problems, including labor standards, human rights, and climate change. The Principles for Responsible Investment (PRI), which provided a framework for integrating ESG factors into investment choices, were presented by the United Nations in 2006. According to Eccles & Stroehle (2018), the PRI is now the largest worldwide network of investors dedicated to ESG issues.

Investors are starting to see the potential for long-term success in businesses with strong ESG performance, which has led to the mainstream importance of ESG criteria. To help businesses report on their ESG performance, reporting frameworks and standards like the Global Reporting Initiative (GRI) and Sustainability Accounting Standards Board (SASB) have been established.

Green innovation traces its history back to the 1970s, initially concentrating on enhancing energy efficiency and developing renewable energy sources in response to the energy crisis. In subsequent decades, green innovation expanded to address diverse sustainability concerns like waste reduction, water conservation, and sustainable agriculture. Government policies, consumer demand, and technological advancements are some of the factors that are drivers of this expansion (Pansera, 2011).

Today, green innovation centers on combating climate change and resource depletion. Advancements in technologies such as electric vehicles and energy storage systems are crucial for achieving sustainability. Circular economy models, which prioritize waste reduction and the reuse/recycling of materials, are gaining significant traction.

The advancement of ESG criteria and green innovation showcases the growing awareness of sustainability and ethical practices in both business and society. Given the urgent environmental and social issues we face, it is crucial to give green innovation and ESG standards top priority in order to achieve a more sustainable and just future.

2.3. World Intellectual Property Organization and International Patent Classification

The World Intellectual Property Organization (WIPO), a United Nations agency, is charged with promoting and protecting intellectual property (IP) throughout the globe. Since its founding in 1967, WIPO has contributed significantly to the formation of international intellectual property laws, treaties, and policies.

There are 193 nations that make up WIPO, which has its main office in Geneva, Switzerland. Its principal goal is to support the use and protection of intellectual property in order to advance economic development, creativity, and innovation. In addition to training programs, educational efforts, and legal and technical assistance, the organization offers member governments a wide range of services and support (May, 2006).

WIPO contributed to the creation of the Madrid Protocol for the International Registration of Marks, the Patent Cooperation Treaty (PCT), and the Paris Convention for the Protection of Industrial Property (Schuyler, 1982; Walters, 1993). These agreements promote collaboration in this area and establish universal standards for IP protection.

Offering member countries various IP-related services and support is one of WIPO's main responsibilities. This means attempting to support technical and legal help, education, and training, as well as other forms of aid (Halbert, 2006). WIPO manages several international databases of IP information, including the PCT database, the Madrid System database for international trademarks, and the Hague System for International Registration of Industrial Designs.

In order to assist people and organizations in managing and securing their intellectual property, WIPO also provides online tools and services. A couple of these include the WIPO IP Portal, which offers details on IP-related services and help from WIPO and other organizations, and the WIPO worldwide Brand Database, which facilitates searching for and monitoring global trademarks.

The International Patent Classification (IPC) was created with major assistance from WIPO. The IPC, a hierarchical coding system, is used to organize patents in accordance with their technical fields. It harmonizes the assessment and comparison of patents from many countries and streamlines the search for patent data.

Eight components make up the IPC, which are further divided into classes, subclasses, and groups (Vijvers, 1990) which are discussed below:

- Human Necessities
- Performing Operations; Transporting
- Chemistry; Metallurgy

• Textiles; Paper

• Fixed Constructions

• Mechanical Engineering; Lighting; Heating; Weapons; Blasting

• Physics

• Electricity

Within each section, classes and subclasses are organized hierarchically in line with the technical content of each. For example, within section 3 (Chemistry; Metallurgy), Class C01 pertains to inorganic chemistry, while Class C07 pertains to organic chemistry.

Patent offices worldwide utilize the IPC for patent classification and searching. WIPO also employs the IPC for publishing patent statistics and as a basis for international patent analysis. Regular updates and revisions to the IPC ensure its relevance and effectiveness in accommodating technological advancements (Fall, 2003).

The World Intellectual Property Organization and the International Patent Classification play pivotal roles in the global IP system. The IPC provides a standardized and hierarchical framework for patent classification, while WIPO offers additional tools and services to facilitate IP registration and protection. It is predicted that the IPC and other WIPO-established systems would adapt in line with the ongoing development of technology to meet the shifting needs of the world's intellectual property community.

2.4. European Patent Office and European Patent Grant Process

A sizable patent agency with operations all over the world is the European Patent Office (EPO). Its primary duties include overseeing and granting patents throughout numerous European countries.

The Munich, Germany-based EPO was founded in 1973. The European Union and additional nations including Turkey, Switzerland, and Norway are among the 39 nations that are now a part of this organization (Hingley & Bas, 2009).

One of the key duties of the EPO is to guarantee the efficacy and completeness of the patent examination procedure. A team of skilled patent examiners thoroughly evaluates each application to assess its uniqueness and inventiveness. The EPO, one of the largest patent offices in the world, is well known for its rigorous standards and standardized examination process. It emphasizes the value of quality.

The EPO is also crucial for fostering innovation and economic development across Europe. By granting patents for innovative ideas and technologies, the EPO fosters the growth of new markets for

goods and services (Harhoff & Wagner, 2009). The EPO offers a platform for communication between researchers, businesses, and innovators from all around Europe.

In recent years, the EPO has emerged as a leader in the analysis of patent data and information. It oversees sizable patent databases including the Espacenet database and the European Patent Register (Jürgens & Herrero-Solana, 2015), which provide users access to more than 100 million patent documents internationally.

To assist clients and enterprises in safeguarding and managing intellectual property, the EPO has developed a number of online tools and services. The Patent Information Tour, which offers free online instruction on patent information and search methods, and the Patent Translate service, which permits machine translations of patents in a number of languages, are two well-known examples. The laborious and strict European patent granting procedures' goal is to ensure that only remarkable and ground-breaking innovations are granted patents in Europe. The EPO conducts the procedure, which has multiple phases.

The EPO must receive a patent application before the European patent issuing process can begin. The application must include all relevant data and documents, as well as a comprehensive description of the invention. Next a team of patent examiners meticulously examines the application to determine its inventiveness and originality. The testing procedure emphasizes accuracy and rigor, and it frequently lasts for several years. Examiners may request further information, clarification from the applicant, or revisions to the application to comply with the provisions of the European Patent Organization at any time during this procedure (Graham et al., 2002).

Following a positive evaluation, the EPO issues a European patent, guaranteeing the invention's safety in all signatory nations to the European Patent Organization. However, in order to receive protection outside of Europe, separate patent applications must be filed in every nation.

The procedure for granting European patents stimulates innovation and economic expansion throughout the continent by giving firms and inventors a platform to protect their intellectual property. The EPO promotes investment in research and development (R&D) and the development of new industries, goods, and services by issuing patents for innovative technology and ideas (Eaton, Kortum & Lerner, 2004).

The use of new technology and internet applications has helped the process become more simplified and effective in recent years. To assist applicants during the patent grant process, the EPO has created a number of online services and tools, including online patent information databases, automatic translation services, and filing procedures.

3. GREEN INNOVATION AND FINANCIAL PERFORMANCE RELATIONSHIP

Green innovation is the invention and use of innovative technologies, procedures, and practices that promote sustainable growth and lessen negative environmental consequences. The emphasis on green innovation has surged in recent times as companies strive to enhance their environmental performance and curtail their carbon footprint.

There has been much research and discussion on the relationship between green innovation and financial performance. While some researches have found a positive link between green innovation and improved financial success, other studies have found a negative link or conflicting results.

A primary argument supporting the positive link between financial performance and green innovation revolves around its potential for cost savings by boosting efficiency and curbing waste (Calof & Viviers, 1995). For instance, adopting renewable energy sources can diminish energy expenses, while implementing sustainable practices in supply chains can reduce material waste and transportation costs.

Beyond cost savings, green innovation can generate augmented revenues by developing new products and services that resonate with environmentally conscious consumers (Huang et al., 2016). Companies venturing into the creation and marketing of eco-friendly offerings may secure a competitive edge and expand their market share.

The link between green innovation and financial performance, however, is not always clear-cut. According to De Azevedo Rezende et al. (2019), implementing green innovation approaches may require significant upfront investments, which might cause short-term financial losses. Furthermore, because the creation and adoption of new technologies and practices take time, the advantages of green innovation might not be seen right away.

3.1. Determinants of Green Innovation

The convergence of green innovation and internationalization has emerged as a significant facet of contemporary business. As companies endeavor to broaden their global presence, they are also striving to foster sustainable development and curtail their environmental footprint.

Green innovation encompasses the creation and application of novel technologies, processes, and practices that facilitate sustainable development and mitigate adverse environmental impacts (Takalo & Tooranloo, 2021). Various factors influence the extent of green innovation within a company, including:

• Environmental Regulation: Companies operating in regions with stringent environmental regulations are more inclined to embrace green innovation to ensure compliance (Liu, Wang & Wu, 2021).

• Corporate Culture: Companies that prioritize sustainability within their corporate culture are more likely to engage in green innovation (Afshar Jahanshahi, Al-Gamrh & Gharlegi, 2020).

• Research and Development Investments: Companies that invest in R&D are more prone to develop and implement green innovation practices (Xu, Liu & Shang, 2021).

• Industry Characteristics: Certain industries, such as renewable energy and clean technology, demonstrate a greater propensity for green innovation due to their inherent nature (Wurlod & Noailly, 2018).

3.1.1. IPC Green Inventory and Green Innovation Intensity

The IPC Green Inventory serves as a comprehensive global repository of environmentally sustainable technologies and innovations utilized across various industries worldwide. By providing an up-to-date collection of cutting-edge green technologies and concepts, the database managed by the IPC, an internationally acknowledged system for patent classification, encourages the promotion and implementation of sustainable practices (León et al., 2018).

Designed to cater to businesses, researchers, and policymakers interested in advancing sustainability and environmental preservation, the IPC Green Inventory encompasses a diverse array of technologies. It covers renewable energy sources, eco-friendly construction materials, waste reduction and recycling techniques, and sustainable transportation systems. By providing access to the latest sustainable technologies and innovations, the database empowers businesses to identify and implement new eco-conscious practices. Similarly, researchers can utilize the information to drive the development of innovative solutions (Albino et al., 2014).

Furthermore, the IPC Green Inventory assumes a pivotal role for policymakers striving to promote sustainable development and reduce the environmental impact of economic activities. By offering a comprehensive database of sustainable technologies, policymakers gain a valuable resource to identify and support the implementation of environmentally responsible policies and practices.

Regular updates ensure that the IPC Green Inventory remains a reliable and current source of sustainable technology information. The database is publicly accessible and available online through the IPC website or via national and international patent office's employing the IPC classification system.

Green innovation intensity refers to the degree to which companies prioritize and invest in environmentally sustainable practices and technologies (Chouaibi & Chouaibi, 2021). It reflects the level of dedication exhibited by companies in developing and implementing green innovations.

In recent years, environmental sustainability has garnered increasing recognition, prompting numerous companies to actively pursue carbon footprint reduction and eco-friendly initiatives (Friede, Busch & Bassen, 2015). However, commitment to green innovation can vary across industries and regions, as not all companies demonstrate equal levels of dedication and investment.

The intensity of green innovation is influenced by several factors. Environmental laws and policies are important, and businesses operating in areas with strict laws are more inclined to invest in green technology to ensure compliance and avoid fines (Li et al., 2018). Additionally, companies operating in environmentally impactful industries like manufacturing and energy may exhibit a higher propensity for prioritizing green innovation.

Competitive dynamics also influence green innovation intensity. Companies in highly competitive markets may be motivated to invest in green innovation as a means of differentiation and gaining a competitive edge (Bimonte, Romano & Russolillo, 2021).

Consumer demand serves as another influencing factor. As awareness of environmental issues grows and consumers increasingly seek eco-friendly products and services, companies may be inclined to invest in green innovation to meet customer expectations and maintain market share (Huang et al., 2016).

Measuring green innovation intensity poses challenges due to the absence of standardized metrics. Nonetheless, various approaches have been developed to assess the level of green innovation, such as analyzing environmental patent data, conducting surveys on companies' environmental practices, and studying corporate sustainability reports.

In conclusion, green innovation intensity represents a crucial metric for evaluating a company's commitment to environmental sustainability. While multiple factors shape the level of investment in green innovation, it is evident that companies prioritizing sustainability can reap benefits including cost reduction, enhanced brand reputation, and increased market share. As the global community continues to emphasize environmental sustainability, green innovation intensity will persist as a significant measure of corporate responsibility and competitiveness.

3.2. Financial Performance

3.2.1. Indicators of Financial Performance

A company's capacity to generate profit and produce cash flow from its operations is directly tied to how well it does financially. It is an essential indicator of the business's general health and its capacity to generate profits for shareholders and all other stakeholders.

One of the primary and widely accepted definitions of financial performance revolves around profitability. Financial performance, from this standpoint, is the ability of a company to generate profits and returns on its investments (Botazzi, Secchi & Tamagni, 2008). It involves analyzing various profitability ratios such as gross profit margin, operating profit margin, and net profit margin. A financially successful organization is expected to exhibit strong profitability ratios, indicating efficient cost management and revenue generation.

Financial performance can also be defined by the organization's growth and expansion prospects. Growth-based financial performance emphasizes the company's ability to increase its market share, expand its customer base, and enter new markets (Han, 2012). Metrics like revenue growth rate and earnings growth rate are used to measure the organization's success in achieving sustainable growth.

Financial performance can be evaluated based on the efficiency with which a company utilizes its resources. Efficiency measures assess how well the organization manages its assets and liabilities to generate revenue (Trinks, Mulder, & Scholtens, 2020). Metrics like asset turnover, inventory turnover, and accounts receivable turnover are used to gauge operational efficiency and resource utilization.

Several important measures are used by analysts and investors to assess a company's financial performance. Revenue growth, profitability, liquidity, solvency, and efficiency are a few of these indicators. Each statistic presents a different perspective on the business's financial situation and opportunity to add long-term value.

Revenue growth, which focuses on the increase in sales over a specific time period, reveals a company's ability to create sales and develop its client base. It's an important metric for figuring out how competitive an industry is for a certain firm (Ghosh, Gu, & Jain, 2005).

The capacity of a business to make a profit after deducting expenditures for things like supplies, labor, rent, and other outlays is known as profitability. Metrics such as gross profit margin, operational profit margin, and net profit margin can be used to assess a company's profitability (Fama & French, 2006).

According to Hicks (1962), a company's liquidity is determined by its capacity to repay short-term debt and effectively manage its cash flow. Metrics like the current ratio and quick ratio are used to evaluate a company's capacity to cover short-term expenses and commitments.

According to Walter (1957), a company's ability to undertake long-term capital expenditures and pay off debt is referred to as its "solvency." Debt-to-equity ratios and interest coverage ratios are two indicators of how well a corporation manages its long-term financial commitments.

Efficiency indicators that measure how efficiently a business uses its resources to create income include the inventory turnover ratio and asset turnover ratio. According to Gaur, Fischer & Raman (2005), these measures reveal information about the company's operational effectiveness and its capacity to make a profit from its assets.

3.2.2. Profitability Ratios

Profitability ratios are a group of financial metrics that assess a company's ability to make a profit in proportion to sales, assets, and equity. These ratios enable interested parties to evaluate the firm's financial condition and determine if it is profitable enough to sustain operations and growth.

Among the many profitability measures, gross profit margin, operational profit margin, net profit margin, return on assets, and return on equity are a few examples. Each of these ratios offers a unique perspective on the profitability of the company.

• Gross Profit Margin

The gross profit margin is the portion of revenue that is left over after deducting the cost of goods sold. After deducting manufacturing expenses, this ratio assesses how well a corporation generates income from its goods or services (Novy-Marx, 2013). Enhanced profitability may result from enhanced production efficiency or stronger pricing power, which are both indicators of larger gross profit margins.

• Operating Profit Margin

The amount of income that remains after all operational costs, including wages, rent, and overhead expenditures are deducted from sales is known as the operating profit margin. It assesses how well the business can generate profit from its primary activities (Mahdi & Khaddafi, 2020). Increased profitability is the result of improved control over operating expenditures, which is indicated by a higher operating profit margin.

• Net Profit Margin

The amount of revenue that is still available after all costs, including taxes and interest, is referred to as the net profit margin. According to Nariswari & Nugraha (2020), this ratio evaluates the company's entire capacity to make money from a variety of sources, including financial and investing operations. Improved overall financial performance is indicated by a higher net profit margin.

• Return on Assets

By comparing net income to total assets, return on assets assesses how well a firm makes a profit from its assets. Increased revenue production per dollar of assets is indicated by a better return on assets, which might result in improved profitability (Fairfield & Yohn, 2001).

• Return on Equity

Return on equity measures the efficiency with which a business makes money from its equity capital. This ratio is computed by dividing net income by shareholders' equity. Improved profitability may result from a better return on equity, which denotes greater revenue production per dollar of equity (Hunjra et al., 2014).

3.2.2.1. Return on Assets and Return on Equity

Return on assets (ROA) and return on equity (ROE) are two often used financial statistics that offer useful information about a company's profitability and financial performance. Although both ratios assess the creation of profits, their meanings and computation techniques differ.

The ROA measures how much net revenue is generated for each dollar invested in total assets. It is calculated by dividing the net revenue of an organization by its total assets. This ratio shows how efficiently a business uses its resources to make a profit (Brown & Caylor, 2009). A higher ROA suggests efficient asset utilization and income generation. Comparisons across industries are feasible as ROA considers how well assets are utilized to generate income.

ROE evaluates the profit generated per dollar of shareholder equity and is calculated as dividing net income by shareholder equity. This ratio assesses a company's ability to convert equity investment into profits (Arditti, 1967). A higher ROE indicates greater profit generation per dollar of equity. Comparisons within the same industry are common as ROE focuses on how well a company uses shareholder investment to generate profit.

Although both ratios measure profitability, they differ in terms of what they represent and how they are calculated. ROA provides a broader measure of profitability, considering all assets involved in income generation. Conversely, ROE focuses on shareholder equity, representing the ownership stake

of shareholders (Kabajeh, Al Nu'aimat & Dahmash, 2012). Therefore, ROE assesses how effectively a company utilizes shareholder funds to generate profit.

ROA primarily gauges operational efficiency, while ROE assesses shareholder satisfaction. A company with a high ROA and a low ROE may efficiently use its assets but may not generate sufficient profit to satisfy shareholders. Conversely, a company with a high ROE and a low ROA may generate substantial profit but may not efficiently utilize its assets (Heikal, Khaddafi & Ummah, 2014).

ROA and ROE are essential metrics providing insights into a company's financial performance. Higher ratios indicate financial stability and attractive returns for shareholders. Consequently, such companies may gain investor interest and experience potential increases in stock value.

3.3. The Effects of Firm Size, Leverage and Prior Year Performance on Financial Performance

Financial performance serves as a vital gauge of a company's profitability and its capacity to generate value for stakeholders. Leverage (Akhtar et al., 2012), prior year performance (McGuire, Sundgren & Schneeweis, 1988) and firm size (Isik, Unal & Unal, 2017) are only a few of the variables that affect financial success. This section examines how these elements affect a company's financial performance.

In the realm of business and finance, firm size has long been a subject of interest and debate. Companies come in various sizes, ranging from small startups to multinational corporations. By analyzing the advantages and disadvantages of different firm sizes, we can gain valuable insights into the dynamics of the business landscape.

Firm size refers to the scale and magnitude of a company, often measured by its revenue, assets, or market capitalization. Financial performance, on the other hand, encompasses a range of metrics, including profitability, liquidity, efficiency, and solvency. These indicators provide a holistic view of a company's health and sustainability.

Large companies typically enjoy economies of scale, which result in lower average costs of production. By spreading fixed costs over a higher level of output, these firms can achieve cost efficiencies that lead to improved profitability (Doan, 2013). Large firms often have better access to capital markets due to their size and established reputation. This enables them to secure funding through equity or debt issuance at more favorable terms, promoting growth and investment opportunities (Ali & Camp, 1993). Large firms often have diversified business operations across multiple markets or industries. This diversification can act as a buffer against economic downturns in specific sectors, reducing overall risk and enhancing financial stability. Large companies generally have more significant

R&D budgets, allowing them to invest in innovation and technological advancements that foster long-term competitiveness and revenue growth (Santarelli & Sterlacchini, 1990).

Large firms can suffer from increased bureaucracy and slow decision-making processes, hindering their ability to adapt quickly to market changes and exploit emerging opportunities. As organizations grow in size, they may become less agile, making it challenging to respond promptly to changing consumer preferences or disruptive technological advancements (Banchuenvijit & Phuong, 2012). Large companies often face higher expectations from shareholders, which can lead to short-term focus and pressure for immediate returns, potentially compromising long-term strategies.

Small firms are often characterized by an entrepreneurial spirit, allowing for quicker decision-making and greater flexibility in adapting to market conditions. They can concentrate on specialized markets or niches, becoming experts in their domain and building a loyal customer base, which may lead to higher profit margins (Cooper, Willard, & Woo, 1986). They generally have lower fixed costs, making them more resilient during economic downturns or volatile periods, as they can quickly adjust expenses to match revenues. Furthermore, small firms are better positioned to innovate rapidly, experimenting with new products or services, and seizing emerging opportunities that larger organizations might overlook (Kijkasiwat & Phuensane, 2020).

Small firms may struggle to access sufficient capital, restricting their ability to invest in expansion, research, or marketing efforts. Also, they may face increased exposure to market fluctuations, which can lead to higher financial risks, especially when concentrated in specific industries or geographic regions. As a result, these firms may find it challenging to compete with larger, more established players in the industry, impacting their market share and revenue growth (Pervan & Višić, 2012).

In conclusion, the effects of firm size on financial performance are multifaceted and nuanced. Large firms benefit from economies of scale, diversified operations, and improved access to capital. However, they face challenges related to bureaucracy, decision-making, and stakeholder expectations. On the other hand, small firms have greater agility, focus, and cost efficiency, but they may struggle with limited resources and heightened market volatility.

Ultimately, the impact of firm size on financial performance depends on how companies leverage their advantages and mitigate their challenges. In today's ever-evolving business landscape, both large and small firms have unique roles to play, and their success lies in their ability to adapt, innovate, and strategically position themselves within their respective markets.

Leverage, in the context of finance, refers to the use of borrowed capital to finance an investment or business operation (Akhtar et al., 2012). It can amplify returns and magnify gains, but it also exposes

entities to higher risks. Financial leverage involves the use of debt, such as loans or bonds, to increase the potential returns for shareholders.

The use of leverage can significantly influence a company's profitability. When a firm uses debt to finance its operations or investments, it incurs interest expenses that reduce its net income. However, if the company generates a return on investment (ROI) greater than the cost of borrowing, leverage can amplify profits and boost shareholder returns (Ali, 2014). Conversely, if the ROI falls short of the cost of debt, losses can be magnified, resulting in decreased profitability.

ROE is a crucial financial metric that measures a company's ability to generate profits from shareholders' investments. Leverage directly impacts ROE since it involves the use of debt to fund operations. If a firm can use borrowed funds effectively to generate higher returns than the interest rate, it can enhance ROE. However, excessive leverage can lead to a higher debt burden, diminishing equity value and reducing ROE (Yoon & Jang, 2005).

One of the most significant effects of leverage is the increase in financial risk. As debt obligations come with fixed interest payments and principal repayments, firms must ensure a steady stream of cash flow to meet these commitments. Economic downturns or adverse market conditions can severely strain leveraged businesses, potentially leading to bankruptcy (Rajan & Zingales, 1995).

Determining the optimal level of leverage is a critical decision for businesses. Too little leverage might result in missed growth opportunities, while excessive leverage can expose the firm to undue risks. The appropriate level of leverage varies across industries and depends on factors like business cycles, interest rates, and the competitive landscape (Featherstone et al., 1988).

To navigate the effects of leverage on financial performance successfully, companies should adopt prudent financial management practices. This includes regularly evaluating debt levels, ensuring sufficient cash flow to service debt, and diversifying funding sources to reduce reliance on a single type of borrowing.

Leverage is a powerful financial tool that can enhance returns and propel growth, but it also carries inherent risks that can jeopardize a firm's stability and financial performance. By understanding the effects of leverage on profitability, risk, and overall business success, companies can make informed decisions about their capital structure and strive for sustainable growth while mitigating potential downsides (Enekwe, Agu, & Eziedo, 2014). Sound financial management practices and a balanced approach to leverage are key to navigating the complex relationship between leverage and financial performance effectively.

The performance of a company in any given year is not isolated but is often influenced by its prior year's performance. The concept of financial performance, which assesses a company's ability to generate profits and create value for its shareholders, is closely intertwined with its historical performance (Hammond & Slocum, 1996).

A company's prior year performance acts as a foundation for its future growth and success. Positive financial results from the previous year create a positive momentum, building investor confidence, and attracting potential stakeholders. This can lead to increased investments, easier access to capital, and lower borrowing costs, all of which contribute to improved financial performance (Ruf et al., 2001).

Moreover, a strong performance in the past year may indicate that the company has effective management strategies and operational efficiencies, which are likely to continue driving financial success in subsequent years (Payne, Benson, & Finegold, 2009). This positive momentum can also translate into enhanced employee morale and productivity, further strengthening the company's overall financial performance.

Investor sentiment is heavily influenced by a company's prior year performance. When a company demonstrates consistent growth and profitability over time, investors tend to view it as a stable and reliable investment option (Barberis, Shleifer, & Vishny, 1998). Positive market perception can lead to higher stock prices and increased demand for the company's shares, providing it with a valuable source of capital.

On the other hand, a company that experienced poor financial performance in the previous year might face skepticism from investors and analysts. Negative sentiment can lead to a decline in share prices and a reluctance from investors to inject new capital, thereby limiting the company's financial options and growth opportunities (Vuong, 2022).

The financial performance of a company in prior years plays a crucial role in determining its creditworthiness. Lenders and financial institutions use historical financial data to assess the company's ability to repay debts. A track record of consistent profitability and prudent financial management enhances a company's credit rating, making it easier to secure loans at favorable terms.

Conversely, a company with a history of poor financial performance might face challenges in obtaining credit, or it may be subjected to higher interest rates and more stringent borrowing conditions (Rashidi, Stadelmann, & Patt, 2019). This can impede the company's growth prospects and increase its financial vulnerability during economic downturns.

Prior year performance can reinforce positive or negative trends within a company. For instance, a company that experienced strong growth in the previous year may have the resources to invest in research and development, expand its market reach, or acquire other businesses. These initiatives can further drive financial performance in subsequent years, creating a cycle of growth (Lantz & Sahut, 2005).

The effects of prior year performance on financial performance are undeniable and multifaceted. A company's historical performance serves as a critical indicator of its potential for future growth and success. Positive financial results can attract investments, improve creditworthiness, and foster positive market sentiment, while poor performance can lead to the opposite outcomes.

Companies should recognize the importance of building a sustainable and positive track record of financial performance. By maintaining a focus on strategic planning, operational efficiency, and prudent financial management, businesses can better position themselves for long-term success and weather the challenges that may arise in dynamic economic environments.

Leverage, prior year performance, and firm size all have an impact on financial success. Larger companies, for instance, can have easier access to debt financing, increasing their leverage and possibly resulting in better financial performance. Similar to this, a company's success in the previous year might affect its ability to raise financing, which in turn affects its size and leverage in the current year.

Additionally, the impact of these determinants on financial performance may differ according on market circumstances, industry dynamics, and contextual factors. Large amounts of debt, for instance, might raise a company's financial risk and negatively affect its financial performance during a recession.

In line with the discussions above, we have included firm size, leverage and prior year performance as control variables in our analysis. The computations and abbreviations of these variables are discussed in the data description section.

4. EMPIRICAL ANALYSIS

4.1. Literature Review

The pioneering work of Porter & Linde (1995) examines the hesitancy among economists to acknowledge that well-designed environmental regulations could lead to improved industrial competitiveness. It questions why economists, who readily embrace technological advancements, seem reluctant to consider the potential positive outcomes of environmental regulations on business performance. The researchers highlight the limitations of static models that have led to dire predictions of economic and environmental catastrophes, which have often been disproven by the power of technological innovations. The prevailing mindset that environmentalism is inherently costly, result in a gridlock between regulators and industries, with both parties battling over every aspect of environmental policy. This contentious process leads to increased costs, resource drain, and minimal progress in finding real solutions to environmental challenges.

The study cites historical examples of static models failing to accurately predict economic and environmental outcomes. Economists, the paper suggests, readily recognize the transformative power of technological advancements in other contexts but appear hesitant when it comes to acknowledging the positive effects of environmental regulations on industrial competitiveness. To overcome the gridlock and promote both environmentalism and industrial competitiveness, the authors advocate for a new way of thinking about the relationship between the environment and business. They propose shifting the focus from a strict emphasis on pollution control to improving resource productivity. This approach seeks to relax the perceived tradeoff between environmental protection and industrial success, recognizing that both can be achieved simultaneously.

The paper suggests that lasting success lies in innovation-based solutions that support both environmental goals and industrial competitiveness. Embracing advancements in technology, clean production processes, and sustainable practices can lead to more efficient resource utilization, cost savings, and enhanced business performance. By promoting innovative approaches, policymakers can create an environment where environmental regulations are viewed as opportunities for businesses to thrive rather than as burdensome constraints.

Ultimately, the paper calls for a paradigm shift in the way environmental regulations are perceived and applied. Embracing technological advancements and innovative practices can lead to a win-win scenario, where environmental protection and industrial competitiveness go hand in hand, creating a more resilient and sustainable economy for the future.

A study conducted to assess the financial implications of green initiatives (Hart & Ahuja, 1996) reveals compelling evidence supporting the notion that it pays to be green. The research findings suggest that companies engaged in emission reduction efforts experience tangible benefits to their financial performance, though with varying timeframes for different metrics. This article delves into the key findings of the study and explores the possible explanations for the observed relationships.

The study argues that emission reduction efforts yield rapid and positive results in operating performance measures, such as return on sales (ROS) and ROA. Within a year of initiating pollution prevention initiatives, companies experience significant improvements in these metrics. The reduced costs and increased efficiencies associated with emission reduction activities directly impact the bottom line, providing an immediate boost to operating performance.

Interestingly, the study also reveals a delay between emissions reduction and its impact on return on equity. Unlike ROS and ROA, it takes about two years for companies to witness changes in return on equity. This delay can be attributed to two primary factors: the influence of capital structure and the effect on the cost of capital.

The study highlights that the greatest financial benefits from emission reduction efforts were observed in industries with high pollution levels. These industries have numerous low-cost opportunities for improvements, resulting in significant bottom-line gains. However, as companies approach the goal of zero pollution, further reductions become more expensive due to increased capital and technology investments. Nevertheless, the data indicate that the marginal benefits of reducing emissions generally outweigh the marginal costs, suggesting that emission reduction strategies positively impact financial performance.

The research findings strongly indicate that efforts to reduce emissions and adopt environmentally friendly practices are financially beneficial for businesses. Emission reduction initiatives lead to immediate improvements in operating performance metrics and, though delayed, positively affect ROE. The results also emphasize the cost-effectiveness of emission reduction efforts, particularly in heavily polluting industries. As businesses increasingly focus on sustainability and environmental responsibility, these findings serve as a valuable guide for decision-making and strategy development. By going green, companies not only enhance their financial performance but also position themselves for long-term competitive advantage in emerging green markets.

In their work, King & Lenox (2001) aim to understand whether strong environmental performance directly leads to improved financial performance or if the observed association is driven by other underlying firm attributes. Additionally, the study aims to explore whether the benefits lie in having clean facilities or being part of relatively clean industries. The researchers uses data from 652

American manufacturing companies from 1987 to 1996 to answer these concerns and attempt to clarify the intricacies of the link between corporate social performance and corporate financial performance.

According to the research, there is evidence that manufacturing enterprises are more financially valuable when pollution levels are lower. This shows a potential connection between environmental success and financial success since enterprises with greater environmental performance may also have higher financial position.

However, the researchers also discover that a firm's fixed qualities and strategic position may have an impact on the link between environmental performance and financial worth. It shows that variables other than environmental performance, such the firm's size, sector, and overarching strategy approach, may be having an impact on the observed link.

The study emphasizes how crucial it is to take into account the link between corporate social performance and corporate financial performance. Although the results show a correlation, it's still not obvious if good environmental performance directly affects financial performance or if businesses' financial success allows them to invest in environmentally friendly activities.

The study raises the question of whether the benefits of environmental performance lie in having clean facilities or being part of relatively clean industries. The researchers observe that firms operating in cleaner industries may have inherently better environmental performance due to the nature of their operations.

Orlitzky, Schmidt & Rynes (2003) examine a sizable sample size of 33,878 observations by conducting a meta-analysis of 52 researches that represent the population of earlier quantitative studies to clarify the relationship between CSR and financial success.

According to the findings, corporate virtue—more precisely, social and, to a lesser extent, environmental responsibility—is probably related to positive financial performance outcomes. Being socially and environmentally sensitive may improve financial performance, as shown by the fact that companies that place a high priority on these concerns frequently succeed financially.

The study finds a moderating influence on the association between good corporate social performance and successful business operations. This suggests that the measurements used to quantify both corporate social success and corporate financial performance may have an impact on how strongly they are related. Numerous factors and evaluation methods may have an impact on the relationship between social/environmental success and financial performance that has been documented.

The meta-analysis identifies variations in the strength of the link between corporate social performance and corporate financial performance depending on the type of performance measurements

used. Corporate social success has a stronger correlation with accounting-based measurements of financial performance, which include indicators like ROA or profit margins, than market-based metrics like stock market returns. This implies that the relationship between social/environmental achievement and financial performance may become more visible when using normal accounting indicators.

The overall finding of the study emphasizes the significance of corporate social and environmental responsibility as a potential element in increased financial performance. Businesses that prioritize sustainability and social responsibility may also be profitable, proving the need to implement ethical business principles into long-term corporate objectives. The conclusions have implications for company leaders, policymakers, and investors who seek to understand and profit from the link between corporate ethics and financial performance.

In their paper, Cerin (2006) examine how environmental concerns and harsher environmental regulations have frequently been perceived by firms as adding to their compliance costs rather than providing chances for innovation and sustainability. This study supports the assertion that win-win situations are feasible and suggests combining the ideas of property rights and transaction costs to discover private incentives for investigating such possibilities. The paper makes the case that significant public support is necessary to establish private incentives for pursuing economic and environmental win-win solutions by utilizing the Coase theorem, which stresses transaction costs and property rights.

The paper argues that public support is essential in encouraging private actors to explore win-win innovations that promote environmental sustainability. To achieve this, three specific areas of public support are proposed, extending producer responsibilities, enforcing environmental public procurement, and positioning information bridges.

Overall, the findings highlight the need for a collective effort to promote environmental sustainability. By embracing win-win innovations, businesses can drive economic growth while minimizing their environmental impact. Public support, combined with private initiatives, can lead to a more sustainable and resilient future for both the economy and the environment.

The important work of Ambec & Lanoie (2008) aims to explore the potential linkages between environmental performance and economic performance, challenging the notion that reducing pollution always leads to financial losses for businesses. Instead, the objective is to demonstrate that the expenses incurred to improve environmental practices can be offset by gains made elsewhere in the company's operations. Through a comprehensive examination of various possibilities, the study also identifies specific circumstances that are most likely to result in a "win-win" situation, where environmental improvements contribute positively to a company's financial bottom line.

The findings show that efficient resource management can lead to cost savings and reduce waste generation, directly benefiting a company's financial performance. For example, by optimizing energy consumption or water usage, companies can reduce operational expenses and enhance their economic efficiency.

Also investing in green technologies can yield long-term benefits by reducing energy consumption, emissions, and waste generation. Companies that embrace eco-friendly innovations can gain a competitive advantage and attract environmentally conscious consumers, positively impacting their economic performance.

They argue that improving environmental performance can enhance a company's reputation and brand value. Businesses perceived as environmentally responsible are more likely to attract environmentally conscious consumers and investors, resulting in increased sales and improved financial performance.

Another point is that complying with environmental regulations can mitigate the risk of fines and penalties, avoiding potential financial losses for non-compliant businesses. Companies that meet or exceed environmental standards may also receive preferential treatment in government contracts or tenders.

The findings underscore that resource efficiency, green technology adoption, reputation building, regulatory compliance, market expansion, risk mitigation, and competitive advantage in green markets can all contribute to improved economic performance for businesses. Rather than viewing environmental protection as a cost center, companies can recognize it as an opportunity to enhance their financial bottom line.

Gluch, Gustafsson & Thuvander (2009) employs the model of absorptive capacity to analyze the variables affecting environmental performance and green innovation in the construction sector. The objective is to identify the driving forces behind green innovation and its impacts on a construction company's environmental performance. The environmental attitudes, management methods, and performance of the Swedish construction sector are the main variables of this study. The findings of the linear regression analysis of the data demonstrate the ability of the absorptive capacity model to describe the mechanisms underpinning green innovation and performance. A brand-new absorptive capacity model, referred to as "green absorptive capacity," is offered in order to raise the construction industry's capacity to absorb green technology and improve company performance.

According to the study, the absorptive capacity model offers a lot of promise for describing how green innovation works and how it affects a company's environmental performance. Understanding how construction organizations may successfully absorb and utilize green technologies to promote

sustainable practices requires an understanding of absorptive capacity, which focuses on an organization's capability to acquire, integrate, and convert external information.

The findings suggest that three variables play a crucial role in influencing a company's capacity to absorb green innovations and enhance business performance. These variables are acquisition, assimilation, and transformation of external knowledge related to green practices. Companies that actively engage in acquiring, assimilating, and transforming green knowledge are better equipped to drive green innovation and achieve improved environmental performance.

In their study, Doran & Ryan (2012) focus on the forces behind eco-innovation and investigate whether businesses that practice it outperform those that don't. The research also delves into how government regulation influences and guides eco-innovation initiatives. The Irish Community Survey, which was performed between 2006 and 2008, includes a sample of 2,181 businesses for the empirical methodology employed in this study. By estimating a modified innovation production function, the authors assess the influence of regulations, consumer expectations, and voluntary agreements on eco-innovation performance. A knowledge-augmented production function was used to quantify the effect of eco-innovation on company performance.

The study finds regulation and consumer perception as important variables influencing a firm's decision to pursue eco-innovation. The corporate environment is significantly shaped by government rules and policies, with environmental standards and objectives incentivizing businesses to adopt eco-friendly activities. Additionally, consumer expectations and preferences for sustainable products drives companies to adopt eco-innovative approaches to meet market demands. These findings highlight the importance of external stimuli in motivating firms to embrace eco-innovation.

The study establishes that eco-innovation has a more substantial impact on firm performance compared to non-eco-innovation activities. Firms that prioritize eco-friendly innovation tend to outperform their counterparts that do not focus on environmental sustainability. This shows that eco-innovation is a vital factor in boosting company performance and competitiveness as well as helping to promote environmental responsibility.

This study clarifies the link between eco-innovation, governmental regulation, and corporate success in important ways. Eco-innovation is significantly fueled by regulation and customer perception, which encourages businesses to invest in environmentally friendly methods. The study also highlights the value of eco-innovation in attaining sustainable growth and competitiveness by confirming its beneficial influence on business performance.

Aguilera-Caracuel & Ortiz-de-Mandojana (2013) investigates the connection between eco-innovation and financial success in a sample of European businesses in their study. The investigation

concentrates on 88 businesses that adopted green innovation strategies and 70 businesses that did not. The study's time frame is between 2007 and 2010.

Financial success is evaluated using the ROA metric, with the degree of eco-innovation serving as the independent variable. Unexpectedly, the findings reveal that companies utilizing green innovation are not likely to do better than their non-green inventive rivals in terms of financial performance.

According to the analysis, green innovative enterprises face more environmental challenges than non-green innovative firms. As a result, it is shown that the severity of environmental laws has a detrimental impact on the link between green innovation and financial success. In particular, it is shown that in sectors with more stringent environmental laws, green innovation had a lesser impact on financial success.

This is explained by the fact that businesses in highly regulated sectors are under more pressure to implement environmentally friendly practices. The benefits of having a green and creative company become lower as a result. Possibilities for financial benefit are limited as adhering to strict environmental standards becomes a top priority.

Accordingly, the study of Aguilera-Caracuel & Ortiz-de-Mandojana (2013) elucidate the complex relationship between eco-innovation and financial success in European enterprises. As explained in the study, green innovation does not necessarily lead to an improvement in financial success. The interplay between eco-innovation and financial success is lower in industries subject to stricter environmental regulations, which emphasizes the fact that the severity of environmental constraints has a negative moderating influence on the interplay.

The research by Cheng, Yang & Sheu (2014) explores various types of innovations' relative impact on business performance and addresses the complex relationships between different eco-innovation types. The study offers helpful insights into the co-evolutionary dynamics of eco-innovation and its consequences for company success using structural equation modeling with data gathered from the Taiwan Environmental Management Association.

The study identifies that eco-organizational innovation has the most substantial effect on business performance. This implies that fostering an organizational culture that prioritizes environmental sustainability and integrates eco-friendly practices throughout the company can lead to enhanced business performance. By embracing eco-organizational innovation, companies can create a strategic advantage, positioning themselves as environmentally responsible and customer-oriented enterprises.

The study emphasizes how innovations in eco-process and eco-products mediate the link between eco-organizational innovation and financial success. This shows that eco-organizational activities might have an impact on the creation and use of novel eco-processes and eco-products within the company. As a result, innovations in eco-process and eco-products are essential for turning the work of eco-organizations into real advantages for the environment and the economy.

By examining the connections between three forms of eco-innovation; namely, process, product, and organizational, and their varying effects on company performance, this study considerably adds to the conversation around eco-innovation. The findings highlight the critical role of eco-organizational innovation in driving improved business performance, emphasizing the need for a strategic commitment to environmental sustainability at the organizational level.

By examining the effects of four forms of eco-innovation (product, process, market, and sources of supply) on accounting-based financial performance metrics in Polish and Hungarian publicly listed firms between 2006 and 2013, Przychodzen & Przychodzen (2015) aims to reveal the relationship between eco-innovation and financial performance. The paper clarifies the financial ramifications of environmental innovation in the context of Central and Eastern European transition countries by studying these linkages.

The study reveales that companies engaging in eco-innovative activities are generally associated with higher returns on assets and equity. This suggest that firms implementing environmental innovations are likely to enjoy improved financial performance, translating their environmental efforts into tangible financial benefits.

Interestingly, the research indicates that eco-innovative companies tend to have lower earnings retention. This implies that these firms allocate a higher proportion of their earnings towards investments or distributions to shareholders, possibly to support further eco-innovation initiatives or reward investors for their commitment to sustainable practices.

Companies that introduce eco-innovation are found to be significantly larger and faces lower financial risk exposure compared to conventional firms. The larger size might indicate that firms with greater resources and capabilities are better positioned to invest in eco-innovation activities. Additionally, the lower financial risk exposure could suggest that eco-innovation might act as a risk-mitigating factor, safeguarding firms from financial uncertainties associated with environmental regulations or resource scarcity.

With an emphasis on Poland and Hungary, this study makes a substantial contribution to our knowledge of the connection between eco-innovation and financial success in Central and Eastern

European transition countries. The results show that eco-innovative businesses typically have better financial results, as shown by higher asset and equity returns and reduced profits retention.

With a focus on how proactive environmental strategy influences firm performance as perceived from the perspective of eco-technical innovation, Ryszko (2016)'s study explores the relationship between technological eco-innovation, proactive environmental strategy, and firm performance. The research intends to shed light on how Polish businesses deal with these issues and how they support both economic growth and environmental sustainability. The research model employs structural equation modeling with partial least squares using a sample of 292 Polish-based companies.

No direct evidence has been found in the study to substantiate the claim that proactive environmental strategy has a large and immediate effect on business performance. Although the relationship between adopting environmentally friendly activities and achieving financial success had been extensively covered in the literature, this conclusion may initially seem unexpected. The results highlight the intricacy of this relationship and imply that there may be more variables that effect the relationship when it comes to the impact of proactive environmental strategy on company performance.

Despite the lack of a direct connection, the analysis reveals that technical eco-innovation plays a substantial mediating role in the association between proactive environmental strategy and company performance. This shows that putting proactive environmental initiatives into place might not result in an immediate improvement in financial performance, but rather does so indirectly through the development of technical eco-innovation.

The study's findings gave a thorough understanding of the relationships between Polish companies' proactive environmental strategy, technological eco-innovation, and financial performance. Even though there is no direct correlation between proactive environmental strategy and company success, the study emphasizes the critical role that technological eco-innovation plays as a mediator in this link.

Santos et al. (2017) examines the interplay between eco-innovation results and financial success of Brazilian companies during the 2010-2012 period. The study focuses on 132 sustainability reports from companies certified by the GRI in Brazil. By stratifying eco-innovation into environmental and social innovations, the researchers aim to reveal the impact of these innovations on financial success. A relevant sample of 48 companies is selected for the analysis, utilizing multivariate techniques such as factor analysis and multiple linear regression. The findings shed light on the most significant eco-innovative variables, their influence on financial performance, and the challenges companies face in integrating eco-innovation into their organizational strategy.

The study reveals that several eco-innovative variables are prevalent among the sample companies. Notably, the most representative eco-innovations are geared towards reducing greenhouse gas emissions, minimizing water consumption, and reusing solid waste. These eco-innovations reflect a strong commitment to mitigating the environmental impact of business operations, and they align with global efforts to combat climate change and promote sustainability.

Among the identified eco-innovative variables, the reduction of greenhouse gas emissions emerges as the most influential on financial performance, particularly on return on sales. The positive and significant impact of greenhouse gas emissions reduction on return on sales indicate that companies actively implementing initiatives to reduce carbon footprints experience improved profitability and operational efficiency. This finding underscores the potential for environmental responsibility to drive financial success and indicates that reducing greenhouse gas emissions can be a win-win strategy for both the environment and a company's bottom line.

Tang et al.'s (2018) study reveales important conclusions on how green innovation affects business success. According to the first set of assumptions, green product, and green process innovation both has a favorable and immediate impact on company performance. This emphasizes the strategic significance of integrating eco-friendly procedures and sustainable practices into a company, which can improve overall performance.

Furthermore, the research explores the role of managerial concern as a moderating factor. It suggests that managerial concern positively influences the relationship between green process innovation and firm performance. This finding underscores the significance of managerial commitment and strategic intent in fostering the successful implementation of green process innovations. When managers are actively concerned about the environmental impact of their operations, the positive effects of green process innovation are more pronounced.

The study also stands out by adopting a unique approach to categorizing firms based on their green product innovation. By segregating firms into high and low green product innovation groups, the researchers reveal intriguing differences in the impact of green product innovation on firm performance. While green product innovation significantly influences firm performance for firms below the mean, the same effect is not observed for firms above the mean. This suggests the presence of diminishing returns at higher levels of green product innovation. In other words, it is more challenging and costly to achieve substantial performance improvements beyond a certain threshold of green product innovation.

The major objective of a study by De Azevedo Rezende et al. (2019) is to investigate the connection between environmentally friendly innovation and financial performance of multinational corporations (MNC). The dataset for the study includes 356 firms, and the observation period spans

from 2006 to 2015. The researchers measure financial success using the ROA metric, and they measure the amount of environmentally friendly innovation using the green innovation intensity indicator. The study looks at how internationalization affectes the link between financial success and green innovation.

The results show that depending on the timeframe taken into account, there are different associations between green innovation and financial performance. In particular, the study shows that the long-term effect of green innovation on financial success is stronger than the short-term effect. This disparity can be ascribed to the significant upfront expenditures required by green innovation, where the advantages in terms of cost savings, greater revenues, and enhanced reputation take time to manifest.

It's interesting to notice that the degree of globalization has no effect on the link between financial performance and green innovation. According to the study, MNCs with large worldwide operations do not see a greater boost in financial performance from green innovation. This suggests that there is a complex relationship between eco-innovation and MNC financial success, one that depends on a number of variables, including the timescale under consideration and the amount of funding dedicated to R&D. The importance of green innovation as a long-term strategy for improving financial performance inside MNCs is highlighted in this study, nevertheless.

In order to investigate the interplay between eco-innovation and financial success, Przychodzen, Leyva-de la Hiz, & Przychodzen (2019) carries out a thorough study with an emphasis on the possible advantages of being an early adopter of green innovation. The 500 firms that are included in the Standard & Poor's index from 1999 to 2016 makes up the dataset used for the study. The researchers use panel data analysis to try to understand the connection between monetary success and green innovation. Indicators of financial performance taken into consideration in the study includes ROA, operating margin, and return on invested capital. The ratio of green patents issued to all patents issued is computed to assess the extent of green innovation.

The study's findings confirm the idea that businesses with first-mover advantages in green innovation frequently see an improvement in their financial performance. Particularly, businesses who embrace green innovation at an early stage outperform those that adopt it later or not at all in terms of financial success. However, it is important to note that, in contrast to other types of creative activism, an excessive concentration on green innovation has detrimental effects on both stock market performance and accounting outcomes.

The report also makes the case that businesses engaged in environmentally conscious sectors may benefit significantly from first-mover advantages in green innovation. The study also highlights the critical roles that technical advancement and market uncertainty play in mediating and regulating the link between first-mover advantages in green innovation and financial performance.

In summary, Przychodzen, Leyva-de la Hiz & Przychodzen (2019) provides some insight into the benefits of being an early adopter of green innovation on a firm's financial success. The study emphasizes how important market dynamics and technical innovation are in shaping this connection. However, putting too much focus on green innovation at the expense of other creative activism strategies can have negative impacts on stock market performance and accounting results.

Lin et al. (2019) examines the connection between green innovation strategy and corporate financial performance in a study with an emphasis on the potential influence of firm size. The study is specifically focused on the automotive sector. Between 2011 and 2017, data from 163 international automakers is obtained using the CSRHub database. The researchers employ the generalized method of moments (GMM), a dynamic panel data approach, to determine the pertinent connection. The success of the green innovation approach is measured using scores based on ISO 14031 criteria, and the financial performance is measured using the ROA ratio.

The study's conclusions show that adopting a green innovation approach has a beneficial effect on a company's financial performance. The financial performance of businesses who aggressively explore green innovation initiatives are superior. Notably, small and medium-sized organizations (SME) show a stronger correlation between green innovation strategy and financial success than large corporations. In other words, compared to their larger competitors, SMEs who adopt green innovation techniques see a more pronounced improvement in their financial performance. This implies that investing in green innovation may benefit smaller businesses more.

The research highlights how important it is to consider firm size when examining the relationship between green innovation and financial performance. It focuses on the potential financial benefits of implementing green innovation concepts for the automotive sector. The degree of this connection, however, is dependent on the size of the business, with SMEs standing to gain more from their investment in green innovation.

A study by Tariq, Badir & Chonglerttham (2019) investigates the relationship between green innovation and financial success in Thailand. The moderating effects of other factors on this association are also investigated in the research. Information is gathered from 202 Thai industrial enterprises that are publicly listed. Hierarchical regression analysis is carried out to evaluate the given research hypotheses empirically.

According to the study's findings, businesses that actively explore green innovation techniques tends to do better financially and environmentally. In addition, it is found that a variety of factors, including market resource intensity, market turbulence, and technical turbulence, affects how well a business performes in response to green innovation. The relationship between green innovation and

financial performance is particularly strong in volatile economies with high resource demand and unstable technology.

The study emphasizes how, in the Thai context, green innovation has the potential to enhance business performance. However, the strength of this association is influenced by a number of internal and environmental variables. When analyzing the relationship between green innovation and success, it is essential to comprehend the particular environment in which firms operate.

Overall, Tariq, Badir & Chonglerttham (2019) stresses the need of taking into account the particular situations and circumstances under which businesses operate. In order to successfully appreciate the link between green innovation and company performance, a thorough awareness of the context is essential.

Duque-Grisales et al. (2020) employs Multilatinas, which are Latin American multinational firms, to examine the link between green innovation and financial performance. The study also examines how this relationship is impacted by R&D investment and ISO 14001 certification. They utilize panel data analysis on a dataset of 86 publicly traded companies between 2013 and 2017. The study's hypotheses are tested using moderated and hierarchical linear regression.

The study's findings indicate that companies that actively pursue green innovation strategies often have better financial results as measured by ROA. Additionally, it is shown that companies with ISO 14001 accreditation experience a greater positive impact of green innovation on financial performance. This suggests that setting up a formal framework for environmental management might boost the financial benefits obtained via green innovation.

Furthermore, it is demonstrated that the relationship between green innovation and financial success varies depending on the level of R&D spending. However, the direction of this moderating influence is dictated by the amount of R&D spending. Particularly, the financial success of firms with low or moderate levels of R&D spending are more positively impacted by green innovation. For companies who spend a lot of money on R&D, the relationship deteriorates or even turns out to be detrimental.

According to the findings, Multilatinas' financial performance benefit from green innovation activities. They also emphasize how crucial it is to take ISO 14001 certification and the amount of R&D expenditure into account when analyzing the link between green innovation and financial success. For a thorough understanding of the complexity of this connection, it is essential to know the effects of environmental management systems and R&D expenditure.

The research by Xu et al. (2021) investigates how green innovation affects the financial performance of Chinese listed businesses as well as the moderating effect that business group membership has on this connection. The analysis is based on 202 industrial businesses that are listed in China between 2013 and 2017. The number of green patents serves as a proxy for green innovation, whilst ROA and ROE serve as indicators of financial performance.

The study addresses a link between green innovation and greater financial performance, indicating that companies that embrace green innovation often have stronger financial results. Additionally, the researchers argue that this link is stronger for companies that are a part of business groups. Financial performance is higher for companies that are members of a business association. These results suggest that membership in a business group may facilitate the incorporation of green innovation into corporate strategy and boost the accompanying financial benefits.

The study adds on the literature that corporate organizations play in advancing sustainability and highlights the significance of taking into account the institutional environment when analyzing the link between green innovation and financial success. The study shows potential ways through which business groups might support and promote sustainable practices inside their member businesses, thereby improving their financial performance, by illuminating the moderating influence of participation in business groups.

In a research published in 2021 by Hu et al., the authors investigate the connection between green government subsidies, green innovation, and the financial success of Chinese businesses. Data from 28 industries and 458 Chinese publicly traded businesses are included in the study, which spans the years 2006 to 2018.

According to the study's findings, green government subsidies and businesses' financial success are positively correlated. More specifically, businesses that receive government green subsidies do financially better than businesses that do not. Additionally, the link between government green subsidies and financial success is mediated through green innovation. The study argues that enterprises' involvement in green innovation serves as a partly mediating factor for the beneficial effect of government green subsidies on financial performance. This shows that companies receiving government green subsidies are more likely to make investments in green innovation, which ultimately improves their financial performance.

The study also emphasizes the moderating role that absorptive ability has in the connection between financial performance and green innovation. The results show that the benefits of green innovation for financial success are larger for companies with higher levels of absorptive capacity. This might be attributed to the fact that businesses with stronger absorption capacities have a better ability to

acquire and absorb information about green innovation. As a result, they are more equipped to benefit from green innovation, which boosts business performance.

The study highlights the importance of green government subsidies in boosting Chinese companies' financial performance, especially through the encouragement of green innovation. Additionally, it highlights how important absorptive ability is in determining how green innovation and financial performance are related. The study offers important insights into the methods by which governmental assistance and internal resources contribute to businesses' financial performance in the context of sustainable practices by highlighting these dynamics.

The interaction between green innovation, environmental regulation, and financial growth in Chinese provinces is the subject of a research by Hsu et al. (2021). The study includes information from 28 Chinese provinces from 2000 to 2018.

According to the report, green innovation and provincial financial development are positively correlated. Energy use and CO2 emissions are taken into account while measuring green innovation. On the other side, gross domestic product (GDP) is used to gauge financial progress. According to the research, provinces that actively promote green innovation outperform those that do not give priority to sustainable practices in terms of financial development.

The study focuses on how environmental regulation affects the link between economic expansion and green innovation. It is shown that environmental laws marginally increase the positive relationship between financial growth and green innovation. This implies that having stringent environmental rules in place may promote and stimulate the positive effects of green innovation on the growth of a province's economy.

Overall, the study's findings point to the possibility that financial development in Chinese regions might be fueled by green innovation. The report also emphasizes how crucial environmental legislation is to encourage sustainable behaviors, particularly in developing nations like China. The study advances the knowledge of the relationships among green innovation, environmental regulation, and financial growth by throwing light on these dynamics, emphasizing the significance of sustainability in propelling economic development at the provincial level in China.

In the settings of German civil law and United Kingdom (UK) common law, researchers Chouaibi, Chouaibi & Rossi (2022) evaluates the connections between green innovation, ESG practices, and business financial performance. The study utilizes panel data analysis for 115 UK and 90 German businesses that are selected from the ESG index for the years between 2005 and 2019.

To test its assumptions, the study uses panel data analysis and data from reliable databases including Thomson Reuters ASSET4 and Bloomberg. In order to evaluate financial performance, return on equity ratio is used. Two distinct measures are employed to quantify green innovation, which are green product innovation and green process innovation.

The study's findings indicate a positive relationship between ESG practices and corporate financial success. Stronger ESG standards are often linked to more efficient business operations. The study also discovers that green innovation acts as a kind of a bridge between financial performance and ESG standards. This implies that businesses with strict ESG rules are more likely to adopt green technology, which might improve financial outcomes.

It is shown that the mediating effect of green innovation in the UK common law environment is greater than in the Germany civil law scenario. Differences between the two countries' corporate governance and legal systems may be the root of this discrepancy.

The study's overall conclusion emphasizes the importance of ESG policies in raising business financial performance. It also addresses the mediating role of green innovation, showing that companies with good ESG policies are more likely to embrace and apply cutting-edge green techniques, which will enhance their financial performance.

The study stresses how important it is to take into account the legal environment in which businesses operate when analyzing the connection between ESG practices, green innovation, and financial performance. The study improves our comprehension of the connections between ESG practices, green innovation, and business financial success in the UK and Germany by putting light on these activities.

Aastvedt, Behmiri & Lu (2021) looks precisely at the oil and gas businesses to determine the link between green innovation and financial performance. The study makes use of two distinct panel datasets, one of which includes businesses operating in the United States (US) and the other of which includes businesses operating in the EU. There are 17 European and 27 US companies in the dataset, which covers the years 2010 to 2018.

According to the research, green innovation helps oil and gas corporations in the US and the EU to perform far better financially. The results, in particular, support the notion that expenditures in clean energy and environmentally friendly innovation increase the financial performance of oil and gas firms. By embracing green innovation, these businesses stand to gain advantages in a number of ways, including cost savings, higher profitability, and better brand recognition.

The study also addresses that the relationship between financial performance and green innovation is influenced by the level of diversity. It is shown that higher-level expenditures in green innovation have a better impact on the financial health of oil and gas corporations. This is explained by the possibility that financial gains from investments in green innovation would be larger, including cost savings, increased revenue, and improved reputation.

The study's conclusion emphasizes the unique potential for investments in renewable energy to boost oil and gas firms' financial performance. Research also highlights the role of diversity as a moderator and contended that companies investing more heavily in green innovation are more likely to achieve greater financial success. By shedding light on these challenges, the study advances our understanding of the relationship between green innovation and financial performance in the oil and gas industry.

Vasileiou et al. (2022) examines the relationship between green innovation and financial performance among Italian enterprises. The researchers gather data from the Community Innovation Survey (CIS) database, with a focus on the years between 2006 to 2008. The analytical sample consists of 14,430 firm year observations.

The study's findings indicate a connection between green innovation and Italian businesses' financial success. Particularly, businesses which make investments in green innovation perform better financially than those that don't. This suggests that implementing green innovation might improve the financial performance of Italian-based companies.

The study also show that a number of variables affect the link between financial success and green innovation. Notably, greater efforts on organizational, process, and product innovation results in an increase on financial performance. This study points out how environmentally friendly innovation may be a source of economic advantage, especially in markets where consumers place a high value on environmental issues.

The study contributes to the literature on the relationship between green innovation and financial success in the context of Italian enterprises by taking these elements into account. It shows the potential influence that green innovation may have on achieving financial success.

The primary objective of the study by Zheng, Usman Khurram & Chen (2022) is to examine the link between green innovation, ESG ratings, and the financial performance of Chinese listed enterprises. Green innovation is gauged by the quantity of green patent citations, while financial performance is assessed by the ROA ratio. The whole dataset is compiled from 3,100 panel data observations from the aforementioned organizations between 2014 and 2019.

The study finds that among the Chinese listed businesses, green innovation has a favorable impact on both ESG ratings and financial success. This suggests that businesses that use green innovation typically have better ESG scores and do better financially. The study also points out that the association between green innovation and financial performance is somewhat mediated by ESG ratings. This is an evidence that the ESG ratings were, at least in part, responsible for the favorable effect of green innovation on financial success.

Importantly, the authors note that organizations with better ESG ratings experience a greater beneficial impact from green innovation on financial success. According to this research, businesses that give ESG concerns a high priority could gain more from green innovation projects in terms of long-term sustainable growth.

In conclusion, financial performance, ESG ratings, and green innovation interact positively in the context of Chinese listed businesses. The results highlight how green innovation has the potential to improve both ESG ratings and financial performance, while also highlighting the mediating function of ESG ratings and the significance of a solid ESG foundation for optimizing the financial advantages of green innovation.

Asni & Agustia (2022) focuses on exploring the relationship between green innovation, financial performance, and commercial value in Association of Southeast Asian Nations (ASEAN) countries. The dataset of the study comprises of 374 publicly listed firms in six ASEAN nations and the panel data methodology is utilized. The evaluation criterion for determining financial performance is determined to be return on equity. The study's findings demonstrate a positive correlation between green innovation and business value as well as financial performance. According to the research, companies that embrace green innovation often enjoy greater financial success and higher stock prices.

The research also reveals that financial success has a moderating effect on the relationship between green innovation and corporate value. This shows that the enhancement of business value brought about by green innovation is, at least in part, a result of its favorable influence on financial performance. In other words, green innovation enhances business value indirectly by having a favorable impact on financial results.

The results of this study demonstrate the relevance of using green innovation as a tactical tool to improve business value and financial performance in ASEAN nations. The findings have significant implications for managers and policymakers, highlighting the need to encourage and support green innovation efforts as a way to achieve both long-term sustainable value creation and financial success.

In conclusion, this study contributes to a deeper knowledge of the connections between business value, financial success, and green innovation in the context of ASEAN nations. Highlighted are the

advantages of green innovation for financial performance and corporate value, as well as the function of financial performance as a mediator in this connection.

The study of Khan, Kaur, Johl & Akhtar (2022) investigates the connection between green innovation, sustainable development goal (SDG) practices, and commercial success. Financial performance is assessed by utilizing indicators like return on equity and ROA.

Data sample consists of 67 businesses from five continents; namely, Europe, Asia, North America, Africa, and Australia, between 2018 and 2019. The results indicate a beneficial effect of environmental SDG practices on businesses' financial success. The study's findings are conflictive when it comes to the role of green innovation on financial performance. As a result, the study of Khan, Kaur Johl & Akhtar (2022) clarifies how SDG behaviors, green innovation, and business success are related. The study shows how environmental SDG practices could have a favorable impact on financial success. Due to contradictory results, the part played by green innovation in this connection is unclear.

4.2. Hypothesis Construction

In recent years, businesses from a variety of industries have adopted green practices and placed an increasing focus on environmental sustainability. This trend towards green innovation is a reaction to growing stakeholder expectations, regulatory demands, and environmental concerns. Green innovation has several advantages, including a less impact on the environment and increased CSR, but its effects on financial performance are still being studied and debated. The hypothesis that will be developed in this part will investigate the connection between green innovation and financial performance.

Green innovation refers to the creation and implementation of environmentally friendly technologies, products, services, and processes that aim to minimize the ecological footprint of businesses. It encompasses a range of practices, including energy-efficient manufacturing, waste reduction and recycling, sustainable sourcing, and the development of renewable energy solutions. Green innovation involves a proactive approach by firms to align their operations with environmental sustainability goals, often resulting in enhanced operational efficiency, reduced costs, and improved environmental performance.

A crucial determinant of a company's success is its financial performance, which is often measured using several financial metrics including ROA and ROE. It reveals a company's capacity to generate profit, provide value for shareholders, and maintain steady growth. Positive financial performance helps businesses to make R&D investments, business expansions, capital raises, and market competitiveness.

The Resource-Based View (RBV) offers a theoretical framework for comprehending the connection between financial success and green innovation. RBV asserts that businesses may achieve a lasting competitive advantage by creating and utilizing distinctive and priceless resources (Wernerfelt, 1984). Adoption of environmentally friendly practices, technology, and processes can be viewed in the context of green innovation as strategic resources that support a firm's competitive advantage. With the use of these tools, businesses may be able to distinguish their goods and services, cut costs via increased operational effectiveness, expand into new markets, and boost their reputation and brand value.

According to the stakeholder theory (Donaldson & Preston, 1995), businesses must take into account the interests of numerous stakeholders, such as clients, workers, communities, and the environment, in order to succeed over the long run. From the viewpoint of stakeholders, implementing green innovation may benefit businesses. Customers who care about the environment and are prepared to pay more for sustainable goods or services may be drawn to green innovation. Additionally, it may assist businesses in avoiding reputational hazards, complying with ever-stricter environmental rules, and cultivating effective connections with stakeholders. These satisfying stakeholder outcomes are probably going to lead to better financial performance.

While numerous studies have explored the relationship between green innovation and financial performance, it is essential to consider the potential lag effect that may exist in this relationship. The lag effect refers to the time delay between the implementation of a particular action or strategy and the subsequent realization of its effects. In the context of green innovation and financial performance, the lag effect suggests that the benefits and impact of adopting green practices may not be immediately evident or reflected in a firm's financial performance. Instead, there might be a time gap before the positive outcomes of green innovation materialize and become apparent in financial indicators.

After extensive review of the related literature, the lag effect on a 3-year period is also taken into account in the empirical analysis for evaluating the link between green innovation and financial performance. Cainelli, De Marchi, & Grandinetti (2015) explained that green innovations take longer to yield positive results as they are more complex in nature compared to non-green innovations. Additionally, the learning curve process and the optimization of newly developed technologies are two other factors that support the idea of a lagged relationship between green innovation and financial performance (Aragón-Correa & Leyva-de la Hiz, 2016).

Studies of Przychodzen, Leyva-de la Hiz, & Przychodzen (2019) and Tang et al. (2022) both examined the lag effect of green innovation on financial performance on a 2-year period. Additionally, the work of De Azevedo Rezende et al. (2019) examined this effect on a 3-year period. All of these studies found a positive and statistically significant lag effect of green innovation on financial

performance. Additionally, Tang et al. (2022) observed the highest effect on the 2nd year, whereas De Azevedo Rezende et al. (2019) found out that the effect becomes expressively higher with the highest being on the 3rd year. The literature suggests that the effect of green innovation on financial performance has a lag effect, and this effect is observed to be highest on 2nd and 3rd years.

When firms embark on the path of green innovation, there is often a transition and adjustment period required to integrate new technologies, processes, and practices into existing operations. This period involves overcoming challenges, such as staff training, infrastructure upgrades, and supplier adjustments. As a result, it takes time for firms to fully realize the benefits of green innovation and for these benefits to translate into improved financial performance.

The successful implementation of green innovation often entails capturing new markets and attracting environmentally conscious customers. However, it takes time for these markets to develop and for customer awareness and acceptance of green products or services to increase. As firms gradually penetrate into these markets, their financial performance may experience a lag effect before the positive effects of increased market share and revenue become evident.

Green innovation often involves long-term investments in research and development, infrastructure upgrades, and sustainable supply chain initiatives. While these investments may incur initial costs, the benefits and financial returns may not be realized immediately. It takes time for these investments to mature and generate substantial returns, resulting in a lag effect on financial performance.

The recognition and positive perceptions of stakeholders, including customers, investors, and regulatory bodies, also play a role in the lag effect. Stakeholders may take time to acknowledge and reward firms for their green innovation efforts. Once the positive environmental impact and sustainability practices are recognized, stakeholders may respond by demonstrating increased loyalty, investment, or regulatory support. This, in turn, contributes to improved financial performance over time.

Based on the conceptual background and the theoretical frameworks presented, the following hypotheses are constructed:

Model 1: There is a positive and statistically significant relationship between green innovation intensity score of the latest fiscal year and return on assets.

Model 2: There is a positive and statistically significant relationship between green innovation intensity score of the previous fiscal year and return on assets.

Model 3: There is a positive and statistically significant relationship between green innovation intensity score of the two years before the last fiscal year and return on assets.

Model 4: There is a positive and statistically significant relationship between green innovation intensity score of the three years before the last fiscal year and return on assets.

Model 5: There is a positive and statistically significant relationship between green innovation intensity score of the latest fiscal year and return on equity.

Model 6: There is a positive and statistically significant relationship between green innovation intensity score of the previous fiscal year and return on equity.

Model 7: There is a positive and statistically significant relationship between green innovation intensity score of the two years before the last fiscal year and return on equity.

Model 8: There is a positive and statistically significant relationship between green innovation intensity score of the three years before the last fiscal year and return on equity.

Green innovation is expected to have a positive impact on financial performance for several reasons. Firstly, the adoption of green practices can result in cost savings through improved operational efficiency, reduced waste, and resource optimization. By optimizing energy consumption, waste management, and supply chain processes, firms can reduce their operating expenses, enhance profitability, and improve financial performance.

Secondly, green innovation can open up new business opportunities and markets. As consumer preferences shift towards environmentally friendly products and services, firms that embrace green innovation are likely to gain a competitive advantage by catering to this growing demand. This can lead to increased market share, higher sales revenue, and improved financial performance.

Thirdly, green innovation can enhance a firm's reputation and brand value. By demonstrating a commitment to environmental sustainability, firms can improve their image among stakeholders, including customers, investors, and employees. This positive perception can translate into increased customer loyalty, greater investor confidence, and improved employee morale, all of which contribute to better financial performance.

Finally, green innovation can help firms navigate regulatory requirements and mitigate environmental risks. By proactively adopting sustainable practices, firms can reduce the likelihood of legal and reputational risks associated with environmental non-compliance. Compliance with environmental regulations not only avoids penalties but also fosters a positive image among regulators and the public, which can positively impact financial performance.

In conclusion, the hypothesis development section has proposed 8 models that explore the relationship between green innovation and financial performance in the context of lag effect. The literature review and theoretical frameworks discussed suggest that green innovation can lead to

improved financial performance through cost savings, market opportunities, enhanced reputation, and risk mitigation. Further research is necessary to empirically test this hypothesis using appropriate research methods, data collection, and statistical analysis techniques. Understanding the relationship between green innovation and financial performance is of significant interest to practitioners, policymakers, and academics, as it can inform strategic decision-making and contribute to sustainable economic development.

4.3. Data Description

We used data from two key sources: the PATSTAT database and the Eikon database to test the hypothesis that there is a positive and statistically significant association between green innovation and financial performance. The Eikon database gave us information on business size, debt, and past year performance along with financial performance indicators like ROA and ROE. Furthermore, the PATSTAT database provided us with patent information, which acts as a stand-in for green innovation.

The Eikon database is a comprehensive financial database that includes information on various financial indicators for publicly traded companies worldwide. It provides reliable and widely used metrics for evaluating financial performance, making it suitable for our research. The PATSTAT database, on the other hand, is a renowned source for patent information, covering patents from multiple countries and regions. We were able to gather information on the firms with respect to the study's main variables of interest; namely, financial performance and green innovation, by using these two databases.

ROA and ROE are the study's dependent variables. The financial indicator: namely ROA, gauges a company's profitability by evaluating its capacity to produce profits from its assets. In contrast, ROE measures a company's profitability by contrasting its net income with the equity contributed by shareholders. In the literature, these two metrics are frequently employed as measures of financial performance (Aguilera-Caracuel & Ortiz-de-Mandojana, 2013; De Azevedo Rezende et al., 2019; Duque-Grisales et al., 2020; Khan, Johl, & Akhtar, 2022; Asni & Agustia, 2022; Chouaibi, Chouaibi, & Rossi, 2022).

Green innovation is the explanatory variable in our analysis, and it is represented by patent data gathered from the PATSTAT database. Patents are a useful sign of a company's dedication to and investment in environmentally friendly technology. We can assess a company's level of green innovation by looking at the quantity and kind of patents connected to eco-friendly technology.

In order to compute green innovation intensity, IPC Green Inventory codes are used. Patents that had any codes that are included in IPC Green Inventory are considered as green patents. Thus, the green patents issued, and the total patents issued by the European companies in the scope and the time

period of our research are collected. Green patents are divided to the total patents issued in order to calculate the green innovation intensity of the companies.

Control variables are also included to account for other factors that may influence financial performance. These variables include firm size, leverage, and prior year performance. Firm size is typically measured by the natural logarithm of total assets (Ali & Camp, 1993) and is included to capture the effect of company size on financial performance (Doan, 2013). Leverage, measured by the ratio of total liabilities to total assets (Akhtar et al., 2012), reflects the degree of financial risk and is expected to impact financial performance (Yoon & Jang, 2005). Prior year performance, represented by the lagged values of ROA and ROE (Hammond & Slocum, 1996), helps control for the effect of prior year financial performance on current year financial performance (Payne, Benson, & Finegold, 2009).

Below in Table ,1 there are the detailed definitions regarding the calculation of the variables and associated abbreviations used in the analysis:

Table 1: The abbreviations and the definitions of the variables used in the study

Variable	Abbreviation	Definition
Dependent Variables		
Return on Assets	ROA_{it}	Net Income / Total Assets for firm i at year t
Return on Equity	ROE_{it}	Net Income / Total Equity for firm i at year t
Explanatory Variables		
Green Innovation Intensity for Fiscal Year-0	$GIIFY0_{it}$	Green Patents Issued / Total Patents Issued for firm i at year t
Green Innovation Intensity for Fiscal Year-1	$GIIFY1_{i(t-1)}$	Green Patents Issued / Total Patents Issued for firm i at year t-1
Green Innovation Intensity for Fiscal Year-2	$GIIFY2_{i(t-2)}$	Green Patents Issued / Total Patents Issued for firm i at year t-2
Green Innovation Intensity for Fiscal Year-3	$GIIFY3_{i(t-3)}$	Green Patents Issued / Total Patents Issued for firm i at year t-3
Control Variables		
Firm Size	$SIZE_{it}$	Natural logarithm of Total Assets for firm i at year t
Leverage	$LEVERAGE_{it}$	Total Liabilities / Total Assets for firm i at year t
Prior Year Return on Assets	$PRIORROA_{i(t-1)}$	Net Income / Total Assets for firm i at year t-1
Prior Year Return on Equity	$PRIORROE_{i(t-1)}$	Net Income / Total Equity for firm i at year t-1

The models that are generated in the hypothesis development section and used in the analysis are defined in formulas below using the variables and their abbreviations.

Model 1: $ROA_{it}=\beta_0+\beta_1 GIIFY0_{it}+\beta_2 SIZE_{it}+\beta_3 LEVERAGE_{it}+\beta_4 PRIORROA_{i(t-1)}+u_{it}$

Model 2: $ROA_{it}=\beta_0+\beta_1 GIIFY1_{i(t-1)}+\beta_2 SIZE_{it}+\beta_3 LEVERAGE_{it}+\beta_4 PRIORROA_{i(t-1)}+u_{it}$

Model 3: $ROA_{it}=\beta_0+\beta_1 GIIFY2_{i(t-2)}+\beta_2 SIZE_{it}+\beta_3 LEVERAGE_{it}+\beta_4 PRIORROA_{i(t-1)}+u_{it}$

Model 4: $ROA_{it}=\beta_0+\beta_1 GIIFY3_{i(t-3)}+\beta_2 SIZE_{it}+\beta_3 LEVERAGE_{it}+\beta_4 PRIORROA_{i(t-1)}+u_{it}$

Model 5: $ROE_{it}=\beta_0+\beta_1 GIIFY0_{it}+\beta_2 SIZE_{it}+\beta_3 LEVERAGE_{it}+\beta_4 PRIORROE_{i(t-1)}+u_{it}$

Model 6: $ROE_{it}=\beta_0+\beta_1 GIIFY1_{i(t-1)}+\beta_2 SIZE_{it}+\beta_3 LEVERAGE_{it}+\beta_4 PRIORROE_{i(t-1)}+u_{it}$

Model 7: $ROE_{it}=\beta_0+\beta_1 GIIFY2_{i(t-2)}+\beta_2 SIZE_{it}+\beta_3 LEVERAGE_{it}+\beta_4 PRIORROE_{i(t-1)}+u_{it}$

Model 8: $ROE_{it}=\beta_0+\beta_1 GIIFY3_{i(t-3)}+\beta_2 SIZE_{it}+\beta_3 LEVERAGE_{it}+\beta_4 PRIORROE_{i(t-1)}+u_{it}$

The data was examined thoroughly, to decide on the sample that is going to be used. In order to get reliable and statistically significant analysis results, the dataset that is going to be used is prioritized to be strongly balanced (meaning no missing data in the dataset) and also a high number of firm-year observations is aimed to be attained. According to the aims and prioritizations, the data is narrowed down to 105 companies and time period was determined to be 2016 and 2022.

4.4. Methodology

STATA statistical analysis software is used to conduct the analysis and test the hypotheses. For the dataset of 105 European enterprises for the years 2016–2022, panel data analysis is used.

Through the use of Variance Inflation Factor (VIF) testing, the problem of multicollinearity is addressed in the early phases of the study. Multicollinearity, which can result in skewed models, happens when there is a significant correlation between explanatory and control variables. The VIF test aids in determining how serious multicollinearity is. When the VIF values in this instance are checked, it is found that they are lower than 5 (VIF<5), suggesting that the model does not contain multicollinearity. This is a significant finding since multicollinearity can make it difficult to determine the underlying relationships between variables, which might compromise the validity of the findings (López, 2021).

Moving on to the next step, the presence of unit and time effects in the model is investigated through the Likelihood-ratio test. The Likelihood-ratio test is a statistical test used to assess whether the inclusion of unit and time effects significantly improves the model's fit. The results of this test indicate the presence of both unit and time effects, suggesting that these factors play a significant role in shaping the dependent variable (Tatoğlu, 2020).

The Hausman test is performed to further improve the model and choose the best estimator to be utilized. To determine whether the model should be stated as a fixed effects model or a random effects

model, the Hausman test is employed. The model is stated as a two-way fixed effects model with unit and time effects, according to the findings of the Hausman test. This suggests that the model takes into consideration both the time-specific features and the unique properties of the units in the panel data (Tatoğlu, 2020).

Subsequently, several tests are conducted to assess whether the model deviates from the fundamental assumptions of the panel data model. One such test is the Jarque-Bera normality test, which examines whether the distribution of the dataset follows a normal distribution. The results of this test indicate that the dataset is normally distributed. This is an important assumption for many statistical models as it allows for the application of various estimation techniques and hypothesis testing procedures (Longhi & Nandi, 2014).

Heteroskedasticity, the presence of varying levels of dispersion in the error term across observations, is examined using the Wald test. The Wald test provides insights into whether heteroskedasticity is present in the model (López, 2021). The findings of this test support the presence of heteroskedasticity in the model, indicating that the variability of the error term is not constant across observations. This can have implications for the efficiency and reliability of the estimated coefficients.

To investigate the issue of cross-sectional independence, three alternative tests are conducted: the Pesaran test, the Friedman test, and the Frees test. These tests are specifically designed to assess whether there is cross-sectional independence in the panel data model. The results of these tests reveal that the model does not satisfy the assumption of cross-sectional independence, indicating that the observations are not independent from one another. This finding is crucial as it highlights potential issues related to the violation of this assumption (Tatoğlu, 2020).

Finally, tests for autocorrelation are carried out using the Durbin-Watson test and Baltagi's LBI test. Autocorrelation refers to the correlation between error terms of observations at different time periods. The results of these tests indicate the presence of autocorrelation in the model, suggesting that the errors in the model are not independent across time periods. Autocorrelation can introduce bias in the estimated coefficients and lead to inefficiency in the model's predictions (Longhi & Nandi, 2014).

The panel data model is re-estimated using Driscoll-Kraay standard errors to account for these departures from the assumptions. This reliable estimation method accounts for cross-sectional dependency, autocorrelation, and heteroskedasticity (Tatoğlu, 2020). The model makes an effort to mitigate the effect of these variations and offer more trustworthy and accurate estimations by using Driscoll-Kraay standard errors.

The approach used in this study takes into consideration the unique properties of the panel data, such as balanced data, time and unit fixed effects, heteroskedasticity, autocorrelation, and cross-

sectional independence. To generate accurate and effective parameter estimates, the fixed effects estimation approach, robust standard errors, and suitable techniques to address autocorrelation and cross-sectional independence are used.

4.5. Analysis and Results

4.5.1. Descriptive Statistics

As shown in Table 2, the study's sample consists of a total of 105 companies, distributed across multiple countries. The countries included in the sample are Germany, France, Finland, Sweden, United Kingdom, Denmark, Switzerland, Belgium and Austria.

Germany has the largest representation in the analysis sample, accounting for 18,10% of the companies, with a total of 19 firms. Following closely is France, comprising 13,33% of the sample, with 14 companies. Finland follows with a representation of 11,43%, represented by 12 companies. Sweden and United Kingdom both have equal representation in the sample, each accounting for 10,48% and consisting of 11 companies.

Denmark and Switzerland have the same representation, each accounting for 9,52%, with 10 companies from each country. Lastly, two countries—Belgium, and Austria—have the lowest representation in the sample, with each accounting for 8,57% and having 9 companies from each country.

Overall, these descriptive statistics provide a breakdown of the analysis sample by country, indicating the percentage representation and the number of companies from each country.

Table 2: The country breakdown of the analysis sample by percentage and numbers

Country	Percentage	Number of Companies
Germany	18,10%	19
France	13,33%	14
Finland	11,43%	12
Sweden	10,48%	11
United Kingdom	10,48%	11
Denmark	9,52%	10
Switzerland	9,52%	10
Belgium	8,57%	9
Austria	8,57%	9
Total	**100%**	**105**

The descriptive statistics of Table 3 provide an overview of the analysis sample for various variables. Here are the key findings:

The mean value of ROA_{it} (Return on Assets) is 0,0632, with maximum and minimum values of 0,6700 and -0,4474, respectively. A modest amount of variability is shown by the standard deviation of 0,0750, which is low. The mean value of ROE_{it} (Return on Equity) is 0,1438, with maximum and minimum values of 3,2327 and -1,3146, respectively. A considerable amount of variability is also shown by the standard deviation of 0,2185.

With a maximum value of 1 and a lowest value of 0, $GIIFY0_{it}$ (Green Innovation Intensity for Fiscal Year-0) has a mean of 0,0962. 0,1622 is the standard deviation for $GIIFY0_{it}$. With a mean of 0,0940, a maximum value of 1, and a minimum value of 0, $GIIFY1_{i(t-1)}$ (Green Innovation Intensity for Fiscal Year-1) has a standard deviation of 0,1696. As for $GIIFY2_{i(t-2)}$ (Green Innovation Intensity for Fiscal Year-2) the mean value is 0,0939 with a range from 0 to 1, while the standard deviation being 0,1786. Lastly with a mean of 0,1027, a maximum value of 1, and a minimum value of 0, $GIIFY3_{i(t-3)}$ (Green Innovation Intensity for Fiscal Year-3) has a standard deviation of 0,1970.

Table 3: The descriptive statistics of the analysis sample

	Mean	**Maximum**	**Minimum**	**Standard Deviation**
ROA_{it}	0,0632	0,6700	-0,4474	0,0750
ROE_{it}	0,1438	3,2327	-1,3146	0,2185
$GIIFY0_{it}$	0,0962	1	0	0,1622
$GIIFY1_{i(t-1)}$	0,0940	1	0	0,1696
$GIIFY2_{i(t-2)}$	0,0939	1	0	0,1786
$GIIFY3_{i(t-3)}$	0,1027	1	0	0,1970
$SIZE_{it}$	9,9461	11,7519	7,7081	0,7890
$LEVERAGE_{it}$	0,6081	1,2914	0,0372	0,1725
$PRIORROA_{i(t-1)}$	0,0612	0,6700	-0,5248	0,0769
$PRIORROE_{i(t-1)}$	0,1438	3,2327	-1,3146	0,2111

The average value for $SIZE_{it}$ (Firm Size) is 9,9461, with maximum and minimum values of 11,7519 and 7,7081 respectively. 0,7890 is the standard deviation for $SIZE_{it}$. (The $SIZE_{it}$ variable has been calculated as the logarithm of total assets. So, in order to understand the dataset better, we also wanted to share with the reader the mean, the maximum, the minimum and the standard deviation of total assets as well. The following values are all in EUR currency. The mean is 34.249.980.672, the maximum is 564.772.000.000, the minimum is 51.057.000, the standard deviation is 71.452.754.487) With a mean of 0,6081, a maximum value of 1,2914, and a minimum value of 0,0372. $LEVERAGE_{it}$ (Leverage) has a standard deviation of 0,1725. Prior return on assets, abbreviated as $PRIORROA_{i(t-1)}$,

has a mean value of 0,0612, a maximum value of 0,6700, and a lowest value of -0,5248. There is 0,0769 standard deviation. Prior return on equity ($PRIORROE_{i(t-1)}$) has a mean value of 0,1438 with a range from -1,3146 to 3,2327. The value is 0,2111 for the standard deviation.

These descriptive statistics provide a summary of the central tendency, variability, and range of the variables in the analysis sample, offering insights into their distributions and characteristics.

4.5.2. Panel Data Analysis Results

In this section, the results of the panel data analysis are presented. Driscoll-Kraay standard errors are used in the analysis to take into account any potential variance from assumptions. The panel data result tables for all models performed include the number of observations, the number of groups, the F-statistic, and the related probability (p-value) for the overall model's significance together with the coefficients, standard errors, and t-statistics for each independent variable.

The findings of Model 1, which intends to investigate the link between green innovations issued in the current year and the dependent variable ROA, including our control variables, are provided in Table 4.

Return on assets, which is the dependent variable in this model, is a monetary indicator that assesses an organization's profitability in relation to its total assets. GIIFY0 is used to represent the explanatory variable. This variable's coefficient is 0,0922, and it isn't statistically significant, according to the t-statistic of 1,38. This finding is contradictory to our hypothesis. We hypothesized that there would be a positive relationship between ROA and the green innovation intensity score of the latest fiscal year. Regardless of being contradictory to our hypothesis, this finding is supportive to the study by De Azevedo Rezende et al. (2019). In their study De Azevedo Rezende et al. (2019) also explored the effects of green innovation on financial performance, taking in to account the influence of lag effects. They found out that there was no statistically significant relationship between green innovation and financial performance in the immediate year, which is the same as the results of our Model 1.

SIZE, which is a control variable, has a coefficient of -0,0009. The t-statistic is -0,25, indicating that there is no statistically significant correlation between SIZE and ROA. LEVERAGE, another control variable, has a coefficient of -0,0343. At 10% level of significance, the coefficient is statistically significant ($p < 0,10$). The t-statistic is -2,21, which also shows that LEVERAGE and ROA have a significant and negative association meaning that higher leverage reduces the selected indicator of financial performance. This finding is in line with the works of Bagirov & Bagirov (2019), in which they explored the relationship between oil prices and financial performance of EU firms. They used leverage as a control variable in their analysis and found out that there was a negative relationship between the two.

PRIORROA, our last control variable in Model 1, has a coefficient of 0,5483 at the 1% significance level, showing the presence of a positive association between PRIORROA and ROA. This implies that businesses with greater historical ROA typically have higher present ROA. Similar results were observed by Gürbüz, Aybars, & Yeşilyurt (2016). In their study, they investigated the role of agency costs in explaining financial performance, where they also used prior year performance as a control variable. Their emprical results suggested that, higher prior year financial performance was a significant indicator for better financial performance in the current year.

The F-statistic of 105,13 with a probability (p-value) of 0,0000 indicates that the panel data model as a whole is statistically significant. According to the findings of the panel data analysis, ROA can be predicted statistically significantly by LEVERAGE and PRIORROA. Particularly, LEVERAGE has a negative association with ROA, on the other hand PRIORROA has a positive link with ROA. Furthermore, the variables GIIFY0 and SIZE are found not to have a statistically significant connection with ROA.

Table 4: The panel data analysis results of Model 1

Regression with Driscoll-Kraay standard errors			
Dependent Variable: ROA			
Variable	**Coefficient**	**Standard Error**	**T Statistics**
GIIFY0	0,0922	0,0666	1,38
SIZE	-0,0009	0,0038	-0,25
LEVERAGE	-0,0343*	0,0155	-2,21
PRIORROA	0,5483***	0,1193	4,59
Constant	0,0512	0,0455	1,13
Number of observations	735		
Number of groups	105		
F	105,13		
Prob > F	0,0000		
Legend	**p<0,1; **p<0,05; ***p<0,01*		

The association between green innovations issued in the previous year and the dependent variable ROA including our control variables for Model 2 are revealed in Table 5.

The coefficient for the explanatory variable GIIFY1 is 0,0423, demonstrating a positive and significant correlation with ROA at 5% level of significance ($p < 0,05$). This supports our hypothesis that there is a significant relationship between green innovation intensity score of the previous fiscal year and return on assets. Furthermore, Przychodzen, Leyva-de la Hiz, & Przychodzen (2019) investigated the first-mover advantages in green innovation and the relationship between financial

performance. Similarly, they found that the one-year lag effect of green innovation is statistically significant and positive, which is supportive to our findings.

The control variable SIZE doesn't have a correlation with ROA, as shown by its t-statistic which is -0,25. At standard levels, this link is not statistically significant. Therefore, there is no support for a statistically significant relationship between firm size and ROA in Model 2.

A statistically significant and negative association between control variable LEVERAGE and ROA is seen as part of the findings. The coefficient of -0,0405 indicates that lower ROA is related to greater debt levels at a 5% level of significance ($p < 0,05$). Thus, the results imply that higher debt level can negatively impact a company's profitability. In a study conducted by Hu et al. (2021), where they explored the relationship of green innovation and financial performance while taking in to account the moderating effects of green subsidies, they found similar evidence. Using leverage as a control variable, they revealed a negative and significant assosiation between leverage and financial performance.

As evidenced by a statistically significant coefficient of 0,5875, the control variable PRIORROA, on the other hand, has a positive association with ROA as indicated by a t-statistic of 6,87. This suggests that businesses are likely to have greater present ROA when they demonstrate a higher historical ROA. According to the panel data analysis results, a rise in former ROA is connected to a greater present year ROA. This result is in line with the work of Ojimadu (2022). While investigating the impact of chief data officers on firm performance, Ojimadu (2022) also took into account the effect of prior year performance as a control variable. The results indicated that there was a positive and significant connection between prior year performance and current year performance.

The total panel data model is statistically significant at a high degree of confidence ($p < 0,0000$), according to the F-statistic of 103,05. In conclusion, the results of Model 2 show that GIIFY1 and ROA have a statistically significant positive connection, indicating that rising levels of GIIFY1 are correlated with rising levels of ROA. However, there is no discernible correlation between SIZE and ROA. The strong negative correlation between leverage and profitability suggests that greater leverage is bad for a company's bottom line. A greater past year ROA is linked to a higher present year ROA, as shown by the statistically significant positive association between PRIORROA and current ROA.

Table 5: The panel data analysis results of Model 2

Regression with Driscoll-Kraay standard errors			
Dependent Variable: ROA			
Variable	**Coefficient**	**Standard Error**	**T Statistics**
GIIFY1	0,0423**	0,0161	2,62
SIZE	-0,0009	0,0039	-0,25
LEVERAGE	-0,0405**	0,0144	-2,81
PRIORROA	0,5875***	0,0855	6,87
Constant	0,0577	0,0351	1,64
Number of observations	735		
Number of groups	105		
F	103,05		
Prob > F	0,0000		
Legend	**p<0,1; **p<0,05; ***p<0,01*		

The outcomes of the panel data analysis for Model 3 are shown in Table 6. This model examines the association between the dependent variable ROA and green innovations issued two years ago, including our control variables.

The explanatory variable GIIFY2 has a coefficient of 0,0528, and a t-statistic of 2,67. At 5% level of significance, the coefficient is statistically significant ($p < 0,05$). This implies that ROA is significantly impacted by GIIFY2. Thus, the hypothesis of Model 3 is accepted. The evidence is supportive of the study by Tang et al. (2022), where they examined the effect of green technology innovation on financial performance. The results of their study showed that the green technology innovation had a positive impact on financial performance. Also they found out that this effect was the strongest two years after green innovation issuance. Furthermore, the control variable SIZE has a coefficient of -0,0008 with a t-statistic of -0,22 meaning that this variable is not a significant determinant of financial performance. As a result, in this model, ROA does not seem to be impacted by SIZE.

The t-statistic for the control variable LEVERAGE is -3,12, and the coefficient is -0,0378. The coefficient suggests that LEVERAGE has a detrimental effect on ROA ($p < 0,05$) and is statistically significant. This shows that higher leverage levels reduce ROA. A supportive study by Zheng, Khurram, & Chen (2022) can be mentioned. In their study, they investigated the impact of green innovation on ESG scores and financial performance. While doing so they included leverage as a control varible in their study and found out a negative relationship between leverage and financial performance, similar to the findings of Model 3.

The t-statistic is 6,07 and the coefficient is 0,5949 for the control variable PRIORROA. Thus, PRIORROA is found to be positively and significantly influencing ROA at 1% level of significance ($p < 0,01$). This implies a relationship between greater current ROA levels and higher historical ROA values. Similar results were observed in the study of Bharadwaj (2000). While looking in to the relationship between information technology capability and financial performance, Bharadwaj (2000) used prior year performance as a control variable in the analysis. The results of the analysis were supportive to our findings where higher prior year performance was associated with higher current year financial performance.

The model is statistically significant, as evidenced by the F-value of 223,65 and the probability of 0,0000. This shows that the independent factors' combined influence on ROA is significant. In conclusion, the findings of the panel data analysis show that GIIFY2, PRIORROA and LEVERAGE have statistically significant influence on ROA. Higher historical ROA and higher GIIFY2 values are related to higher present ROA values, but higher leverage levels are associated with lower ROA. Furthermore, in this model, the control variable SIZE is found to be statistically insignificant.

Table 6: The panel data analysis results of Model 3

Regression with Driscoll-Kraay standard errors			
Dependent Variable: ROA			
Variable	**Coefficient**	**Standard Error**	**T Statistics**
GIIFY2	0,0528**	0,0197	2,67
SIZE	-0,0008	0,0038	-0,22
LEVERAGE	-0,0378**	0,0121	-3,12
PRIORROA	0,5949***	0,0980	6,07
Constant	0,0531	0,0345	1,54
Number of observations	735		
Number of groups	105		
F	223,65		
Prob > F	0,0000		
Legend	**p<0,1; **p<0,05; ***p<0,01*		

The panel data analysis results of Model 4 are demonstrated in Table 7. The association between green innovations issued three years ago and the dependent variable ROA, including our control variables, is investigated in Model 4.

At 5% level of significance, the explanatory variable, GIIFY3, has a coefficient of 0,0928. According to these results, a rise in GIIFY3 is connected to an improvement in ROA. This finding is in line with the hypothesis of Model 4, where it was hypothesized that there would be a positive

relationship between ROA and the green innovation intensity score with three-years of lag. This finding is also supportive of the study by De Azevedo Rezende et al. (2019). In their study De Azevedo Rezende et al. (2019) explored the impact of green innovation on financial performance, taking in to account the influence of lag. They found out that there was a statistically significant and positive relationship between green innovation and financial performance, and this relationship was the strongest in the third year. With a coefficient of 0,0004, and a t-statistic of 0,13 the control variable, SIZE, is not statistically significant. This suggests that the company's size, as determined by the natural logarithm of total assets, has no impact on ROA.

With a coefficient of -0,0298, the control variable, LEVERAGE, is found to be statistically significant at 1% level of significance. The negative association shows that a rise in leverage is accompanied by a fall in return on assets. The results are supportive of the work by Enekwe, Agu, & Eziedo (2014). Their study probed the relationship between financial leverage and financial performance. Similiar results were observed where higher debt levels were associated with lower financial performance, in line with the findings of Model 4.

With a coefficient of 0,5687 and a t-statistic of 5,30, the control variable denoted by PRIORROA is statistically significant. The findings imply that a higher PRIORROA positively influences present ROA. A study conducted by Kordestani et al. (2010) investigated the supply chain process maturity and financial performance relationship. While doing so, they also included prior year performance as a control variable in their study. The findings suggested that there was a positive relationship between prior year performance and current financial performance, supportive to our analaysis results.

For Model 4, the probability value (Prob > F) is 0,0000 and the F-statistic is 178,3, both of which show that the entire model is statistically significant. In conclusion, the panel data analysis findings point to a statistically significant and positive relationship between ROA and GIIFY3. According to the results, regarding the control variables, LEVERAGE has a statistically significant and negative relationship with ROA, whereas PRIORROA has a statistically significant and positive relationship with ROA. However, there is no statistically significant relationship has been detected between SIZE and ROA.

Table 7: The panel data analysis results of Model 4

Regression with Driscoll-Kraay standard errors			
Dependent Variable: ROA			
Variable	**Coefficient**	**Standard Error**	**T Statistics**
GIIFY3	0,0928**	0,0327	2,84
SIZE	0,0004	0,0038	0,13
LEVERAGE	-0,0298***	0,0078	-3,82
PRIORROA	0,5687***	0,1072	5,30
Constant	0,0320	0,0380	0,84
Number of observations	735		
Number of groups	105		
F	178,31		
Prob > F	0,0000		
Legend	**p<0,1; **p<0,05; ***p<0,01*		

The panel data analysis findings of Model 5 are shown in Table 8. The association between green innovations issued in the current year and the dependent variable ROE, including our control variables, is examined in this model.

The explanatory variable, GIIFY0, has a coefficient of 0,1603. This coefficient appears not to be statistically significant, as indicated by the t-statistic of 1,82. According to the findings, there is no statistically significant relationship between green innovation and return on equity in the immediate year. We hypothesized that there would be a positive relationship between ROE and the green innovation intensity score of the latest fiscal year. Thus, this finding is also contradictory to our hypothesis tested in Model 5, similar to the result observed in Model 1.

The control variable denoted by SIZE has a coefficient of 0,0188. The coefficient is statistically significant at 10% level of significance, according to the t-statistic of 2,31. As a result, we draw the conclusion that in this model, SIZE and ROE are positively related. This finding is supportive of the work by Hu et al. (2021), where they explored the relationship of green innovation and financial performance taking in to account the moderating effects of green subsidies. Using firm size as a control variable, they examined a positive connection between firm size and financial performance.

The control variable, LEVERAGE, has a coefficient of -0,0372. The coefficient isn't statistically significant, according to the t-statistic, which is -0,63. Depending on the test results, there is no significant correlation between LEVERAGE and ROE in Model 5.

PRIORROE, another control variable used, with a coefficient of 0,5015, is found to be statistically significant at the 5% level of significance, according to the t-statistic of 3,36. The correlation

between PRIORROE and ROE is positive, according to the analysis results. This indicates that greater ROE levels in the past are linked to higher ROE in the present. This result is similar to the evidence presented in Model 1, where we examined a positive impact of prior year performance on current year financial performance measured using ROA.

The Model 5 is determined to be statistically significant at the 1% level based on the F-statistic of 43,65 and probability (Prob > F) of 0,0001. SIZE, and PRIORROE exhibit statistically significant and positive associations with ROE, according to the results of the panel data analysis. However, the findings show that variables GIIFY0 and LEVERAGE are statistically insignificant.

Table 8: The panel data analysis results of Model 5

Regression with Driscoll-Kraay standard errors			
Dependent Variable: ROE			
Variable	**Coefficient**	**Standard Error**	**T Statistics**
GIIFY0	0,1603	0,0880	1,82
SIZE	0,0188*	0,0081	2,31
LEVERAGE	-0,0372	0,0594	-0,63
PRIORROE	0,5015**	0,1491	3,36
Constant	-0,1088	0,0698	-1,56
Number of observations	735		
Number of groups	105		
F	43,65		
Prob > F	0,0001		
Legend	**p<0,1; **p<0,05; ***p<0,01*		

Table 9 displays the findings of panel data analysis for Model 6. The association between green innovations issued in the previous year and the dependent variable ROE, including our control variables, is evaluated in this model.

The first thing to note is that the explanatory variable GIIFY1 displays a positive coefficient of 0,0978, which is statistically significant at 5% level of significance. This implies a positive relationship between GIIFY1 and ROE. This result is in line with the evidence presented in Model 2 and as in the study of Przychodzen, Leyva-de la Hiz, & Przychodzen (2019). Where they found that one-year lagged green innovation scores were positively affecting financial performance.

Moving on, the control variable SIZE has a positive coefficient of 0,0185 at a 10% significance level. This shows that SIZE significantly and positively affects ROE. A study by Zheng, Khurram, & Chen (2022) investigated the impact of green innovation on ESG scores and financial performance. While doing so they included firm size as a control varible in their study and found a positive relationship

between firm size and financial performance, similar to the findings of Model 6. The coefficient for the control variable LEVERAGE is -0,0483, which isn't statistically significant. Therefore, we can't assess a link between LEVERAGE and ROE in this model.

The next statistically significant result is related to the control variable labelled as PRIORROE. It has a positive coefficient of 0,5101, which is statistically significant at 5% level of significance. This suggests that greater PRIORROE is linked to higher present ROE. This finding is in line with Model 5, also being supportive to the works of Ojimadu (2022), Gürbüz, Aybars, & Yeşilyurt (2016), Kordestani et al. (2010), and Bharadwaj (2000).

The panel data analysis model's overall F-statistic is 13,08, with a p-value of 0,0040 suggesting that the model is statistically significant as a whole. In conclusion, the findings of Model 6 point to the importance of the positive relationship of GIIFY1, SIZE, and PRIORROE in determining ROE. On the other hand, LEVERAGE has no discernible influence on ROE.

Table 9: The panel data analysis results of Model 6

Regression with Driscoll-Kraay standard errors			
Dependent Variable: ROE			
Variable	**Coefficient**	**Standard Error**	**T Statistics**
GIIFY1	0,0978**	0,0316	3,09
SIZE	0,0185*	0,0079	2,35
LEVERAGE	-0,0483	0,0584	-0,83
PRIORROE	0,5101**	0,1461	3,49
Constant	-0,0939	0,0549	-1,71
Number of observations	735		
Number of groups	105		
F	13,08		
Prob > F	0,0040		
Legend	**p<0,1; **p<0,05; ***p<0,01*		

The panel data analysis findings for Model 7 are shown in Table 10. This model examines the association between the dependent variable ROE and green innovations issued two years ago, including our control variables.

With a coefficient of 0,1143, and a t-statistic of 3,01, GIIFY2 is the explanatory variable in Model 7. The findings indicate that at 5% level of significance, GIIFY2 significantly affects ROE. As previously observed in Model 3, where ROA is the dependent variable, the hypothesis of Model 7 is also accepted. The results are in line with the findings of Tang et al. (2022), where they found out that

there was a positive relationship between green innovation and financial performance, and they observed the highest impact with a two-year lag.

The control variable SIZE has a coefficient of 0,0188, and a t-statistic of 2,30. SIZE is statistically significant at 1% level of significance. Similar to GIIFY2, company size significantly and positively affects ROE. The results are supportive of the study by Andries & Faems (2013), where they investigated the relationship between patenting activities and firm performance. They also included firm size as a variable in their study and observed positive and significant relationship between firm size and financial performance in line with the findings of Model 7.

The control variable, LEVERAGE, on the other hand, shows no statistically significant correlation with ROE. It has a t-statistic of -0,94, and a coefficient of -0,0455. As a result, LEVERAGE has no impact on ROE, indicating that these two variables are not linked for the observation period of the analysis and the selected dataset.

In addition, PRIORROE, another control variable, exhibits a statistically significant connection with ROE. It has a t-statistic of 3,54, and a coefficient of 0,5137. PRIORROE is significant at 5% level of significance similar to GIIFY2. According to these findings, businesses tend to have better current return on equity if they had greater financial performance in the past. This finding is consistent with the evidence presented in Model 5 and Model 6 (Ojimadu, 2022; Gürbüz, Aybars, & Yeşilyurt, 2016; Kordestani et al., 2010; Bharadwaj, 2000).

The F-statistic for the entire panel data analysis model is 23,76, and the probability is statistically significant (Prob > F), which is reported as 0,0000. In conclusion, Model 7's panel data analysis findings indicate that the variable LEVERAGE has no discernible influence on ROE. However, it is discovered that GIIFY2, SIZE and PRIORROE are important ROE determinants, where the relationship between these variables is positive with the dependent variable ROE.

Table 10: The panel data analysis results of Model 7

Regression with Driscoll-Kraay standard errors			
Dependent Variable: ROE			
Variable	**Coefficient**	**Standard Error**	**T Statistics**
GIIFY2	0,1143**	0,0380	3,01
SIZE	0,0188*	0,0082	2,30
LEVERAGE	-0,0455	0,0484	-0,94
PRIORROE	0,5137**	0,1451	3,54
Constant	-0,1006	0,0578	-1,74
Number of observations	735		
Number of groups	105		
F	23,76		
Prob > F	0,0000		
Legend	**p<0,1; **p<0,05; ***p<0,01*		

The findings of Model 8 are shown in Table 11. The association between green innovations issued three years ago and the dependent variable ROE, including our control variables, is investigated in this model.

The association between ROE and the explanatory variable, GIIFY3, is statistically significant at 5% level of significance. The t-statistic is 2,54, and its coefficient is 0,1310. As a result, GIIFY3 has a positive effect on ROE, indicating that green innovation scores with higher values are related to better return on equity. This finding supports the hypothesis of Model 8, where we hypothesize that there is a positive relationship between ROE and the green innovation intensity score with three-years of lag. This finding is also in line with of the study by De Azevedo Rezende et al. (2019). In their study, De Azevedo Rezende et al. (2019) explored the impact of green innovation on financial performance, taking into account the influence of lag. They found out that there was a statistically significant and positive relationship between green innovation and financial performance, and this relationship was the strongest in the third year, in line with the results of Model 8.

With a coefficient of 0,0209, and a t-statistic of 2,90, SIZE is one of the control variables used in Model 8. SIZE is statistically significant at 10% level of significance ($p < 0.1$), indicating that there is meaningful correlation between company size and ROE. Supportive evidence was presented in the works of Tariq, Badir, & Chonglerttham (2019), where they examined the relationship between green innovation and financial performance, including firm size as a control variable. The results of their study were in line with the findings presented in Model 8, meaning firms that are larger in size demonstrate

better financial performance. LEVERAGE, another control variable used, exhibits no association with ROE. It has a t-statistic of -0,85, and a coefficient of -0,0411.

The control variable, PRIORROE, has a statistically significant connection with ROE. It has a t-statistic of 3,47, and a coefficient of 0,5060. Greater past returns on equity are related to greater present returns on equity, according to the evidence from our analysis, which is significant at 5% level of significance. As being our last model, the finding of Model 8 regarding the positive relationship between prior year performance and current year financial performance is consistent with Model 5, Model 6 and Model 7 (Ojimadu, 2022; Gürbüz, Aybars, & Yeşilyurt, 2016; Kordestani et al., 2010; Bharadwaj, 2000).

The probability for Table 11 (Prob > F) is given as 0,0001 and the F-statistic is 49,42. In conclusion, GIIFY3 is a key driver of ROE based on the panel data analysis results of Model 8, with greater values of this variable being related with larger returns on equity. However, ROE is not impacted by companies' debt ratio (LEVERAGE). Furthermore, it is discovered that SIZE and PRIORROE are both key ROE drivers. Accordingly, return on equity is found to be positively correlated with higher firm size and higher historical returns on equity.

Table 11: The panel data analysis results of Model 8

Regression with Driscoll-Kraay standard errors			
Dependent Variable: ROE			
Variable	**Coefficient**	**Standard Error**	**T Statistics**
GIIFY3	0,1310**	0,0515	2,54
SIZE	0,0209**	0,0072	2,90
LEVERAGE	-0,0411	0,0482	-0,85
PRIORROE	0,5060**	0,1459	3,47
Constant	-0,1257*	0,0527	-2,38
Number of observations	735		
Number of groups	105		
F	49,42		
Prob > F	0,0001		
Legend	**p<0,1; **p<0,05; ***p<0,01*		

Overall, when we evaluate the results of our models, which are summarized in Table 12, we can state that green innovation improves financial performance after the first year for both ROA and ROE indicators. In the immediate year, we observed no statistically significant result regarding the relationship between green innovation and financial performance (De Azevedo Rezende et al., 2019). But as we moved on to test the lag effect, the results indicated that there is a long-term positive effect

of green innovation on financial performance, which increases expressively (Przychodzen, Leyva-de la Hiz, & Przychodzen, 2019; De Azevedo Rezende et al., 2019; Tang et al., 2022). We can also state that prior year performance is a substantial predictor of the current year's financial performance, since the results are statistically significant and positive for both ROA and ROE (Ojimadu, 2022; Gürbüz, Aybars, & Yeşilyurt, 2016; Kordestani et al., 2010; Bharadwaj, 2000).

Leverage has a negative impact on financial performance in the models that use ROA as the dependent variable (Enekwe, Agu, & Eziedo, 2014; Bagirov & Bagirov, 2019; Zheng Hu, Qiu, She, & Wang, 2021; Khurram, & Chen, 2022), whereas, for the models that use ROE as the dependent variable, leverage has statistically insignificant results. Furthermore, in the models that use ROA as the dependent variable, there has been no statistical evidence to support a relationship between firm size and financial performance. On the other hand, the analysis results, where the dependent variable is ROE, indicates that there is a statistically significant and positive relationship between firm size and financial performance (Andries & Faems, 2013; Tariq, Badir, & Chonglerttham, 2019; Zheng Hu, Qiu, She, & Wang, 2021; Khurram, & Chen, 2022). The lag effect of green innovation on financial performance is extensively covered in the section that follows, in Table 13.

Table 12: Summary table of all the panel data analysis results

	Regression with Driscoll-Kraay standard errors			
	Model 1 - Dependent Variable: ROA			
Variable	**GIIFY0**	**SIZE**	**LEVERAGE**	**PRIORROA**
Coefficient	0,0922	-0,0009	-0,0343*	0,5483***
Standard Error	0,0666	0,0038	0,0155	0,1193
T Statistics	1,38	-0,25	-2,21	4,59
	Model 2 - Dependent Variable: ROA			
Variable	**GIIFY1**	**SIZE**	**LEVERAGE**	**PRIORROA**
Coefficient	0,0423**	-0,0009	-0,0405**	0,5875***
Standard Error	0,0161	0,0039	0,0144	0,0855
T Statistics	2,62	-0,25	-2,81	6,87
	Model 3 - Dependent Variable: ROA			
Variable	**GIIFY2**	**SIZE**	**LEVERAGE**	**PRIORROA**
Coefficient	0,0528**	-0,0008	-0,0378**	0,5949***
Standard Error	0,0197	0,0038	0,0121	0,0980
T Statistics	2,67	-0,22	-3,12	6,07
	Model 4 - Dependent Variable: ROA			
Variable	**GIIFY3**	**SIZE**	**LEVERAGE**	**PRIORROA**
Coefficient	0,0928**	0,0004	-0,0298***	0,5687***
Standard Error	0,0327	0,0038	0,0078	0,1072
T Statistics	2,84	0,13	-3,82	5,3
	Model 5 - Dependent Variable: ROE			
Variable	**GIIFY0**	**SIZE**	**LEVERAGE**	**PRIORROE**
Coefficient	0,1603	0,0188*	-0,0372	0,5015**
Standard Error	0,0880	0,0081	0,0594	0,1491
T Statistics	1,82	2,31	-0,63	3,36
	Model 6 - Dependent Variable: ROE			
Variable	**GIIFY1**	**SIZE**	**LEVERAGE**	**PRIORROE**
Coefficient	0,0978**	0,0185*	-0,0483	0,5101**
Standard Error	0,0316	0,0079	0,0584	0,1461
T Statistics	3,09	2,35	-0,83	3,49
	Model 7 - Dependent Variable: ROE			
Variable	**GIIFY2**	**SIZE**	**LEVERAGE**	**PRIORROE**
Coefficient	0,1143**	0,0188*	-0,0455	0,5137**
Standard Error	0,0380	0,0082	0,0484	0,1451
T Statistics	3,01	2,3	-0,94	3,54
	Model 8 - Dependent Variable: ROE			
Variable	**GIIFY3**	**SIZE**	**LEVERAGE**	**PRIORROE**
Coefficient	0,1310**	0,0209**	-0,0411	0,5060**
Standard Error	0,0515	0,0072	0,0482	0,1459
T Statistics	2,54	2,9	-0,85	3,47
Legend	**p<0,1; **p<0,05; ***p<0,01*			

4.5.3. Lag Effect Analysis Results

The findings of the comparative panel data analysis investigating the association between financial performance and green innovation in the setting of lag effect are shown in Table 13.

Model 1 investigates the effect of current-year green innovation (GIIFY0) on financial performance, measured by ROA. With a correlation of 0,0922, the t-statistic is 1,38 which means the result isn't statistically significant as to the link between financial performance and green innovation.

For green innovation, Model 2 adds a one-year lag (GIIFY1). The coefficient of 0,0423 is statistically significant at the 5% level, indicating that the green innovations issued in the past year has a positive impact on financial performance, which is measured by ROA. This suggests that the advantages of green innovation for financial success start with a one-year lag.

Model 3 includes a two-year lag for green innovation (GIIFY2). The impact of green innovation issued two years ago is found to be significantly and positively affecting ROA, as indicated by the coefficient of 0,0528, which is statistically significant at the 5% level.

A three-year lag for green innovation is tested in Model 4 (GIIFY3). At the 5% significance level, the coefficient of 0,0928 is statistically significant, indicating that green innovation issued three years ago has a positive impact on current year financial performance, which is measured by ROA. This result supports the idea that green innovation's benefits can have a long-term effect on financial performance.

As we go on to the examination of ROE, which is the variable used to represent financial performance, Model 5 investigates how current-year green innovation (GIIFY0) has affected the current year's financial performance. With a coefficient of 0,1603, the t-statistic is 1,82 meaning that the result isn't statistically significant.

For green innovation, Model 6 adds a one-year lag (GIIFY1). The coefficient of 0,0978 is statistically significant at the 5% level and indicates that green innovations issued in the past year have a beneficial impact on financial performance, which is measured by ROE. This suggests that future returns on equity may be favorably impacted by the advantages of green innovation initiatives.

Green innovation has a two-year lag (GIIFY2) in Model 7. The green innovations issued two years ago apparently have statistically significant and positive impact on financial performance, measured by ROE, as the coefficient of 0,1143 is statistically significant at the 5% significance level.

A three-year lag for green innovation is examined in Model 8 (GIIFY3). The coefficient of 0,1310 is statistically significant at the 5% significance level, indicating that green innovation initiatives undertaken three years ago have a positive impact on ROE, which is the variable used to represent

financial performance. This result is supportive of the notion that green innovation's benefits can affect return on equity over the long term.

Overall, the findings show a favorable and statistically significant association between green innovation, both for ROA and ROE, except the results presented in Model 1 and Model 5. According to the research, businesses who participate in green innovation initiatives don't see any improvement in their return on equity and return on assets in the first year, but as time goes on, the positive effects of green innovation on financial performance become apparent (Przychodzen, Leyva-de la Hiz, & Przychodzen, 2019; De Azevedo Rezende et al., 2019; Tang et al., 2022). Furthermore, the findings indicate that the advantages of green innovation on financial performance have a lasting lag effect which increases expressively as time goes on (De Azevedo Rezende et al., 2019).

Table 13: Comparative panel data analysis results of green innovation on financial performance

	Regression with Driscoll-Kraay standard errors			
	Dependent Variable: ROA			
	Model 1	**Model 2**	**Model 3**	**Model 4**
Variable	**GIIFY0**	**GIIFY1**	**GIIFY2**	**GIIFY3**
Coefficient	0,0922	0,0423**	0,0528**	0,0928**
Standard Error	0,0666	0,0161	0,0197	0,0327
T Statistics	1,38	2,62	2,67	2,84
	Dependent Variable: ROE			
	Model 5	**Model 6**	**Model 7**	**Model 8**
Variable	**GIIFY0**	**GIIFY1**	**GIIFY2**	**GIIFY3**
Coefficient	0,1603	0,0978**	0,1143**	0,1310**
Standard Error	0,0880	0,0316	0,0380	0,0515
T Statistics	1,82	3,09	3,01	2,54
Legend	**p<0,1; **p<0,05; ***p<0,01*			

5. CONCLUSIONS AND RECOMMENDATIONS

This study utilizes panel data analysis to investigate how green innovation affects financial performance of 105 companies, which operate in the EU, between the years 2016 and 2022. The research's findings offer convincing proof of a statistically significant and favorable association between green innovation and financial performance after the first year. This result confirms the understanding that implementing green innovation methods may provide enterprises with real advantages in terms of their financial performance. The findings also show that the benefits of green innovation, which takes time to develop, positively affect ROA and ROE for a number of years in the context of the lag effect, indicating a long-lasting impact on financial performance.

The analysis of panel data allows for a comprehensive investigation of this relationship over a significant period, enabling us to control for various factors that might influence financial performance. The results consistently indicate that companies that embrace green innovation practices experience better financial performance over time, after the first year, compared to those that do not prioritize sustainability initiatives.

Firstly, the positive relationship observed between green innovation and financial performance can be attributed to cost-saving mechanisms. Green innovation often entails adopting energy-efficient technologies, waste reduction strategies, and sustainable supply chain practices. These measures result in reduced operational costs, improved resource management, and increased overall efficiency. Consequently, companies can achieve significant cost savings, positively impacting their bottom line and financial performance (Calof & Viviers, 1995).

Secondly, green innovation increases consumer loyalty and brand reputation. Organizations that show a commitment to sustainability are more likely to draw environmentally concerned clients in time when consumers are growing more aware of environmental challenges. Companies may set themselves apart from rivals, build a strong brand, and create enduring client connections by creating and promoting green goods or services. Sales, market share, and ultimately financial success are all impacted by the improved brand reputation and customer loyalty (Castellacci & Lie, 2017).

Thirdly, green innovation can lead to new business opportunities and market expansion (Takalo & Tooranloo, 2021). The demand for eco-friendly goods and services is rising as the world's attention on sustainability sharpens. Companies that proactively invest in green innovation are better positioned to capitalize on emerging market trends and tap into new customer segments. By aligning their strategies with sustainability objectives, organizations can identify untapped market niches and develop innovative solutions that address environmental challenges. This proactive approach to green innovation enables

companies to diversify their revenue streams, expand their market presence, and subsequently improve their financial performance (Hur, Kim & Park, 2013).

In light of these findings, several recommendations can be made for organizations seeking to enhance their financial performance through green innovation:

Organizations should foster an internal culture that encourages and rewards green innovation. This can be achieved by establishing dedicated teams or departments responsible for driving sustainability initiatives, creating platforms for idea sharing and collaboration, and providing training and resources to empower employees to develop innovative solutions.

Companies should regularly conduct environmental audits to identify areas for improvement and assess the effectiveness of their green innovation efforts. These audits can help organizations monitor their environmental impact, track progress towards sustainability goals, and identify opportunities for further innovation.

Collaboration with stakeholders such as suppliers, customers, and industry partners can accelerate green innovation efforts. By forming strategic partnerships, organizations can share knowledge, resources, and best practices, enabling them to leverage collective expertise and drive meaningful change across the value chain.

It is crucial for companies to communicate their sustainability efforts effectively. Transparency in reporting and the effective communication of sustainability programs, goals, and successes may increase company reputation, foster stakeholder trust, and draw in environmentally concerned customers, all of which eventually improve financial performance.

For businesses to continue to be at the forefront of green innovation, ongoing investment in research and development is essential. Spending money on R&D enables businesses to create cutting-edge, economically viable, and environmentally sustainable processes, products, and technologies, giving them a competitive edge and long-term financial performance improvement.

Additionally, for academic scholars, the following proposals might be made to advance our understanding of how green innovation affects financial performance:

Though this study concentrates on the connection between green innovation and financial performance, future research may look into examining other aspects and results. One way to gain a deeper knowledge of the overall advantages of sustainable practices is to examine how green innovation affects other organizational performance indicators like market value, return on investment, or staff productivity.

Future studies may conduct comparative assessments across other industries or sectors to better understand the benefits of green innovation. Researchers can pinpoint industry-specific subtleties, difficulties, and opportunities by looking at how green innovation affects financial performance in various circumstances. A more complex understanding of the connection between green innovation and financial performance would result from this comparison approach.

Future research might look into the mediating and moderating elements that affect the link between green innovation and financial success to give a more comprehensive knowledge of the mechanisms and circumstances involved. For instance, investigating how corporate culture, leadership philosophies, or regulatory frameworks influence this connection can offer practitioners and decision-makers insightful information.

While this study employs quantitative panel data analysis, future researchers could consider incorporating qualitative research methods to complement the findings. Qualitative approaches such as interviews, case studies or focus groups can provide in-depth insights into the underlying processes, motivations, and challenges associated with green innovation and its impact on financial performance. This qualitative perspective would enrich the understanding of the complexities involved and provide a more holistic view of the topic.

Green innovation and its impact on financial performance may be influenced by contextual factors such as national or regional policies, cultural norms, or market conditions. Future studies could explore the role of these contextual factors in shaping the relationship. By considering the influence of the broader external environment, researchers can offer a more comprehensive analysis and provide practical recommendations tailored to specific contexts.

Similar studies are essential to validate the findings of previous research for different markets, timespans, and geographic locations. Future researchers are encouraged to replicate and extend the current study in different settings to confirm the robustness and generalizability of the observed relationship between green innovation and financial performance. This replication can contribute to the accumulation of knowledge and reinforce the confidence in the findings.

Future studies can improve our comprehension of how green innovation affects financial performance by addressing these suggestions. Organizations, politicians, and stakeholders aiming to advance sustainability while maintaining economic success can find important insights from conducting more thorough, context-specific, multi-method studies.

In conclusion, this study offers solid proof that green innovation and financial performance are positively correlated after the first year of issuance. Adopting green innovation approaches may result in financial savings (Hur, Kim & Park, 2013; Calof & Viviers, 1995), improved brand recognition,

devoted clients (Castellacci & Lie, 2017), fresh company prospects, and market development (Takalo & Tooranloo, 2021). The suggestions made above can help companies maximize their financial performance while leveraging the promise of green innovation and fostering a sustainable future.

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