The impact of firm performance and carbon emissions on the cost of capital for the Johannesburg Stock Exchange (JSE) listed firms

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DECLARATION

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ABSTRACT

The study investigated the impact of firm performance and carbon emissions on the cost of capital for the Johannesburg Stock Exchange (JSE) listed firms. The mining firms listed on the JSE were selected as the sample, and they were observed for a period of 5 years starting from 2018 to 2022, which amounted to 75 observations. A quantitative methodology, which used panel data and the Panel Least Squares regression model, was employed, using both fixed and random specifications. The study focused on a historical analysis, which made use of quantitative secondary data through secondary analysis. Sources of relevant secondary data include firms that gather information on climate change, carbon reporting, and financial performance on listed firms. The study employed two independent variables (carbon emissions and firm performance) and one dependent variable (cost of equity capital). Carbon emissions were calculated as an inverse value of carbon intensity (scope 1 & 2 emissions). Firm performance was indicated by return on assets (ROA), return on equity (ROE) and firm size. Financial leverage, book to market ration and market beta were employed as control variables. The study found that carbon emissions have a non-statistically significant negative relationship with the cost of capital, which implies that the higher the carbon emissions intensity, the lower the cost of equity capital. Furthermore, it showed that firm performance also has a non-statistically significant negative impact on the cost of capital, which implies that the greater the firm performance, the lower the cost of equity capital. The findings further indicate that carbon emissions influenced return on assets and firm size negatively. This is because firms that are capital intensive tend to have higher carbon emissions, which results in lower return on assets. In addition, leverage also has a negative association with return on assets because leverage increases the risk of bankruptcy and default, thus affecting firm profitability/performance. This study provides insight into how carbon emissions and firm performance affect how much investors are willing to invest in a company (cost of equity capital) and how environmental issues such as climate change affect the cost of equity of listed firms.

Keywords: Climate change; Carbon emissions; Firm performance; Legitimacy theory

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CHAPTER 1: INTRODUCTION

1.1 Introduction

The study investigated the impact of firm performance and carbon emissions on the cost of capital for the Johannesburg Stock Exchange (JSE) listed firms. The present chapter presents the framework of this study, providing an overview of the research topic. A concise explanation of the problem statement, study objectives, and questions is provided. Furthermore, the chapter highlights the importance and constraints of the study.

1.2 Overview of the Study

Humanity's most pressing challenge is climate change, as it has an impact on environmental, economic, and social stability (Gao et al., 2024). The term global warming relates to the rise in temperature of the earth's surface owing to human activities through the emission of greenhouse gases (Gao et al., 2024). The top five global risks over the past few years and for the next decade have been noted to be environmentally related (Gao et al., 2024). This has been attributed to the growing awareness amongst individuals and various stakeholders of firms about the effects of, more specifically, the global warming-related financial risks, as these can lead to disorders in all of society (Gao et al., 2024). Climate change and environmental degradation have led to the occurrence of frequent catastrophes which have resulted in destruction of properties, risks imposed on human life and health, and the rising number of insurance claims and credit risk exposures threatening financial stability (Gao et al., 2024).

Climate change and environmental degradation constitute some of the top five global risks; as such, the growing awareness of risks linked to environmental, social, and governance (ESG) issues has prompted discussions on sustainability, which include sustainable business practices and sustainable economic growth and development (Johnson, 2020). Climate change does not only pose a threat to the greater public but also to firms' existence as it can lead to greater financial losses; thus, the identification and reporting of ESG-related factors will lead to better management and create sustainable businesses (Johnson, 2020).

In the era of dynamic technological innovations and economic changes, the firm's processes affect stakeholders, and the firm is also affected by stakeholders (Hristov and Appolloni, 2022). As such, addressing climate related risks requires collective action of both individuals and firms to transition

to a more sustainable and stringent future (Gao et al., 2024). Firms that are seen to be responsible corporate citizens are those with business activities and practices that are closely aligned with the expected values, norms, and beliefs of society (Bozzolan et al., 2015). Firms seek to achieve and protect legitimacy, which is a status given by society to firms that have the aforementioned business activities and practices, as this is essential for firms' continued survival (Bozzolan et al., 2015). Engaging in sustainable practices, including disclosure and reduction of carbon footprints, can be a great way for firms to gain a legitimate status and legitimise their business activities and practices (Olateju et al., 2021) when they assess their carbon impact and show their commitment to reducing it.

Society can request firms to reduce energy and resource consumption, and carbon emissions through improved production processes (Xiao et al., 2018). Firms that only focus on value creation for investors limit their ability to build prosperous firms, as firms need to extend their reach to the broader society (Freeman et al., 2020). Firms can only be going concerns if the public believes that the firm's operations are in accordance with their expectations (Baldini et al., 2018; Olateju et al., 2021). Social evaluations play a crucial role in setting a public image for firms (Ekanayake & Heyden, 2024).

In most cases, it is firms with slack resources that can extend their reach to meeting expectations of all stakeholders. The availableness of slack resources show a shield of resources that a firm can use to solve problems and/or make possible the fulfilment of strategic goals (Xiao et al., 2018; Uwuigbe et al., 2018). Slack resources can assist firms meet their goals (Uwuigbe et al., 2018). Firms continually reallocate resources and/or activities around their boundaries to enhance firm performance (Munjal et al., 2019).

To reach the expectations of the various stakeholders, firms have opted for integrated reporting, which is the voluntary reporting of financial and non-financial data. The objective of voluntary reporting is to safeguard against skewness between management and capital contributors by providing pertinent details relating to the long term sustainability of the reporting firm (Ngcobo, 2020). Greater performing firms hold and report voluntary pertinent details as compared to poor performing firms, which helps various stakeholders in their decision-making (Garzón-Jiménez & Zorio-Grima, 2021). Reporting firms are advised to make as such information available as to avoid possible assumptions being made by the capital contributors or other stakeholders that the firm has

something negative to hide (Schiller & Lundh, 2013). Firms listed on the JSE are obligated to produce both annual and integrated documents, which is why this study focused on JSE listed firms. In the context of ESG, firms who withhold information relating to carbon emissions can be seen to be engaging in suspicious activities and appear not to be interested in helping sustain the planet for future generations.

Capital contributors are more interested in the return on investment being greater than the cost of capital (CoC). If firms appear to be going against the grain, they have a high potential of losing current and future business, which will have a negative impact on the returns to be received by investors. The CoC is the anticipated yield from an investment that economic agents need to allure financial resources to a certain investment (Pratt & Grabowski, 2008; Berry-Stölzle & Xu, 2018). Shareholder value is created when firms make investments where the returns are greater than the CoC for such investments (Pratt & Grabowski, 2008, Berry-Stölzle and Xu, 2018). In the context of ESG, firms that identify, manage, and report on ESG-related risks have higher chances of survival and creating sustainable shareholder wealth as well as positively impact the greater society.

The management of ESG-risks and other financial risks can increase firm performance. A lot of firms seek to enhance their performance, and firms who win are those who dare to be innovative, to acquire, and maintain performance (Taouab & Issor, 2019). Evaluating and measuring firm performance in current economic conditions is crucial to reporting firms and their stakeholders (Taouab & Issor, 2019). In the last few years, there has been an exponential increase in the recognition about the prospective risks of climate change (Khatib et al., 2023; Garzón-Jiménez & Zorio-Grima, 2021). The part of greenhouse fumes, chiefly carbon emissions, grew into a crucial topic. The increasing significance of firm sustainability has captivated attention from investors and other stakeholders (Sabirali & Mahalakshmi, 2023). Investors who invest long-term make sustainability practices a priority as opposed to short-term shareholders who do not, as they believe that firms with great ESG performance surpass the market (Sabirali & Mahalakshmi, 2023).

The correlation linking firm effectiveness and the CoC is a compound and robust feature of financial management (Sabirali & Mahalakshmi, 2023). Firms with greater performance are more inclined to have a lower CoC than those with poor performance (Myers & Majluf, 1984; Drobetz et al., 2018). The market inflicts a penalty on firms for greater carbon emissions owing to the fact

that climate risks and the likelihood of not being able to act in accordance with regulations, which can impact the firm's earnings in the future (Khatib et al., 2023; Bui et al., 2020). Furthermore, shareholders may be convinced that a firm can obtain an edge over its competitors by lowering carbon emissions (Khatib et al., 2023). A firm can gain a competitive edge when it utilises environmentally sustainable operations that are of high value, rare, complex to duplicate and does not have a replacement (Khatib et al., 2023). A firm's sustainability has a positive relationship with its financial health/performance (Trinks et al., 2022a). Firms' carbon performance influences the valuation of the firms, and better carbon disclosures increase firms' market valuation (Bui et al., 2020). Thus, firms with greater carbon emissions may not be considered as having environmentally sustainable procedures, which may decrease shareholders' presumptions of the firm's earnings in the future (Khatib et al., 2023).

A firm's comprehensive success is normally assessed by its financial performance, which shows its well-being with respect to maximisation of returns, investor's wealth, and stake in the market (Sabirali & Mahalakshmi, 2023). The sustainability of firms goes above monetary goals, highlighting a firm's participation in economic development, social parity, and protection of the environment (Sabirali & Mahalakshmi, 2023). A firm's capacity to manage carbon costs in relation to the correlation linking financial performance and carbon emissions within the European Union Emission Trading Scheme shows that better carbon emission performance seldom leads to financial well-being; rather, lesser levels of carbon emissions are at most compensated if a company cannot transfer carbon costs to customers because of industry traits or firm-specific carbon efficiencies (Khatib et al., 2023). When managers of firms react to carbon emissions emitted by the said firms, their overall response can have an effect on both carbon emissions and firm effectiveness (Houqe et al., 2022). A firm's value may decline as carbon emissions increase, and the market tends to impose penalties on firms with high carbon emissions (Houqe et al., 2022).

1.3 Problem Statement

Climate change and environmental degradation constitute some of the top five global risks (i.e. waste management, water and energy security, climate change, corruption and diversity); as such, the growing awareness of ESG related risks have prompted discussions on sustainability, which include sustainable business practices and sustainable economic growth and development (Johnson, 2020). Climate change does not only pose a threat to the greater public but also to firms' existence as it can lead to greater financial losses; thus, the identification and reporting of ESG-related factors will lead to better management and create sustainable businesses (Johnson, 2020). When a company incurs financial losses, the return on investment that the capital contributors expect to receive is affected; thus, the CoC indicates the anticipated yield from an investment that the capital contributors (both debt and equity) require from a firm (Johnson, 2020; Fama & French, 1992).

In most cases, firms that actively and effectively manage and report on ESG-related risks are in a better position to reduce their risk exposure and the CoC, which consequently leads to greater creation of shareholder wealth (Johnson, 2020). However, there is no conclusive evidence from literature available on the association linking carbon emissions and firm performance on the CoC and the benefits that can be reaped by the reporting firms and various stakeholders, which brings about the following questions:

- What is the relationship between carbon emissions and the cost of capital for the JSE listed firms?
- How does firm performance affect cost of capital for the JSE listed firms?

1.4 Study Objectives

This study sought to investigate the effect of firm performance and carbon emissions on the CoC. The study's specific objectives are to:

1. examine the impact of carbon emissions on cost of capital for the JSE listed firms, and
2. analyse the effect of firm performance on cost of capital for the JSE listed firms.

1.5 Research Questions

This study sought to investigate the effect of firm performance and carbon emissions on the CoC. The research questions were:

- What is the relationship between carbon emissions and cost of capital for the JSE listed firms?
- How does firm performance affect cost of capital for the JSE listed firms?

1.6 Significance of the Study

The influence of firm performance and carbon emissions on the CoC is an increasing crucial area of study, more especially as sustainability is becoming the main concern for providers of capital, regulators, and broader society. Firms with stronger financial performance tend to have a lower financing cost. Furthermore, firms that prioritise ESG factors tend to experience better overall performance, more especially as investors seek to invest in sustainable firms. Firms with high carbon emissions can be perceived as more risky investments, while firms that invest in the reduction of carbon emissions often show improved operational efficiency and overall performance and reduced costs. As the emphasis on sustainability grows, the impacts of firm performance and carbon emissions on the CoC tend to become more highlighted. This study aimed to contribute to the paucity of research related to the effect of firm performance and carbon emissions on the CoC. It is on these grounds that the following are the likely beneficiaries of this study.

1.6.1 Reporting Firms

The reporting firms can utilise insights from this study to improve their sustainability practices. They can also reduce carbon emissions. These will improve their overall firm performance and potentially lower their CoC.

1.6.2 Policy Makers, Academic Researchers, and the Government

This study can stimulate further studies on ESG factors, expanding research on sustainable finance. This study, together with further studies on the related topic, will assist policy makers and regulators in crafting policies that incentivise lower carbon emissions. This has the potential to contribute to sustainable economic growth.

1.6.3 Other Stakeholders

For stakeholders such as financial analysts, investors and employees who are invested in a firm's decision-making process regarding sustainable business practices, activities and wealth management, this study will assist them understand how firm performance and carbon emissions affect a firm's CoC and assist them make more informed decisions. This also has the potential of leading them to be more in favour of firms with better/sustainable environmental practices.

1.7 Constraints of the study

The study constraints include the nature of the sampling technique employed, which was the preselected mining firms listed on the JSE. A further limitation was that some of the mining firms did not make their integrated/climate reports available and some did not disclose their carbon emissions for the whole period 2018 to 2022, which resulted in the reduction of the number observations. To circumvent this, the observation of the available samples was done thoroughly. The other limitation arose owing to the lack of guidance on specific guidelines for reporting carbon emissions, as such, carbon emissions could not be compared effectively amongst the firms. However, the analysis tried to establish emerging trends and patterns.

1.8 Structure of the Study

Chapter 1 gives a general outline of the study, covering the problem statement, objectives, questions, importance, and constraints of the study. Chapter 2 presents both theoretical and empirical literature underpinning the study, while Chapter 3 provides the research methodology, an overview of the methods for collecting data, and how the data were collected and analysed. While Chapter 4 provides a presentation and analysis of the results from the data collected and analysed, Chapter 5 provides a conclusion on the study's objectives and questions, provides recommendations, outlines constraints of the study, and includes proposals for subsequent studies.

1.9 Summary

This chapter presented an overview of the research topic. It highlighted the problem statement, study objectives and questions, importance and constraints of the study. The chapter that follows highlights the theoretical and empirical studies underpinning this study.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

The previous chapter introduced the study by reflecting a concise foundation of carbon emissions, the problem statement, research objectives and questions, as well as the importance of the study. This chapter discusses the theoretical framework underpinning the study and reviews relevant empirical studies. It looks at the theories used and their relevance to carbon emissions, firm performance, and the CoC.

2.2 Theoretical Literature

For accelerating understanding of the variables used in this study, it is imperative to recognise the framework of theories that underpins this study. Many advocates of theories believe that theories solve important problems, and as such the essence of the problem to a certain extent assists ascertain the usefulness or lack of usefulness of that theory (Freeman et al., 2020). This section outlines a broad understanding and outlook of related and linked theories that have been widely researched in analysing the impact of firm performance and carbon emissions on the CoC. The four theories in this regard include stakeholder theory, legitimacy theory, slack resource theory and voluntary disclosure theory. Below, the study provides an overview of these four theories.

2.2.1 Stakeholder Theory

The theory of stakeholders is a theory of firm ethics as well as firm management (Mahajan et al., 2023). This theory sees firms as part of the general public, and holds that stakeholders impact the firm's potential to realise its intentions/purpose (Donaldson & Preston, 1995; Dao & Phan, 2023). In the era of dynamic technological innovations and economic changes, it is imperative that accounting theories adapt to the requirements of stakeholders; even though the firm's processes affect stakeholders, the firm is also affected by stakeholders (Hristov & Appolloni, 2022). The chief stakeholders are providers of capital, consumers, members of the workforce, suppliers, financial institutions, preservationists, and society (Dao & Phan, 2023; Mahajan et al., 2023). The main responsibility of managers of firms is to control and amalgamate the interests and relationships of all chief stakeholders by ensuring their rights and involvement, and by managing the firm for long-term success (Dao & Phan, 2023; Mahajan et al., 2023). Equally, firms require the support of the various stakeholders to be in existence for longer and to thrive (Mahajan et al., 2023).

From the earliest days, stakeholder theory has been linked to strategic considerations (Freeman et al., 2020). The stakeholder concept was created as a form of arranging information, which was progressively crucial in strategic planning, aiming to make business policies and strategy more efficient and effective (Freeman et al., 2020). The main concept of the theory was not limited to finding the root cause for why a company would outperform others. It was the regulating concept of assisting opinion-formers make better decisions (Freeman et al., 2020; Dao & Phan, 2023). This theory can be used to address many critical issues and inform firms' decision making (Barney & Harrison, 2020; Dao & Phan, 2023). The distinguishing components of stakeholder theory encompass management and their interactions in their operations of creating economic value, aligning their ethics, values, and norms as drivers for effective and efficient prosperity within and among firms (Freeman et al., 2020). Every stakeholder adds value for a firm to prosper and, as such, they must also reap benefits for the firm to continue to prosper (Freeman et al., 2020; Dao & Phan, 2023). Members of the workforce want to earn more while putting in less effort; consumers want to pay low prices for goods and/or services; suppliers and distributors want to boost their margins (charge higher prices while cutting down costs); capital contributors want higher returns on their investments, and the preservationists and public seek to hold firms accountable for their actions (Freeman et al., 2020). Firms that have the expertise to bring to equilibrium the interests of the various stakeholders will keep hold of support, benefaction, and involvement, and they will advance substantially sturdily (Dao & Phan, 2023). The requests of the chief stakeholders are determined from the aptness of firm value creation (Dao & Phan, 2023).

Society can request firms to reduce energy and resource consumption as well as carbon emissions through improved production processes (Xiao et al., 2018). Focusing only on value creation for investors is a limitation to building a prosperous firm (Freeman et al., 2020). Stakeholder theory affirms that the governance of a firm has a legal obligation to satisfy the interests of stakeholders (Gelmini et al., 2015). Ngcobo (2020) notes that for these interests to be satisfied, governance of the firm needs to implement activities that are considered as crux by stakeholders. Stakeholders can exert pressures on firms by using their influence and legitimacy for their own benefits (Xiao et al., 2018). Firms respond to and address stakeholders' requests to make certain that they have the support of the stakeholders (Xiao et al., 2018; Mahajan et al., 2023). Firms are encouraged to find a balance between maximising profits for shareholders and needs satisfaction of stakeholders (Mahajan et al., 2023).

Some executive officers of firms who are globally known and whose names trigger much attention receive a high amount of attention from the public, and this creates advantageous emotional reaction from various stakeholders (Ekanayake & Heyden, 2024). According to Ekanayake and Heyden (2024), the firms who are led by public figure executive officers are perceived to indulge reputational advantages and greater firm financial performance. They add that stakeholders' attribute actions of firms to their executive officers. Stakeholders with the ultimate control in the firm influence the performance of the firm, especially promoting firms' corporate social responsibility and gain goodwill and legitimacy, as firms want to gain these from their stakeholders (Dong et al., 2024). It has also been argued that the stakeholder theory suggests that the interests of various stakeholders must be taken into account in firm policies, however, it does not explain how that could directly impact the performance of firms and their operations (Olateju et al., 2021).

Stakeholder theory gives a suitable optic for determining a greater elaborate view of the value that various stakeholders search for as well dynamic ways to evaluate it (Harrison & Wicks, 2013). In the paper written by Harrison and Wicks (2013), they developed a four-factor view for defining value, which also includes the economic value of firms that stakeholders look for. The perspective of stakeholders on the value of firms is drawn from those factors that are closely related to building more value for various stakeholders, which allows practitioners and academics to better understand, measure, and amplify firms' ability to create value (Harrison & Wicks, 2013).

Firms need to achieve harmony, fairness, and balance for all stakeholders, as failure to do so will disrupt the prosperity of the firm (Freeman et al., 2020). This theory's aim is to convey the correlation between firms and stakeholders; and suggests that reporting companies need to find a balance in meeting their stakeholders' suppositions (Deegan, 2002). A firm can demonstrate corporate responsibility through actions and decisions that benefit all stakeholders (Barney & Harrison, 2020). This theory is relevant as stakeholders play a role in a firm's performance and reporting of carbon emissions, as firms always want to meet the interests of stakeholders (Freeman et al., 2020).

2.2.2 Legitimacy Theory

Legitimacy theory is rooted in the notion of firm legitimacy, which has been explained as a status which is borne when a firm's principles are aligned with those of the general public (Deegan, 2019a; Olateju et al., 2021; Uwuigbe et al., 2018). A firm can claim legitimacy by being agreeable to beliefs, norms, values, procedures or practices which are universally accepted (Zelditch Jr, 2018; Olateju et al., 2021). Legitimacy could be defined as popularised insights or suppositions that the activities of firms are appropriate, desirable or proper inside a socially developed system of beliefs, definitions, norms, and values (Silva, 2021; Baldini et al., 2018; Olateju et al., 2021). Legitimacy can be obtained, managed, conserved and preserved (Silva, 2021; Olateju et al., 2021). This theory highlights the significance of public acceptance in making certain that a firm continues to survive (Baldini et al., 2018; Olateju et al., 2021; Uwuigbe et al., 2018). Engaging in sustainable practices, including disclosures of carbon footprints and reduction of emissions, can be a great way for firms to gain a legitimate status and legitimise the actions of the firm (Olateju et al., 2021).

This theory has to do with a company's licence for existing as there is a "social contract" between the company and the general public (Janang et al., 2020; Deegan, 2019b; Olateju et al., 2021; Uwuigbe et al., 2018). When there is a gap in existence between the two's principles or disputes affecting the contract, the company's continuance is in danger (legitimacy threats) (Deegan, 2019a). The function of accounting reports is to legitimise the continued survival of a firm (Deegan, 2019b). When firms disregard pressures from society to be legitimate, there is an increased probability of losing legitimacy (Silva, 2021). Firms can only be going concerns if the public believes that the firm's operations are in accordance with their expectations (Baldini et al., 2018; Olateju et al., 2021). Social evaluations play a crucial role in setting a public image for firms (Ekanayake & Heyden, 2024). Firms and their managers purposefully acknowledge and adapt the social evaluations as they exert influence on a firm's resources, such as the firm's reputation and legitimacy (Ekanayake & Heyden, 2024; Dong et al., 2024, Olateju et al., 2021).

Management of a firm's natural inclination to partake in legitimising strategies and plans is also influenced by the measure to which a firm relies on its legitimacy status for commercial purposes (Deegan, 2019b). Researchers have found that legitimacy threats drive environmental and social reporting (Silva, 2021; Olateju et al., 2021). Legitimacy threats also have a potential of making management of firms present information in a manner that is favourable and benefits only the firm

rather than both the firm and stakeholders (Deegan, 2019b). Firms that keep themselves in the public eye disclose greater information than those firms that do not (Magness, 2006). Legitimacy theory has been employed in a wide range of studies, especially in contexts of firm behaviour/performance and environmental disclosures (Olateju et al., 2021). The increase in the levels of disclosures by poor performing firms can be explained through legitimacy theory as an effort to change the perception of the firm by the public (Mahmood et al., 2017). Some stakeholders, such as members of the workforce, consumers, and providers of capital, can decline association with a firm that has a reputation of poor performance (this includes both financial performance and environmental behaviour) (Uwuigbe et al., 2018). It is for this reason that this study not only used reported information but also confirmed scores by global ratings agencies.

Most social and environmental disclosures are voluntary; the question then arises as to what motivates firms to disclose social and environmental matters (Deegan, 2019b). Comprehending what motivates firms to disclose is imperative in determining whether stakeholders should place reliance on them when making decisions about the firms (Deegan, 2019b). The one motivation for disclosure that has been singled out is the desire by management of firms to legitimise several aspects of a firm's activities (Deegan, 2019b). Management of firms will utilise social and environmental disclosures as a defence mechanism against legitimacy threats, to appear socially conscious and partake in generally accepted behaviour in terms of stakeholder suppositions (Deegan, 2019b; Baldini et al., 2018). For firms to affirm their legitimacy status, firms disclose different social and environmental matters to form an impression about the firm's operations; firms do this using the legitimacy device, which can be the annual reports or ESG reports (Uwuigbe et al., 2018).

Findings are noted in Deegan et el. (2002) which are in support of legitimacy theory. These findings show that social and environmental matters that enticed greatest media attention were also matters which had the greatest amount of disclosures in annual reports (Deegan, 2019b). Firms manage their legitimacy through communicating sustainability performance in environmental and social disclosures (Silva, 2021). If a firm discloses sustainability reports, it stands to gain a legitimate status, and if it does not, the firm may face risks such as market risk, financial risk, and reputational risk (Olateju et al., 2021). This suggests that when firms report information on sustainability, this helps improve their reputation, which will in turn be attractive to stakeholders

(Uwuigbe et al., 2018). This attraction can set in motion an influx of providers of capital, highly qualified workforce and more consumers, which will inherently lead to greater firm performance (Uwuigbe et al., 2018). This supposition is appropriate in this study, as carbon emissions reporting is done to show how companies impact society and plan to rehabilitate natural elements and create value (Ngcobo, 2020; Deegan, 2019b).

2.2.3 Slack resources theory

Firms are encapsulated in the middle of associations with external and internal stakeholders, who can impact or are impacted by the firm achieving its objectives (Xiao et al., 2018). Firms place reliance on their stakeholders, such as employees, suppliers, customers, investors and the public, for resources which are pivotal for competitive edge and survival (Xiao et al., 2018). Slack resources consist of managerial, technical, and financial resources that firms can utilise voluntarily (Xiao et al., 2018). The availability of slack resources shows an array of resources that a firm can use to solve problems and/or make possible the fulfilment of strategic goals (Xiao et al., 2018; Uwuigbe et al., 2018). Slack resources can assist firms meet their goals (Uwuigbe et al., 2018). Firms continually reallocate resources and/or activities around their boundaries in order to enhance firm performance (Munjal et al., 2019). Firm managers are encouraged to consistently check the resources of the firm, especially slack resources, to ensure that they utilise available resources to improve the performance of the firm (Munjal et al., 2019).

The slack resource theory argues that greater financial performance has the potential of resulting in slack resources being available (slack being financial and other resources) that grant a firm the opportunity to invest in corporate social responsibility activities (Waddock & Graves, 1997; Uwuigbe et al., 2018). Firms can acquire and manage slack resources in the form of experienced management and technical personnel, advanced technologies, and financial resources (Xiao et al., 2018). Islam et al. (2021) and Uwuigbe et al. (2018) note that slack in "slack resources" is a shield of resources that firms can use to address threats and utilise opportunities. A firm may have a lot of slack resources but the most discretionary form of slack resources are the financial resources (Islam et al., 2021). Slack resources have the potential of easing limitations and improving strategic plans for firm activities, and the resources that are freely available provide a shield against threats and flexibility to overcome barriers (Sun et al., 2020; Xiao et al., 2018). Greater levels of profitability are generally seen as indicator of slack resources (Xiao et al., 2018).

Slack resource theory states that slack resources are in essence an outcome of greater financial performance and these resources warrant firms to participate in social programs (Islam et al., 2021). This theory foretells that firms with an abundance of resources have a better motivation to invest in social causes as these resources furnish a firm with opportunities to function and compete with efficiency (Islam et al., 2021; Xiao et al., 2018). When firms have considerable amounts of resources accumulated, they can afford to implement new strategies using trial and error (Xiao et al., 2018). Islam et al. (2021) and Xiao et al. (2018) note that firms with abundant resources are not concerned about making difficult trade-offs as those firms with limited resources. The availability of slack resources can make it easier for firms to engage in sustainability (Xiao et al., 2018). This theory is relevant, as a firm's performance will influence the availability or lack of availability of slack resources, which will in turn impact carbon emissions and the CoC (Xiao et al., 2018).

2.2.4 Voluntary disclosure theory

Voluntary disclosure theory is rooted in the financial disclosure literature, and it focuses on the role of financial reporting (Guidry & Patten, 2012). Disclosures that are voluntary are perceived to enhance analysts' understanding of firms prospects by providing added information (Beyer et al., 2010). Thus, disclosures should contain all the information required by investors (Beyer et al., 2010). In this context, voluntary means that firms use their own discretion to prepare and produce additional reports (Ngcobo, 2020). Voluntary reporting happens when firms provide additional information to all relevant stakeholders to facilitate their decision-making (Ngcobo, 2020). The objective of voluntary reporting is to safeguard against skewness between management and capital contributors by providing pertinent details relating to the long term sustainability of the reporting firm (Ngcobo, 2020). Greater performing firms hold and report voluntary pertinent details as compared to poor performing firms, which helps various stakeholders in their decision-making (Garzón-Jiménez & Zorio-Grima, 2021). Reporting firms are advised to make such information available to avoid possible assumptions being made by the capital contributors or other stakeholders that the firm has something negative to hide (Schiller & Lundh, 2013).

Some studies have shown that carbon disclosures have a negative influence on the CoC, and this has been found to be in line with voluntary disclosure theory (Li et al., 2019). The capital contributors expect risk and return, and liquidity of the shares impact the association between the

CoC and the information reported (Li et al., 2019). The greater the liquidity of shares and the lower the expected risks, the lesser the CoC; this link applies to financial and non-financial details (Li et al., 2019). Most capital contributors are highly likely to provide financial resources to firms with transparent disclosures and lower risk expectation (Li et al., 2019). The increased levels of disclosures by good performing firms can be explained by the voluntary disclosure theory as an effort to differentiate themselves from other firms, and signalling their good performance (Mahmood et al., 2017). The escalating requests for disclosures of non-financial information and the motion for sustainable practices, are all bringing firms to the awareness of making their operations sustainable and better their performance (Uwuigbe et al., 2018). Voluntary disclosures are not without costs, as these disclosures can reveal pertinent information about the firm that the firm would otherwise not opt to reveal to consumers, suppliers, competitors, and new entrants (Enache & Hussainey, 2020).

Firms need to consider reporting greater carbon emissions details, amplifying the communication impact with providers of capital, lowering the uncertainty of decisions related to investments, and circumventing unfavourable selection by the said capital contributors (Li et al., 2019; Garzón-Jiménez & Zorio-Grima, 2021). Carbon emissions disclosures assist capital contributors to be in the know about a firm's carbon emissions and give crucial information for decision-making (Garzón-Jiménez & Zorio-Grima, 2021). Carbon disclosures assist in reducing the perceived risk of a firm and circumventing negative outlooks of the firm by market participants (Garzón-Jiménez & Zorio-Grima, 2021). Market participants stand to gain when firms provide clear and sufficient pertinent details to evaluate the firm's current and future performance (Enache & Hussainey, 2020). Previous empirical and theoretical literature indicate that voluntary disclosures decrease the CoC, improve firm performance and liquidity of shares, and decrease information skewness (Enache & Hussainey, 2020). This theory was pertinent to the study as carbon emissions disclosures will influence both firm effectiveness and the CoC (Li et al., 2019; Garzón-Jiménez & Zorio-Grima, 2021).

2.3 Empirical Literature

For accelerating understanding of the variables used in this study, it is also imperative to recognise past studies that form a foundation for this study. This section looks at past studies on the CoC, firm performance, carbon emissions, the association of firm performance and the CoC, the relationship between carbon emissions and the CoC, and the integration of firm performance and carbon emissions.

2.3.1 Cost of Capital (CoC)

The CoC is the anticipated yield on investment that economic agents need to allure financial resources to a certain investment (Pratt & Grabowski, 2008; Berry-Stölzle & Xu, 2018). Shareholder value is created when firms make investments in which the returns are greater than the CoC for such investments (Pratt & Grabowski, 2008; Berry-Stölzle & Xu, 2018). The CoC represents shareholders' suppositions, the expectation of obtaining an amount in exchange for letting firms use their money and the riskiness of how much and when money will be received (Pratt & Grabowski, 2008; Berry-Stölzle & Xu, 2018). The CoC is not determined by book value but by market value (Pratt & Grabowski, 2008).

The CoC is influenced by equity capital and debt capital (Botosan, 2006). The equity capital is the most sensitive form of capital as it can be affected by certain disclosures made by companies, and these can contribute to a reduction or an elevation in CoC (Botosan, 2006; Berry-Stölzle & Xu, 2018). The CoC is impacted by numerous factors, for instance inflation, market conditions, interest rates, credit ratings, and financial leverage (Khatib et al., 2023). The focal point of this study was the equity element of CoC, as this element gets a lot of attention in written works (Botosan, 2006). Based on the above, below are the key justifications for using the cost of equity (Ke):

- Focus on capital contributors – Ke represents the anticipated return required by capital contributors, which is the primary concern in this study with one of the objectives being to analyse the effect of firm performance. As such, the use of Ke provides a more direct measure of the returns expected by the capital contributors. Carbon emissions may have a direct impact on capital contributor's perception of risk and return, which means that the capital contributors will need a greater return for their investments in higher carbon risk firms (Kim et al., 2015). Ke directly reflects the increased risk, making it a suitable

measure when examining the impact of carbon emissions on the cost of capital. Furthermore, capital contributors are more sensitive to ESG risks, thus focusing on Ke allows the study to capture these dynamics better.

- Complexity of debt costs – Estimating the cost of debt and/or weighted average cost of capital (WACC) introduces complexity as the cost of debt requires market-based information which is not always available and debt financing is subject to high levels of volatility. Furthermore, mining firms have complex and variable debt structures which are influenced by a range of factors such as geopolitical risks, carbon taxes and commodity price volatility which make estimating debt costs accurately very challenging and could introduce errors and/or inconsistencies in the analysis (Myers & Majluf, 1984). It is for this reason that focusing on Ke would provide a more reliable measure for this study.

2.3.2 Firm Performance

A lot of firms seek to enhance their performance, and firms who win are those who dare to be innovative, to acquire and maintain performance (Taouab & Issor, 2019). Evaluating and measuring firm performance in current economic conditions is crucial to scholars and firm stakeholders, and there is insufficient literature on the matters of firm performance (Taouab & Issor, 2019). Performance of firms quickly became a notion in research for strategic management and is used as a response variable (Taouab & Issor, 2019).

In the 1950s, performance of a firm was noted as the counterpart of firm productivity, that constitutes the measure to which a firm accomplishes its objectives with limited resources and minor effort (Taouab & Issor, 2019). In the 1960s and 1970s, firms explored different ways to measure performance; performance was then explained as a firm's ability to capitalise on its environment for obtaining and utilising limited resources (Taouab & Issor, 2019). In the twentieth century, firm performance was then defined as an integration of financial and non-financial assessments that yield aboveboard information of achieving goals and outcomes (Taouab & Issor, 2019). A firm is advised to advance practices that are sustainable because of the foreseen advantages to the firm's small and massive economic performance (Jan et al., 2021). Small performance consists of social justice and environmental protection, while massive performance consists of financial benefits in the short-term (Jan et al., 2021). Adopting sustainable practices

might see the firm realising financial benefits in the short term, while enhancing their performance in the long term (Jan et al., 2021).

There is an imperative disjuncture between what companies do (production and sale of services or goods) and what scholars look at and/or what they can look at (Siepel & Dejardin, 2020). Firm performance indicators scholars look at may be completely different from those that are important to the company, and these do not look the same under various measures (Siepel & Dejardin, 2020). The various firm performance measures show an association but the association is not strong, financial indicators can show good firm performance while non-financial indicators show poor firm performance (Siepel & Dejardin, 2020). It is for this reason that it is imperative to highlight that what scholars capture may not certainly be a total frame of the company; it may be a snapshot (Siepel & Dejardin, 2020).

The main reason for existence of a firm is profit maximisation to influence capital contributors to invest in the firm as it appears to be worth investing in; such returns seek to better investors' wealth, which can be seen through dividend payments which increase the market price of the shares (Ngwakwe & Msweli, 2013). Dividends paid out by firms to providers of capital increase their liquid capital and creates opportunity for them to re-invest the money in the firm or invest in more profitable firms or diversify their investments (Ngwakwe & Msweli, 2013). The payment of dividends by a firm communicates to the current and future capital contributors that the performance of the firm is great and that they will get return on their investment (Ngwakwe & Msweli, 2013; Dao & Phan, 2023).

There are many widely used measures for performance of a firm such as employment, turnover, profitability, productivity, innovation, and firm survival (Siepel & Dejardin, 2020). Firm performance can also be represented by yield on equity, yield on assets, and Tobin's q (Dao & Phan, 2023). A company's capability to create major profits may be a clear indication of how well the firm is performing (Siepel & Dejardin, 2020). A firm that is performing well can show great and longer term profits, a firm's financial profitability will improve returns for its stakeholders (Taouab & Issor, 2019).

There are various ways of calculating profitability, ranging from measures reported in the financial statements to financial ratios that can be independently computed (Siepel & Dejardin, 2020). Firm financial performance is a non-objective measuring unit of how a firm uses its total assets to create

profits and maximise the wealth of capital contributors in its daily operations (Secinaro et al., 2020). Economic performance is also used as a unit for assessing a firm's economic viability in a financial year (Secinaro et al., 2020). Analysts, providers of capital, and managers use financial ratios to elucidate financial performance as the most successful decision-making tools (Delen et al., 2013). Financial ratios are categorised into various categories such as profitability, liquidity, solvency, turnover, and asset turnover (Secinaro et al., 2020).

2.3.3 Carbon Emissions

In the last few years, there has been an exponential increase in the recognition about the prospective risks of climate change (Khatib et al., 2023; Garzón-Jiménez & Zorio-Grima, 2021). The part of greenhouse fumes, chiefly carbon emissions, grew into a crucial topic. The increasing significance of firm sustainability has captivated attention from investors and other stakeholders (Sabirali & Mahalakshmi, 2023). Investors who invest for the long run make sustainability practices a priority as opposed to short-term shareholders who do not, as they believe that firms with great ESG performance surpass the market (Sabirali & Mahalakshmi, 2023). Sustainability reports and carbon reporting are crucial tools used by firms to communicate their environmental impact and sustainability efforts; as a result, firms that produce sustainability reports show reduced carbon emissions (Sabirali and Mahalakshmi, 2023).

Carbon disclosures are an important aspect of the firm's environmental approach as they indicate the firm's part in climate change (Khatib et al., 2023). Disclosing carbon emissions has a beneficial and significant effect on a firm's accomplishments (Khatib et al., 2023). There is substantial evidence that disclosing carbon credits gives a firm an opportunity to evade penalties that capital markets impose dependent on the magnitude of carbon emissions and the denial to disclose carbon emissions statistics (Khatib et al., 2023). Climate change-related risks increase a firm's comprehensive exposure and the CoC, which means that the capital contributors will need a greater return for their investments in higher carbon risk firms (Kim et al., 2015).

Khatib et al. (2023) noted that previous studies show that investors have a tendency to devalue firms that are extremely carbon intensive. Furthermore, there are indirect regulatory costs that can impact the correlation between sustainability and firm economic performance (Khatib et al., 2023). Firms with better environmental performance could circumvent high financial risks emanating from direct and indirect costs, such as costs for reducing carbon emissions, and for expanding regulatory intervention and damage to a firm's reputation (Khatib et al., 2023). Considering the

above and the expanding exposure of a firm to climate change risks, this correlation is becoming more crucial (Khatib et al., 2023). A study was conducted by Garzón-Jiménez and Zorio-Grima (2021) to analyse the impact of carbon emissions, ethical business practice assurance, and environmental disclosures on the cost of equity in developing markets. It was noted that corporate social responsibility scores, carbon emissions and disclosure scores, and environmental disclosures were evidenced as measures that decrease cost of equity capital.

Under the Greenhouse Gas Protocol, greenhouse gas emissions are grouped into three scopes. Where Scope 1 pertains to direct greenhouse gas emissions which are emitted directly by firms through their activities (Ngwakwe & Msweli, 2013), Scope 2 is electricity indirect emissions which are greenhouse emissions that are caused by usage of electricity purchased (Ngwakwe & Msweli, 2013). Scope 3 is all other indirect greenhouse gas emissions which are emissions arising from firms' usage of outsourced goods, material and/or services (Ngwakwe & Msweli, 2013). These classifications allow firms to report their carbon footprint and to participate in the reduction of carbon emissions along the various scopes in their operations (Ngwakwe & Msweli, 2013).

2.3.4 The Link Connecting Firm Performance and Cost of Capital (CoC)

The link connecting firm performance and the CoC is a compound and robust feature of financial management (Sabirali & Mahalakshmi, 2023). A firm's management is perceived to be more knowledgeable about the firm's performance and value than prospective investors, the latter analyse the firm's activities rationally (Myers & Majluf, 1984). Firms with greater performance are more inclined to have lower CoC than those with poor performance (Myers & Majluf, 1984, Drobetz et al., 2018).

Information failure (information asymmetry) between management of firms and shareholders can have an effect on firm effectiveness as well as on the CoC (Verrecchia, 2001; Li et al., 2019). The capital contributors are of the assumption that firms' limited carbon information disclosed have greater information skewness (Li et al., 2017). Clarity and functional communication can result to a lesser CoC (Verrecchia, 2001). Firms that provide annual reports that limit middleman costs (agency costs) and information failure have greater access to financial resources (Cheng et al., 2014). This is attributable to shareholders' eagerness to provide financial resources for investment projects considered to have great growth prospects at nominal risk (Cheng et al., 2014). These

annual reports ought to provide pertinent financial information relating to historic, current, and future financial performance of the firm (Cheng et al., 2014).

Market conditions, industry trends and economic factors can influence the CoC (Fama & French, 1992; Drobetz et al., 2018). Firms that operate in favourable conditions tend to experience a lower CoC (Fama & French, 1992; Drobetz et al., 2018). Belkhir et al. (2020) did a study that evaluated the correlation between shares with low liquidity and the CoC. The results showed that firms with shares that have high prospects for low liquidity were hurt by higher CoC (Belkhir et al., 2020). The results further showed that this relation is impenetrable in times of low markets and great volatility, whilst it is penetrable in conditions with good information quality and impenetrable shareholder protection (Belkhir et al., 2020).

Drobetz et al. (2018) did a study to investigate the effect of economic policy uncertainty on the link connecting the CoC and investment. The study found that the firmness of the negative correlation among the CoC and investment decreases during periods of greater economic policy uncertainty (Drobetz et al., 2018). Uncertainty affects investment dynamics, economic growth, and equity prices and premiums (Drobetz et al., 2018; Li et al., 2014; Trinks et al., 2022a). Drobetz et al. (2018) also found that financial policies in effect in firms, such as dividend policies and capital structure resolutions, can have an impact on firm performance as well as the CoC.

Firm performance with limited financial capital can be magnified by a moderate investment in numerous post-production activities (Khatib et al., 2023). Newly established firms have an impenetrable association between their returns and a firm's performance because they are the sizeable investors (Khatib et al., 2023).

2.3.5 The Link Connecting Carbon Emissions and Cost of Capital (CoC)

The market inflicts a penalty on firms for greater carbon emissions because of climate risks and the likelihood of not being able to act in accordance with regulations, which can impact the firm's earnings in the future (Khatib et al., 2023; Bui et al., 2020). Furthermore, shareholders may be convinced that a firm can obtain an edge over its competitors by lowering carbon emissions (Khatib et al., 2023). A firm can gain a competitive edge when it utilises environmentally sustainable operations that are of high value, rare, complex to duplicate, and do not have replacements (Khatib et al., 2023). A firm's sustainability has a positive relationship with its financial health/performance (Trinks et al., 2022a). Firms' carbon performance influences the

valuation of the firms; better carbon disclosures increase firms' market valuation (Bui et al., 2020). Thus, firms with greater carbon emissions may not be considered as having environmentally sustainable procedures, which may decrease shareholders' presumptions of the firm's earnings in the future (Khatib et al., 2023).

Shareholders consider the impact of carbon disclosures and carbon emissions when assessing the riskiness of firms (Bui et al., 2020). Bui et al. (2020) did a study that extends literature on the impact of firms' carbon disclosures in reducing the CoC. The study found that firms with greater emissions receive a penalty of an additional premium on the CoC equity element (Bui et al., 2020; Li et al., 2014; Trinks et al., 2022a; Garzón-Jiménez & Zorio-Grima, 2021). Firms with risk averse environmental management plan of action attract lower CoC and less costly debt, which is attributable to the reduced perilousness of penalties related to the environment (Bui et al., 2020; Li et al., 2014). Firms with greater toxic carbon emissions have remarkably greater CoC than those with lesser carbon emissions (Bui et al., 2020; Garzón-Jiménez & Zorio-Grima, 2021). A study done on companies whose operations are under the European Union Emission Trading Scheme found that valuation of firms is not linked with total carbon emission liability and, in sharp contrast it is negatively linked with the deficiency of a firm's carbon emissions that are greater than the firm's free allowance and valuation of the firm, thus confirming that companies with a dynamic environmental plan, such as carbon emissions reduction, could achieve a competitive edge and thus improve financial performance (Bui et al., 2020; Li et al., 2014). Firms that reduce their carbon footprint by engaging in sustainable activities might be rewarded in capital markets through a decreased discount rate that capital contributors relate to a firm's liquidity streams (in other words, through a decrease of the CoC) (Trinks et al., 2022a; Garzón-Jiménez & Zorio-Grima, 2021).

Many studies (e.g. Li et al., 2014; Trinks et al., 2022a; Garzón-Jiménez & Zorio-Grima, 2021; Khatib et al., 2023; Bui et al., 2020) show a link between firms' carbon emissions and the CoC. The link can be theorised from two perspectives, namely ethical investing theory and market equilibrium theory (Bui et al., 2020). Ethical investing theory shows firms and investors screening investments that meet the responsible corporate behaviour definition (Bui et al., 2020). Market equilibrium theory suggests that companies could increase their shareholder base by going after more initiatives that are environmentally focused (Bui et al., 2020). When risk-sharing is improved and shareholder base is expanded, this arguably translates to a decreased cost of capital (Bui et al.,

2020). According to findings of the study by Bui et al. (2020), companies that engage in environmental initiatives can entice more investors who could supply cheaper capital. Firms that are considered to be committing environmental misconduct could attract penalties, which could cause disruptions to cash flows and affect the firm's ability to honour debt agreements negatively, which will likely raise the premium that capital contributors would request from the company (Bui et al., 2020; Li et al., 2014; Trinks et al., 2022a).

Agency theory puts forward that information asymmetry between agents and principals brings about conflict which leads to greater perceived risk by investors (principals). The more detail the firm provides, the less riskier it is perceived (Bui et al., 2020, Li et al., 2019). The carbon emissions reduction strategy is a sign that can indicate information skewness between managers of firms and the capital contributors regarding carbon emissions (Li et al., 2014; Trinks et al., 2022a). Companies with better carbon disclosures are more likely to decrease information skewness by making more information available to providers of capital. This attracts beneficial investments and reduces the CoC (Bui et al., 2020, Li et al., 2014; Garzón-Jiménez & Zorio-Grima, 2021; Enache & Hussainey, 2020). A study conducted by Garzón-Jiménez and Zorio-Grima (2021) to evaluate the link connecting carbon emissions and other factors on the CoC showed that assurance on sustainability disclosures reduces information skewness and increases legitimacy, in the form of decreasing the CoC (Garzón-Jiménez & Zorio-Grima, 2021).

A study was conducted by Li et al. (2014) to examine the effect of reducing carbon emissions on the CoC and the link connecting the firms' carbon emission intensity and the CoC. The findings showed that the CoC increases for emissions-liable firms, while little proof validates the emission intensity impact on the CoC (Li et al., 2014). This is deemed noteworthy because these results provide proof that carbon emissions, a non-financial performance unit of measurement, are echoed in the CoC (Li et al., 2014; Li et al., 2019). Carbon emissions disclosed is influential in aiding firms evaluate risks and seize opportunities caused by climate change, and voluntary disclosure is also a reliable platform for managers to provide such pertinent information to capital contributors and other stakeholders (Li et al., 2017). Transparent information provided by firms to stakeholders can improve a firm's financial efficiency and liquidity, as well as provide better decision-making basis for different investors (Li et al., 2017).

As there exists a perceived connection among carbon emissions and the CoC, managers of firms might withhold some disclosures relating to carbon emissions to prevent outsiders from identifying

the firm as risky (Li et al., 2014; Li et al., 2019). It is for this reason that the capital contributors and/or financial institutions might incur extra charges and risks when providing financial resources to these firms (Li et al., 2014). Trinks et al. (2022a) conducted a study that evaluated the extent to which financial market capital contributors demand a premium for investing in high carbon emitting firms, which inversely affects the CoC by raising the cost of equity. Findings indicate that the CoC (equity element) premium for carbon intensity is more visible in cases where carbon risk poses a major risk, such as in high carbon emitting industries (Trinks et al., 2022a). This shows chief effects of firm level carbon intensity on pricing of equity and risk of the firm (Trinks et al., 2022a).

Quality information disclosed by listed firms became one of the weight measures of the cost of equity capital (Li et al., 2017). Quality information disclosed in relation to carbon emissions enhances awareness of the firm by providers of capital, decreases information skewness, betters the degree of investment risk sharing, and decreases the CoC (equity element) (Li et al., 2017). Li et al. (2017) conducted a study with a hypothesis that there is a non-positive link among carbon information disclosed and the CoC on the base that non-financial information by capital contributors preference has a positive impact on capital costs, capital contributors provide their preference on firms with greater environmental responsibility, which will reduce information skewness between capital contributors and firms, decrease expected risk and return, and so decrease the CoC. Findings of the study indicate that carbon data disclosed has a negative association with the CoC, which means that carbon data disclosed can decrease the cost of equity capital (Li et al., 2017).

2.3.6 The Integration of Firm Performance and Carbon Emissions

A firm's comprehensive success is normally assessed by its financial performance, which shows its well-being with respect to maximisation of returns, investor's wealth, and stake in the market (Sabirali & Mahalakshmi, 2023). The sustainability of firms goes above monetary goals, highlighting a firm's participation in economic development, social parity, and protection of the environment (Sabirali & Mahalakshmi, 2023). The influence of a firm's capacity to manage carbon costs on the link between economic performance and carbon emissions within the European Union Emission Trading Scheme indicates that better carbon emission performance seldom leads to financial well-being, but instead, lesser levels of carbon emissions are at most compensated if a company is unable to transfer carbon expenses to customers because of industry traits or firm-

specific carbon efficiencies (Khatib et al., 2023). When managers of firms react to carbon emissions emitted by the said firms, their overall response can influence carbon emissions and firm effectiveness (Houqe et al., 2022). As carbon emissions rise, a firm's value can diminish, and the market tends to penalise those with high carbon outputs (Houqe et al., 2022).

Many researchers have found a pivotal association between firm sustainability practices and financial performance, in particular regarding asset return and equity return alongside earnings per share (Sabirali & Mahalakshmi, 2023; Ganda & Milondzo, 2018). They discovered that firm sustainability has a positive impact on market-based performance (Tobin's Q and market capitalisation) whilst it did not yield beneficial results on accounting-based metrices (asset and equity return) as a result of extra costs associated with sustainability (Sabirali & Mahalakshmi, 2023). Many studies show that better ESG performance enhances economic performance (Sabirali & Mahalakshmi, 2023; Ganda & Milondzo, 2018). Some researchers found a neutral relationship, while others found a negative correlation between sustainability practices and economic performance, which shows that the influence of ESG on firm performance differs across sectors and geographical locations (Sabirali & Mahalakshmi, 2023). There is great emphasis on the need for firms to embrace environmentally sustainable activities to achieve greater financial performance, thus increasing firm effectiveness (Khatib et al., 2023; Ganda and Milondzo, 2018).

Khatib et al. (2023) conducted a study assessing how management environmental training took part in a role in carbon emission reports and leading to greater firm performance. The study expands resource-based view theory by showing how management environmental training is able to act as a high value resource that allows firms to effectively handle their carbon emissions, thus improving the firm's financial performance (Khatib et al., 2023; Gallego-Álvarez et al., 2015). Carbon emissions are one of the crucial measures of a firm's environmental performance (Khatib et al., 2023; Gallego-Álvarez et al., 2015). A firm's success depends on its chief resources, which can be both physical and intangible assets, and firms can utilise unique, precious, and non-replaceable capital to create firm value and better performance to gain an edge over competitors (Khatib et al., 2023; Gallego-Álvarez et al., 2015). Firms with greater carbon emissions are exposed to lower firm effectiveness owing to the negative response from the market (Houqe et al., 2022; Ganda & Milondzo, 2018). Negative responses from the market cause greater agency costs, which then increases the negative effect of greater carbon emissions on the performance of the firm (Houqe et al., 2022). Agency expenses, in the company's carbon emissions, can impact the

firm's economic performance (Houqe et al., 2022).

As a result of the severe impact of climate change that pose a risk to human survival and firms, carbon emissions disclosures have become an increasingly crucial consideration across the globe (Khatib et al., 2023; Gallego-Álvarez et al., 2015). In addition, firms are expected to show impenetrable environmental performance, which cogitate firms' authentic attempts to reduce carbon emissions and hold up high environmental sustainability (Khatib et al., 2023; Gallego-Álvarez et al., 2015). Khatib et al. (2023) conducted a study with a hypothesis that carbon emissions bring to bear a great impact on the firm's economic performance. Their assessment found a statistically significant favourable effect of carbon emissions disclosure on the firm's financial performance. Carbon emissions reporting enhances a firm's profitability (Khatib et al., 2023). Trinks et al. (2020) performed an investigation to explore the effect of carbon efficiency on economic performance. The results showed that there is superior financial performance in firms with greater carbon efficiency (Trinks et al., 2020). Furthermore, a study conducted by Houqe et al. (2022) evaluating the influence of agency expenses and carbon emissions on firm effectiveness, showed that firms with greater carbon emissions have decreased economic performance, and that greater agency expenses amplify this influence of carbon emissions on the performance of the firm (Houqe et al., 2022). Reducing carbon emissions can help improve market competitiveness of firms and increase profitability (firm performance) (Houqe et al., 2022).

Gallego-Álvarez et al. (2015) examined the influence of the variation in carbon emissions on operational and economic performance. Findings of the study showed a reduction in carbon emissions, which results in a favourable impact on economic performance. Therefore, firms promote better environmental behaviour to gain greater economic performance, though no evidence was shown for operational performance (Gallego-Álvarez et al., 2015). Similarly, a study was conducted by Ferrat (2021) examining the impact of carbon emissions on corporate economic performance, and it showed that carbon emission performance negatively affected short-term financial performance. Miah et al. (2021) did a study to implore the effects of carbon emissions on market and accounting-based performance of both financial and non-financial companies in uprising markets. The results showed that non-financial firms emit more carbon emissions than their counterparts, and carbon emissions decrease the return in equity of firms, Tobin's q, credit rating, and z-score (Miah et al., 2021). Firms' financial performance when improved by implementing carbon reduction plans can positively impact the return on assets, thus enhancing

the value of the firm (Yu et al., 2022; Houqe et al., 2022).

Given greater carbon emission levels, research on the link among carbon emissions and firm effectiveness from a social and economic perspective (to evaluate conduct of firms) is crucial (Ganda & Milondzo, 2018). As firm performance is influenced negatively by carbon emissions, firms should aim to reduce carbon emissions from their operations as this will reduce environmental damage (Ganda & Milondzo, 2018). Studies have shown that firms that reduce their carbon emissions effects through integrating green investment drives are more likely to better manage firm performance (Ganda & Milondzo, 2018).

2.4 Summary

Based on the literature evaluated, the greater the slack resources a firm has, the greater its performance. Furthermore, such a firm is highly likely to provide more carbon disclosures and commit to the reduction of carbon emissions in their operations. Stakeholder theory, legitimacy theory, and voluntary disclosure theory support a firm's strategy of providing carbon disclosures to prevent a negative outlook of the firm by capital contributors and market participants and give the firm a competitive edge. These theories will all help achieve the objectives of the study. The theories of slack resources and legitimacy augment each other (Uwuigbe et al., 2018). The legitimacy theory was the optimal choice for this context as it provides the theoretical foundation for firms, proving discretionary disclosures. This theory was appropriate for this research as it helped establish whether carbon emission disclosures reflect and deliver to various stakeholders an overall picture of the firm's performance and legitimacy through the provision of non-financial information on top of the financial information. This will assist in determining the influence of carbon emissions and firm effectiveness on the CoC.

The link connecting ethical business practices, financial effectiveness, and the CoC has been explored significantly in past and current literature. Nonetheless, there are varied findings on the impact of carbon emissions and firm performance on the CoC. The contrast in results in literature is as a result of various methodological aspects such as methodology used, period of the study, and the geographical location studied (Busch & Lewandowski, 2018). In addition, in the South African context there has not been research on whether factors such as corporate governance and financial structures in existence impact the link between voluntary disclosures and carbon risk for firms listed on the JSE. This study sought to ascertain how firm performance and carbon emissions influenced the CoC for the mining industry firms that are listed on the JSE. The following chapter focuses on methods of data collection, selection of samples and tools for analysis of data to assess the link connecting firm performance and carbon emissions on the CoC.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

The previous chapter put forward theoretical and empirical evidence underpinning this study. The aim of this chapter is to focus on the research methods and design followed in conducting the study. Research is a systematic investigation to acquire knowledge from facts that are already in existence (Kale & Jayanth, 2019). Business research is academic research tackled to reply to inquiries in relation to business and management field topics (Bell et al., 2022). The research process was made up of three tiers, namely putting forward a question for analysis, data collection to respond to the question, and then displaying the responses to the question (Abutabenjeh & Jaradat, 2018). Abutabenjeh and Jaradat (2018) define a research design as a blueprint to direct the research process by presenting how a study proceeds from the research objective/questions to the results. It is an all-inclusive planning technique utilised to collect and examine data to heighten comprehension of a presented topic (Abutabenjeh & Jaradat, 2018). Research methodology is defined as the steps that investigators utilise to collect data and analyse it (Abutabenjeh and Jaradat, 2018). The elements below constitute research methods:

a. Research paradigm,
b. Research approach,
c. Research design,
d. Collection of data, and
e. Tools for data analysis.

3.2 Research Paradigm

Kaushik and Walsh (2019) state that the term paradigm is employed to make reference to the philosophical suppositions or to the primary beliefs that direct the actions and interpret the worldview of the investigator. The worldview is explained as a method of thinking about and sense making of real world complexities (Kaushik & Walsh, 2019). In nature, paradigms are all philosophical and enclose the following prevalent components:

Axiology – axioms about the part that morals and values play in research;

Ontology – presumptions about the essence of reality;

Epistemology – presumptions about how the world is known, how we obtain knowledge, and the connection between the known and the knower;

Methodology – mutual comprehension of best techniques to gain knowledge about the world, and

Rhetoric – mutual comprehension of the research language (Kaushik & Walsh, 2019).

Paradigms are tools utilised to solve research issues, and each tool has a distinct outlook on the prevalent components discussed above (Kaushik & Walsh, 2019). To provide brief examples, on one hand, post positivism is frequently linked to quantitative methods and supreme rhetoric (Kaushik & Walsh, 2019, Park et al., 2020). On the other hand, constructivism is linked to qualitative methods and informal rhetoric (Kaushik & Walsh, 2019, Park et al., 2020). Post positivists try to work detached and objectively, while constructivists rely mostly on the views of their participants and work with them closely and subjectively (Kaushik & Walsh, 2019). Positivism is characterised as an epistemological stance that supports the employment of natural science tools to study social reality and beyond (Bell et al., 2022; Park et al., 2020). The epistemological strategy is to evaluate the economic theories by real world data collection, while the principles of post positivism challenge the researcher to be objective (Bell et al., 2022; Park et al., 2020), making it the most suitable for this study. This study sought to unearth how firm performance and carbon emissions impact the CoC.

3.3 Research Design

There are two types of methods that researchers use to extract and organise information from various sources, namely the qualitative approach and quantitative approach (Abutabenjeh & Jaradat, 2018). On one hand, the benefit of using the qualitative approach is that investigators gain deeper understanding of designing, carrying out, and explaining assessment and testing as well as inspecting participants' perceptions, feelings, behaviours, and comprehension (Rahman, 2016). On the other hand, the quantitative approach is less time consuming when it comes to data collection, as it does not involve evaluating participants' feelings and behaviours, and it is dominant in assessment research (Rahman, 2016). The qualitative method is researcher-dependent, while the quantitative approach is objective (Rahman, 2016). The quantitative approach is rooted in the

positivist paradigm which seeks to uncover patterns and behaviours using a systematic and predictable understanding (Park et al., 2020).

This study utilised the quantitative method. This was because the research questions required an interpretation of the existence of a relationship between the dependent and independent variables. This quantitative method was deemed more suitable as the study sought to use mathematical quantification, and arithmetical and statistical data analysis. Thus, the post positivist paradigm, which is well suited for quantitative research (Bell et al., 2022, Kaushik & Walsh, 2019; Park et al., 2020), was applied to the study.

3.4 Research population

A research population refers to a set of components with shared characteristics from which a sample is drawn for analysis (Bell et al., 2022). For this study, the population encompassed all firms that were listed on the JSE at the time of the study. These firms are required to compile and produce integrated reports which include environmental, social, and governance impact reporting. This means that common assumptions about voluntary disclosures do not apply.

The following factors were considered in defining the population for this study:

- Financial performance information is readily available for firms listed on the JSE;
- The biggest firms by market capitalisation on the JSE set market trends and are highly likely to produce voluntary carbon footprint disclosures, and
- Climate change is included in the JSE Sustainability Reporting Index analysis.

3.5 Research sample

This study was done on the firms in the mining industry listed on the JSE. As this sample is predetermined, it is referred to as quota sampling (Bell et al., 2022). Most studies have sampled economic sector listed firms, which affects direct comparison (Ngcobo, 2020). In South Africa, firms in the mining industry have a major impact on the Gross Domestic Product (GDP), and furthermore; they have the biggest pie in job creation and the industry is sensitive to climate change issues (social, environment, and ethical issues) (Ngcobo, 2020; Johnson, 2020). It is on this basis that this study focused on mining firms listed on the JSE which were 32 firms at the time of the study.

3.6 Model Specification and Variables

3.6.1 Data Sources

Secondary data were used in the study. Secondary data are data that are available to the public and are free from researcher bias (Bell et al., 2022). The information collected from the company websites are annual reports and ESG/sustainability reports. The reports of the selected firms were downloaded from the firms' individual websites. A summary of the variables used in this study and data sources is provided in Table 3.1 below.

Variables	**Concept**	**Source**
Carbon emissions intensity (CEI)	$(-1) * ln \frac{Scope\ 1\ and\ 2}{Total\ assets}$	ESG/Sustainability reports McGregor database (IRESS)
Return on Assets (ROA)	$\frac{Operating\ income}{Total\ assets}$	Integrated Reports McGregor database (IRESS)
Return on Equity (ROE)	$\frac{Net\ profit}{Shareholders\ equity}$	Integrated Reports McGregor database (IRESS)
Firm Size (Size)	$\ln Total\ assets$	Integrated Reports McGregor database (IRESS)
Leverage (Lev)	$\frac{Total\ debt}{Total\ assets}$	Integrated Reports McGregor database (IRESS)
Book to market ratio (BP)	$\frac{Market\ capitalisation}{Book\ value}$	Integrated Reports McGregor database (IRESS)
Market Beta (MB)	Beta factor	McGregor database (IRESS)
Cost of capital (equity element) (KE)	*"Risk free Rate of Return + Beta * (Market Rate of Return – Risk free Rate of Return)"*	Integrated Reports McGregor database (IRESS)

Table 3. 1 Description of Variables and Sources of Data

Source: Researcher's conceptualization

3.6.2 Model Specification

The study adapted the panel data regression model to evaluate the association between the input (independent) and output (dependent) variables similar to the studies by Dhaliwal et al. (2011) and Zhou et al. (2017). The study observed the firms in the mining industry listed on the JSE over a specified period, the model suitable to respond to the research questions is the panel linear regression model. The multifactorial equations were reverted to achieve the objectives of the study. The study covered mining industry listed firms over a period of five years (2018 to 2022). The panel regression model was guided by the objectives as noted in Chapter 1:

Objective 1: To examine the impact of carbon emissions on the cost of capital for the JSE listed firms. The following regression was estimated to test this objective:

$$KE_{it} = C + \beta_1 CEI_{it} + \beta_2 ROE_{it} + \beta_3 Size_{it} + \beta_4 Lev_{it} + \beta_5 BP_{it} + \beta_6 MB_{it} + \varepsilon_i \quad \ldots (1)$$

Objective 2: To analyse the effect of firm performance on the cost of capital for the JSE listed firms. The following regression was estimated to test this objective:

$$KE_{it} = C + \beta_1 ROA_{it} + \beta_2 Size_{it} + \beta_3 LEV_{it} + \beta_4 BP_{it} + \beta_5 MB_{it} + \varepsilon_{it} \quad \ldots\ldots\ldots\ldots (2)$$

where:

- KE – is the cost of capital (equity element);
- CEI – is the carbon emissions (scope 1 and scope 2) intensity;
- ROA – is the return on assets;
- ROE – is the return on equity;
- Size – is the firm size;
- LEV – is the financial leverage (debt-to-equity ratio);
- BP – is the book to market ratio, and
- MB – is the beta factor, which is the sensitivity of shares to market returns.

A brief description of the above variables is provided under 3.6.3 (Justification of Variables). The source data were collected and organised in a Microsoft Excel spreadsheet. Afterwards, a panel regression analysis was performed using EViews software package.

3.6.3 Justification of Variables

An independent variable (input variable) is an element that is utilised to establish the impact the element has on dependent variables (outcome variables) for the topics under review (Bell et al., 2022). In addition, when an input variable has been identified, it needs to be evaluated to ascertain whether it is the cause or consequence of outcome variables.

The following variables formed part of the regression analysis to examine the impact of carbon emissions on the CoC and the effect of firm performance on the CoC:

- Carbon emissions – independent variable;
- Firm performance – independent variable, and
- Cost of capital (equity element) (KE) – dependent variable.

Carbon emissions – Input variable (Objective 1)

One of the input variables in this study was carbon emissions. This variable displays the level of successfulness of the environmental strategies implemented by the firm throughout its economic chain. Some carbon emissions are unregulated pollutants, and as such, they are some of the top environmental issues that add to climate change (Delmas et al., 2015). Scope one (CE1) and Scope two (CE2) carbon emissions were utilised for the purpose of meeting Objective 1. Scope one (CE1) is the direct greenhouse gas emissions which are emitted directly by firms through their activities (Ngwakwe & Msweli, 2013). Scope two (CE2) is electricity indirect emissions which are greenhouse emissions that are caused by usage of electricity purchased (Ngwakwe & Msweli, 2013). Scope three (CE3) intensity carbon emissions relate to firms' indirect impact through the economic chain, and these were excluded from this study.

A firm's total sales was utilised to determine the carbon intensity because the comparative measure of carbon emissions to turnover allows for an accurate incorporation of size and growth effects (Busch et al., 2022). This allows for the justification of specific impacts to the same degree as acquisitions or action of outsourcing in addition to emission variations caused by various production changes and capacity in economic situations (Busch et al., 2022). The study used the inverse value of carbon intensity as per the idea of Busch et al. (2022), which that smaller carbon emission levels correspond to higher environmental performance. Higher carbon emission levels correlate to lower environmental performance (Busch et al., 2022).

Firm performance – Input variable (Objective 2)

Most quantitative research studies use market-based or accounting evaluation methods to ascertain firm performance (Busch et al., 2022; Trinks et al., 2020; Busch & Lewandowski, 2018; Delen et al., 2013; Khatib et al., 2023; Miah et al., 2021), and these evaluation methods provide similar results. In this study, firm performance was measured using a financial indicator, namely ROA and ROE. ROA is a performance indicator that considers turnover and expenses relative to a firm's total assets as a base; it is a short-term performance indicator (Delmas et al., 2015). On the contrary, ROE evaluates the capacity of the firm to generate returns (Tzouvanas, 2019). Investment opportunities are considered to be lucrative when they generate profits or provide steady income (Gupta et al., 2020; Karwowski, 2018). Using both the ROE and ROA assisted in contrasting the effect of firm performance on the KE and the firm's efficiency in creating earnings.

Cost of capital (equity element) (KE) – Output variable (Objective 1 and 2)

The KE is the anticipated return on investment that economic agents need to allure financial resources to a certain investment (Pratt & Grabowski, 2008; Berry-Stölzle & Xu, 2018). The CoC is a function of equity capital and debt capital (Botosan, 2006). The KE is the most sensitive form of capital as it can be affected by certain disclosures made by companies, which can lead to a lower or higher KE and is affected by the level of disclosure and risk (Botosan, 2006; Berry-Stölzle & Xu, 2018; Cordeiro da Cunha Araújo & André Veras Machado, 2018). The study focused on the KE as this element gets a lot of attention in written works (Botosan, 2006). The KE can be measured by various methods, and in this study the capital asset pricing model was used, a decision highly influenced by the supremacy of its employment in searches on the Bloomberg database, and that eighty percent of experts calculate the KE using the capital asset pricing model (Bancel & Mittoo, 2014). The capital asset pricing model can be used to measure the cost of equity capital to explore the impact of disclosures (Khlif et al., 2019). The cost of capital (equity element) was calculated using the following formula:

$$KE = R_f + \beta\,(R_m - R_f)$$

where:

- KE is the cost of equity;
- R_f is the return on investment with no risk;

- β is the beta factor, which is the sensitivity of shares to market returns, and
- R_m is the expected return on the market portfolio.

Control variables (Objective 1 and 2)

Extant studies have demonstrated that some variables have a correlation with the KE (Khlif et al., 2019). Thus, this study incorporated control variables in the model. Adapted from previous studies by Loohuis (2022), Dhaliwal et al. (2011), Vitolla et al. (2020), and Zhou et al. (2017), the control variables below were included in the model:

- Firm size (Size) – The size of the firm is presented by the discrepancies in total assets (Delmas et al., 2015), which implies that the size of the firm is reflected by the resources that the firm owns. The greater the size of the firm is an indication that the firm has a bigger asset base; the size of the firm is one of the crucial components that capital contributors look at when authoring investment resolutions (Hapsoro & Falih, 2020). There exists an inverse link between the KE and firm size (Botosan & Plumlee, 2005). This study employed the natural log of total assets as the firm size measure, similar to the study conducted by Dang et al. (2018).
- Leverage (LEV) – Financial leverage is the measure to which a firm utilises credit to fund its operations (Tzouvanas, 2019; Thaib & Dewantoro, 2017). Capital contributors utilise financial leverage to ascertain if the firm has adequate resources to settle its present debt as well as ascertain whether a firm can obtain monetary gains from its investments (Ganda & Milondzo, 2018). There is a negative correlation between firm performance and leverage (Busch et al., 2022).
- Book to market ratio (BP) – The book to market ratio contrasts a firm's book value to its market value (Chai et al., 2020; Cordeiro da Cunha Araújo & André Veras Machado, 2018). There is an inverse link between market to book value and the CoC (Drobetz et al., 2018).
- Market Beta (MB) – The beta factor being the sensitivity of shares to market returns (Khlif et al., 2019). The beta factor has an impact on the KE in the CAPM model hence it has been included as a control variable in this study (Khlif et al., 2019).

3.7 Estimation Procedure

3.7.1 Data Preparation

The data employed in this study for analysis and presentation were obtained from different sources and collated in a spreadsheet on Microsoft excel. A list of the mining firms listed on the JSE was obtained and the names of the companies were documented on the spreadsheet, a total of 32 firms were documented on the spreadsheet. The ESG/Sustainability reports and Integrated reports for the period 2018 to 2022 were downloaded from the firms' websites and were perused for the carbon emissions (scope 1 and 2) figures, and these were recorded on the spreadsheet. The data for firm performance (ROA and ROE), firm size, leverage, book to market ratio, beta factor, and KE for the period 2018 to 2022 were obtained from the McGregor database (IRESS) and documented in the spreadsheet. The spreadsheet was thoroughly checked for any missing or duplicate information (3 firms had data for 1 year missing, 1 firm had duplicate information and a total of 13 firms had various data for various years missing). After this exercise, a total of 15 firms remained. There were 75 observations for final analysis. Afterwards, the Microsoft excel spreadsheet was imported into EViews, the statistical software employed in this study.

3.7.2 Regression method

The EViews software package provides a variety of equation estimation methods which can be employed. The LS-Least Squares (LS and AR) has three specifications for cross-section which are none, fixed, and random. For this study, regression tests were run on both the random effects and fixed effects specifications, with the aim of selecting the most appropriate model. The fixed effects specification model holds constant the time variant factors that could impact the analysis of the correlation between the output and the input variables (Androniceanu & Georgescu, 2023; Islam & Toor, 2019; Lopes, 2021; Olanrewaju et al., 2019; Sani et al., 2023; Zulfikar & STp, 2018). On the other hand, the random effects specification model deliberately includes the time variant factors as explanatory variables, as it states that other factors, which are random, may have an effect on the output variable (Androniceanu & Georgescu, 2023; Islam & Toor, 2019; Lopes, 2021; Olanrewaju et al., 2019; Sani et al., 2023; Zulfikar & STp, 2018). The Hausman test was run as the test aids in the selection of the appropriate regression model between the random effects model and the fixed effects model (Androniceanu & Georgescu, 2023; Islam & Toor, 2019; Lopes, 2021; Olanrewaju et al., 2019; Sani et al., 2023; Zulfikar & STp, 2018). The decision between the random

effects model and the fixed effects model was crucial to this study owing to the fact that the output variable could be influenced by the time variant factors. The results of the Hausman test run in this study are presented in the next chapter.

3.7.3 Diagnostic Analysis

Prior to the analysis of the regression model results, the model was evaluated for statistical significance using the unit root analysis. This is a statistical tool employed to confirm whether time series data contains a unit root, which helps identify if a time series is stationary or displays patterns that make it non-stationary (Trinks et al., 2020; Levin et al., 2002). The Levin-Lin-Chu panel unit root test includes a null and an alternative hypothesis (Levin et al., 2002). The null hypothesis states that panel data are non-stationary, while the alternative hypothesis states that panel data are stationary (Levin et al., 2002). If the p-value is less than 0.05, then the data are stationary, making it appropriate for the purposes of the study. Furthermore, the model was evaluated for statistical significance using the multicollinearity test as the model employed the multilinear regression analysis. If the centred variance inflation factors (VIF) is less than 10, then no multicollinearity exists between the input variables (Shrestha, 2020). The results of the diagnostic tests run in this study are presented in the next chapter.

3.8 Data Presentation and Analysis Plan

The impact of carbon emissions and firm performance on the CoC was analysed using panel data. This type of data is the most dynamic analytical model as it utilises section units (firms) over time periods (Hsiao, 2022). EViews 13 statistical software package was utilised to run all analysis, regression, and tests for the study. The results are presented in tables and graphs.

3.9 Data Validity and Reliability

The source data utilised in this study were determined as valid as they secondary data that were extracted from firms' official websites, and the Bloomberg and McGregor database. The researcher used audited annual financial statements and signed annual reports/sustainability reports. These ensured the validity of the data.

3.10 Ethical Considerations

The investigator received ethical clearance from UKZN prior to data collection. This endured that the study is ethically and responsibly undertaken. Furthermore, ethical clearance ensured that no harm was caused directly or indirectly to anyone.

3.11 Summary

This study followed a quantitative approach to respond to the research questions and as guided by the research objectives, a panel regression model was used. The chapter discussed the research design, population, sampling, and estimation procedures employed in analysing the data in this study. The input, output, and control variables were introduced and discussed, providing reasons for their inclusion in the study. The following chapter presents the analysis of data and results. The data are presented and analysed considering the research questions and objectives.

CHAPTER 4: DATA PRESENTATION AND ANALYSIS

4.1 Introduction

This study investigated the relationship between carbon emissions and the CoC as well as how firm performance affects the CoC. The particular focus was on the mining firms listed on the JSE. The first chapter introduced and gave a background to the study. The second chapter discussed relevant theoretical and empirical literature, noting the open question to which this study sought to respond to. The third chapter discussed the methodology and research design used to conduct the study. The aim of this chapter was to present an analysis of the data collected from mining firms' sustainability reports and the Bloomberg/McGregor database.

The analysis focused on identifying the link connecting carbon emissions and the CoC as well as how firm performance affects the CoC. The initial sample was all mining firms listed on the JSE, which totalled 32 firms, resulting in 160 firm-year observations. The observation period was from 2018 to 2022. However, because of exclusions of missing information within the dataset, the data were trimmed. Consequently, the analysis was based on 15 firms, providing 75 firm-year observations. The carbon emissions (scope 1 and 2) were obtained from individual firms' sustainability reports. This data, proxies for firm performance, firm size, and CoC were obtained from the McGregor database. As stated in the preceding chapter, the analysed data consisted of 6 variables, namely carbon emissions (scope 1 and 2), ROA, ROE, firm size, financial leverage, and book to market ratio.

The data were analysed and presented in line with the following study objectives:

- To examine the impact of carbon emissions on cost of capital for the JSE listed firms, and
- To analyse the effect of firm performance on cost of capital for the JSE listed firms.

This chapter is systematised into various components. The first component is the presentation and analysis of the results from the descriptive statistics, correlation matrix, and unit root test. The second component is the presentation and analysis of the results from the panel linear regression model utilised by drawing a connection between the model to the study objectives. The last component provides a conclusion on the reported results.

4.2 Descriptive Test Results

Descriptive test results provide a synopsis of the sample's or population's characteristics and the distribution of variables; it includes the analysis, synopsis, and presentation of findings related to the data set samples or population (Kaur et al., 2018). This, therefore, allows investigators to present data in a meaningful way that facilitates a lesser complex interpretation. Table 4.1 below reflects descriptive statistics of the input, output, and control variables employed in this study to investigate the impact of firm performance and carbon emissions on the CoC.

Variables	Mean	Median	Maximum	Minimum	Standard Deviation
CEI	1.864638	1.753225	4.473784	-0.829895	1.509914
ROA	12.08200	11.64000	59.52000	-43.95000	16.51483
ROE	13.93400	15.72000	77.27000	-77.70000	22.40707
Size	16.61737	17.23871	19.00929	12.48877	1.807536
Lev	0.558267	0.430000	1.890000	0.080000	0.408863
BP	1.716667	1.350000	5.720000	0.400000	1.104096
MB	1.133404	1.228600	2.161400	-1.296800	0.690302
KE	14.93409	15.55440	21.05180	0.463800	4.124661

Table 4. 1 Descriptive Statistics of the Variables

Source: Researcher's Deductions

The table above portrays the mean, median, maximum, minimum, and standard deviation for all the variables employed in this study. The mean value of carbon emissions (scope 1 and 2) intensity is 1.86, ranging from -0.83 to 4.47 and representing the direct and indirect amount of greenhouse gas emissions produced by the firm relative to the firm's total assets. The mean value of ROA is 12.08, ranging from -43.95 to 59.52 and representing the firm's profitability in relation to its total assets. Comparably, the mean value of ROE is 13.93, ranging from -77.70 to 77.27 and representing the firm's profitability in relation to its equity. The mean value of the cost of equity capital is 14.93, ranging from 0.46 to 21.05. The four control variables, namely firm size (measured as a natural log of total assets), leverage, book to market ratio, and beta factor, reported the mean values 16.61, 0.55, 1.71, and 1.13 respectively.

4.3 Hausman Test Results – Fixed or Random Effects Model

The Hausman test was run as the test aids in the selection of the appropriate regression model between the random effects model and the fixed effects model (Androniceanu & Georgescu, 2023; Islam & Toor, 2019; Lopes, 2021; Olanrewaju et al., 2019; Sani et al., 2023; Zulfikar & STp, 2018). The random effects model includes time variant factors that could have an impact on the analysis of the relationship between the output and input variables, whereas the fixed effects model holds the time variant factor constant (Androniceanu & Georgescu, 2023; Islam & Toor, 2019; Lopes, 2021; Olanrewaju et al., 2019; Sani et al., 2023; Zulfikar & STp, 2018). The Hausman test has a null hypothesis that states that the random effects model is better and an alternative hypothesis that the fixed effects model is better (Androniceanu & Georgescu, 2023). The acceptance or rejection of the null hypothesis is guided by the p-value; if the p-value is less than 0.05 then the null hypothesis is accepted that the random effects model is better (Androniceanu & Georgescu, 2023). The table below provides the results of the Hausman test.

Equation	Chi-Sq. Statistic	Chi-Sq. d.f.	P-value	Outcome
1	7.961664	6	0.2409	Fixed effects
2	7.088833	5	0.2141	Fixed effects

Table 4.2 Hausman Test Results

Source: Researcher's Deductions

Table 4.2 above presents the results from the Hausman test. The p-value for both equations employed in this study are not significant at the p-value less than 0.05 testing level. The null hypothesis was that the random effects specification model is better while the alternative hypothesis was that the fixed effects specification model is better. For both equations, the p-values are well above 0.05, which indicates that for each equation, the null hypothesis of the random effects model is better is rejected. Therefore, this makes the fixed effects model more appropriate for this study.

4.4 Diagnostic Test Results

This section provides a summary of the diagnostic tests performed in this study prior to the final regression analysis.

4.4.1 Levin-Lin-Chu Panel Unit Root Analysis

A unit root analysis is a statistical tool employed to confirm whether a time series data contains a unit root, which helps identify if a time series is stationary or displays patterns that make it non-stationary (Trinks et al., 2020; Levin et al., 2002). The utilisation of the unit root analysis has been frequently employed by researchers to establish whether data should firstly be differenced or regressed on predictable functions of time so as to render the data stationary (Trinks et al., 2020; Levin et al., 2002). The Levin-Lin-Chu panel unit root test includes a null and an alternative hypothesis (Levin et al., 2002). The null hypothesis states that the panel data are non-stationary, while the alternative hypothesis states that the panel data are stationary (Levin et al., 2002). The latter implies that the data's statistical properties remain constant over time, it is imperative that the panel data remain constant/stationary, which will make it more predictable and suitable for regression analysis and other models (Levin et al., 2002; Trinks et al., 2020). In this study, the null hypothesis that the carbon emissions (scope 1 and 2) series is non-stationary was analysed against the alternative hypothesis that the carbon emissions (scope 1 and 2) series is stationary. The remaining variables were analysed using similar hypotheses. Table 4.3 below presents the results of the Levin-Lin-Chu panel unit root test.

Levin-Lin-Chu		
Variable	**Statistic**	**Probability**
Carbon emissions (scope 1 and 2) intensity (CEI)	-3.19437	0.0007
ROA	-18.5605	0.0000
ROE	-68.5435	0.0000
Firm Size (Size)	-2.95049	0.0016
Financial leverage (Lev)	-2.77271	0.0028
Book to market ratio (BP)	-11.7111	0.0000
Market Beta (MB)	-3.62814	0.0001
Cost of Capital (equity element) (KE)	-3.38358	0.0004

Table 4. 3 Levin-Lin-Chu Panel Unit Root Test Results

Source: Researcher's Deductions

Table 4.3 above presents the results from the Levin-Lin-Chu panel unit root test. The *t*-statistic for all variables employed in this study are significant at the p-value less than 0.05 testing level. The null hypothesis was that the panel data contain non-stationary data while the alternative hypothesis was that the panel data contain stationary data. For all variables, the p-values are well below 0.05

which indicates that for each variable, the null hypothesis of a non-stationary (unit root) is rejected. This means that all variables in the table are stationary, making them appropriate for this study.

4.4.2 Multicollinearity Test

For the purposes of confirming whether high correlation exists between the input variables, a multicollinearity test was performed for the three regression analyses employed in this study. The results for the multicollinearity tests are presented in the table below.

Cost of capital (equity element)			
Variable (equation 1)	**Coefficient variance**	**Uncentered VIF**	**Centred VIF**
C	164.6202	21113.04	NA
CEI	0.630576	284.3279	3.141604
ROE	4.77E-05	3.526214	2.337492
LEV	0.679967	28.63894	1.459603
Size	0.692991	24546.75	4.188274
BP	0.037269	15.63331	1.547423
MB	0.081114	15.34236	1.978501
Variable (equation 2)	**Coefficient variance**	**Uncentered VIF**	**Centred VIF**
C	98.06868	12619.04	NA
ROA	7.44E-05	3.373568	1.975247
SIZE	0.362941	12898.23	2.200753
LEV	0.603986	25.52255	1.300774
BP	0.034875	14.67720	1.452785
MB	0.073216	13.89409	1.791737

Table 4.4 Multicollinearity Test Results Source:

Researcher's Deductions

The table above provides a summary of the VIF command on EViews for the regression models (1 and 2) covering the two objectives of the study. A multicollinearity does not exist between variables when the centred VIF is below 10 (Shrestha, 2020). The centred VIF for all the variables employed in the equations are well below 10; thus, there is no multicollinearity that exists in the regression models employed in this study.

4.5 Pearson's Correlation Analysis

Pearson's correlation analysis is a statistical tool employed to determine the robustness of the correlation between two variables and the course of the correlation (Schober et al., 2018; Armstrong, 2019). Correlation values range from -1 to 1. Below, -1, 0 and 1 correlation results are explained according to Schober et al. (2018):

- A correlation value of -1 implies that there exists a perfect adverse association amongst any two variables.
- A correlation value of 0 implies that there is no association between any two variables.
- A correlation value of 1 implies that there exists an affirmative association between any two variables.
- A very high correlation between variables could lead to multicollinearity (Shrestha, 2020). A correlation coefficient above 0.8 or below -0.8 between input variables suggests potential multicollinearity (Shrestha, 2020).

The significance level of correlation is a threshold employed to establish if the interdependence observed is statistically significant (Kim & Choi, 2021). However, Komaroff (2020) argues that the correlation coefficients alone are not sufficient to determine whether the association observed between the two variables is statistically significant or it as a result of random chance. Researchers have used probability values (p-values) to determine the significance of the interdependence coefficients as it shows whether the correlation is likely to be true (i.e. not as a result of random chance) (Komaroff, 2020). A low p-value shows that the observed correlation is statistically significant, whilst a high p-value shows that the correlation is not statistically significant (i.e. could be as a result of random chance) (Komaroff, 2020). It is imperative to note that p-values alone do not determine the robustness of a correlation, but they are crucial to be used to validate the results of statistical analysis (Komaroff, 2020).

Researchers have widely used p-value thresholds 0.05, 0.01 and 0.10 (Kim & Choi, 2021; Komaroff, 2020). In this study, 0.05 and 0.01 p-value thresholds were employed to determine the statistical significance of the correlations. These thresholds assisted in identifying correlations which highly likely represented true relationships in the data rather than those being as a result of random chance; in other words, they assist us focus on meaning correlations (Komaroff, 2020). Although Pearson's correlation coefficient analysis is a powerful statistical tool employed for

evaluating interdependence relationship between two variables, the results from this tool are not always conclusive (Armstrong, 2019; Schober et al., 2018; Sürücü & Maslakci, 2020).

Table 4.5 below displays the Pearson's correlation coefficients for the variables employed in this study.

Coeff. P-value	CEI	ROA	ROE	Size	Lev	BP	MB	KE
CEI	1.0000 -----							
ROA	0.2192 0.0589	1.0000 ----						
ROE	0.3639** 0.0013	0.8542** 0.0000	1.0000 ----					
Size	0.6189** 0.0000	0.0800 0.4950	0.2779* 0.0158	1.0000 ----				
Lev	-0.0390 0.7397	-0.0704 0.5483	-0.1332 0.2546	0.1608 0.1683	1.0000 ----			
BP	0.3530** 0.0019	0.5015** 0.0000	0.4646** 0.0000	0.2084 0.0727	0.1871 0.1080	1.0000 ----		
MB	0.3582** 0.0016	0.3012** 0.0086	0.3832** 0.0007	0.6401** 0.0000	0.1151 0.3255	0.3012** 0.0086	1.0000 ----	
KE	0.3574** 0.0016	0.2932* 0.0107	0.3653** 0.0013	0.6344** 0.0000	0.1023 0.3824	0.2672* 0.0205	0.9848** 0.0000	1.0000 ----

Table 4. 5 Pearson's Correlation Coefficient Matrix

** Significant correlation at 0.05. ** Significant correlation at 0.01.*

Source: Researcher's Deductions

Table 4.5 above presents the Pearson's correlation coefficient matrix. The analysis of this study focuses only on the statistically significant correlations. Below is an interpretation of the correlation coefficients for the variables employed in this study:

Carbon Emissions (Scope 1 and 2): Intensity and other variables

A statistically significant correlation of r=0.3639; p<0.01 is reported between carbon emissions intensity (Scope 1 and 2) and return on equity (ROE). This means that carbon emissions intensity increases as return on equity increases. A statistically strong correlation of r=0.6189; p<0.01 is reported between carbon emissions (scope 1 and 2) intensity and firm size (Size). This means that there is a direct relationship linking carbon emissions intensity and firm size. A statistically significant correlation of r=0.3530; p<0.01 is reported between carbon emissions (scope 1 and 2)

intensity and book to market ratio (BP), which shows the existence of a direct relationship linking carbon emissions intensity and book to market ratio. A statistically significant correlation of $r=0.3582$; $p<0.01$ is reported between carbon emissions (scope 1 and 2) intensity and beta factor (MB), showing the existence of a direct relationship linking carbon emissions intensity and beta factor. A statistically significant correlation of $r=0.3574$; $p<0.01$ is reported between carbon emissions (scope 1 and 2) intensity and KE, which means that there exists a direct relationship between carbon emissions intensity and the CoC.

Return on Assets (ROA) and other variables

A statistically significant correlation of $r=0.8542$; $p<0.01$ is reported between ROA and ROE, and this means that there is a direct relationship between ROA and ROE. The high correlation between ROA and ROE is an indicator of multicollinearity, which could affect regression analysis if both variables are employed as input variables in a single model. ROA and ROE are employed as input variables on different models in this study. A statistically significant correlation $r=0.5015$; $p<0.01$ is reported between ROA and Book to market ratio (BP); this shows the existence of a direct relationship between ROA and BP. A statistically significant correlation $r=0.3012$; $p<0.01$ is reported between ROA and beta factor (MB), showing the existence of a direct relationship between ROA and MB. A statistically significant correlation $r=0.2932$; $p<0.05$ is reported between ROA and the KE, which means that there exists a direct link connecting ROA and the CoC.

Return on Equity (ROE) and other variables

A statistically significant correlation of $r=0.2779$; $p<0.05$ is reported between ROE and firm size (Size), meaning that there is a direct relationship between ROE and firm size. A statistically significant correlation $r=0.4646$; $p<0.01$ is reported between ROE and Book to market ratio (BP). This shows the existence of a direct relationship between ROE and BP. A statistically significant correlation $r=0.6401$; $p<0.01$ is reported between ROE and beta factor (MB), showing the existence of a direct relationship between ROE and MB. A statistically significant correlation $r=0.3653$; $p<0.01$ is reported between ROE and the KE, which means that there exists a direct link connecting ROE and the CoC.

Firm size (Size) and other variables

A statistically significant correlation of r=0.6401; p<0.01 is reported between firm size (Size) and beta factor (MB), and this means that there is a direct relationship between firm size and MB. A statistically significant correlation of r=0.6344; p<0.01 is reported between firm size (Size) and KE, which means that there is a direct link connecting firm size and CoC.

Book to market ratio (BP) and other variables

A statistically significant correlation of r=0.3012; p<0.01 is reported between book to market ratio and beta factor (MB). This means that there is a direct relationship between BP and MB. A statistically significant correlation of r=0.2672; p<0.05 is reported between book to market ratio and KE, and this means that there is a direct link connecting BP and CoC.

Beta factor (MB) and other variables

A statistically significant correlation of r=0.9848; p<0.01 is reported between beta factor (MB) and KE. This means that there is a direct link connecting MB and CoC.

4.6 Results and Analysis

To achieve the objectives of this study and provide responses to the research questions, panel regressions were employed to analyse the effects of the input variables (carbon emissions (scope 1 and 2) intensity and firm performance (ROE and ROA) and control variables, namely firm size (Size), financial leverage (Lev), Book to market ratio (BP) and beta factor (MB) on the dependent variable (KE). This section reports on the results from the fixed effects panel regression model based on the multivariant equations for the objectives of this study laid out in Chapter 1.

4.6.1 Objective 1: Impact of carbon emissions on cost of capital

Objective 1: To examine the impact of carbon emissions on the cost of capital for the JSE listed firms

The regression below was estimated to test this objective:

$$KE_{it} = C + \beta_1 CEI_{it} + \beta_2 ROE_{it} + \beta_3 Size_{it} + \beta_4 Lev_{it} + \beta_5 BP_{it} + \beta_6 MB_{it} + \varepsilon_{it} \quad \ldots (1)$$

The results from the model employed are presented in the table below. The coefficients, standard errors, t-statistics, and p-values for the input and control variables are shown in Table 4.6 below.

Variable	Coefficient	Std. Error	P-value
Constant	-2.0366	12.8304	0.8745
CEI	-0.0285	0.7941	0.9715
ROE	-0.0062	0.0069	0.3707
LEV	-1.1063	0.8246	0.1854
Size	0.7132	0.8325	0.3954
BP	-0.3749	0.1931	0.0574
MB	5.7534	0.2848	0.0000
Effects specification			
Cross-section fixed			
R-squared		0.974917	
Adjusted R-squared		0.965627	
Total panel (balanced) observations		75	

Table 4.6 Objective 1 regression results Source:

Researcher's Deductions

Table 4.6 above presents the results of the fixed effects LS regression that was run in EViews statistical software. Similar to studies conducted by Li et al. (2017), Trinks et al. (2020), Trinks et al. (2022b), and Bui et al. (2020), there is a negative correlation linking carbon emissions intensity (CEI) and the KE at r=-0.0285. The results imply that there is an inverse association between the two variables, which can be understood to mean that as the firms improve their carbon emissions, the KE will decrease. In Chapter 2 of this study, it was indicated that when risk-sharing is improved and shareholder base is expanded, this could be translated to a decreased CoC (Bui et al., 2020). This is also in line with slack resource theory, which states that in essence slack resources are an outcome of greater financial performance and these resources warrant firms to participate in social programs (Islam et al., 2021). Firms that engage in environmental initiatives/social programs to decrease their carbon emissions entice more investors who could supply cheaper capital (Bui et al., 2020; Li et al., 2019; Trinks et al., 2022b). However, the link connecting the carbon emissions intensity and the KE is not significant as the p-value is 0.9715, which is way above 0.05. Dissimilar to other studies conducted previously, the carbon emissions intensity has an insignificant effect on the CoC.

The beta factor was the only variable with a significant positive impact on the KE at r=5.7534, with a p-value of 0.0000, which is less than 0.05. This is expected as the beta factor has an impact on the KE in the CAPM model (Khlif et al., 2019). There exists a negative correlation linking the market to book ratio and the cost of equity capital at r=-0.3749, which is not significant as the p-value is 0.0574, which is consistent with prior studies (Ngcobo, 2020). There is a negative correlation between financial leverage and the KE of r=-1.1063, which is not significant as p-value is 0.1854. In addition, there is a direct link connecting firm size and KE of r=0.7132, which is not significant as the p-value is 0.3954. Overall, the input variables accounted for 0.9656 of the output variable (KE), which means that the model selected can explain the output variable (cost of equity capital) with 97% approximation. The remainder, which is 3% (100-97), consists of variables other than those in the model. This signifies that the use of the fixed effects LS model to analyse the link connecting the cost of equity capital, carbon emissions, and other input variables was valid.

To respond to the research question, 'What is the relationship between carbon emissions and the cost of capital?' the analysis above showed that carbon emissions have a non-statistically negative relationship with the CoC. This implies that the higher the carbon emissions intensity, the lower the KE. These findings are consistent with prior studies, which concluded that firms with more resources to invest in environmental initiatives to improve carbon emissions intensity attract lower CoC.

4.6.2 Objective 2: Effect of firm performance on cost of capital

Objective 2: To analyse the effect of firm performance on the cost of capital for the JSE listed firms

The following regressions were estimated to test this objective:

$$KE_{it} = C + \beta_1 ROA_{it} + \beta_2 Size_{it} + \beta_3 LEV_{it} + \beta_4 BP_{it} + \beta_5 MB_{it} + \varepsilon_{it} \quad \ldots\ldots\ldots\ldots (2)$$

The results from the model employed are presented in the table below. The coefficients, standard errors, t-statistics, and p-values for the input and control variables are shown in Table 4.7 below.

Variable	Coefficient	Std. Error	P-value
Constant	3.5629	9.9030	0.7204
ROA	-0.0003	0.0086	0.9728
LEV	-0.8654	0.7772	0.2703
Size	0.3618	0.6024	0.5506
BP	-0.4371	0.1867	0.0229
MB	5.8201	0.2706	0.0000
Effects specification			
Cross-section fixed			
R-squared		0.974536	
Adjusted R-squared		0.965740	
Total panel (balanced) observations		75	

Table 4.7 Objective 2 regression results

Source: Researcher's Deductions

Table 4.7 above presents the results of the fixed effects LS regression that was run in EViews statistical software. Similar to studies conducted by Alrjoub and Ahmad (2017), Cordeiro da Cunha Araújo and André Veras Machado (2018), Hapsoro and Falih (2020), and Ismail and Obiedallah (2022), there is a negative correlation between firm performance, measured using return on assets, and the KE. This implies that there is an inverse relationship between the two variables, which can be interpreted as the higher the return on assets, the lower the KE. Firms that effectively employ their assets for greater returns will inevitably entice investors and attract lower KE, which is supported by the studies done by Drobetz et al. (2018) and Myers and Majluf (1984), which found that firms with greater performance are more inclined to have a lower CoC, which was indicated in Chapter 2 of this study. However, this relationship is not significant as the p-value is 0.9728, which is way above 0.05. There is a negative correlation between financial leverage and the KE at r=-0.8654, which is not significant as the p-value is 0.2703. There is a direct relationship between firm size and the KE at r=0.3618, which is not significant as the p-value is 0.5506.

Furthermore, there exists a negative significant correlation between the market to book ratio at r=-0.4371; p-value=0.0229, which is consistent with prior studies (Ngcobo, 2020). The beta factor had a direct significant correlation with the KE at r=5.8201; p-value=0.0000. This is expected as the beta factor has an impact on the KE in the CAPM model (Khlif et al., 2019). Overall, the input variables accounted for 0.9657 of the output variable (KE), which means that the model selected can explain the output variable with 97% approximation. The remainder, which is 3% (100-97),

consists of variables other than those in the model. This signifies that the use of the fixed effects LS model to analyse the impact of firm performance on the KE and other input variables was valid.

To respond to the research question, 'How does firm performance affect the cost of capital?' the analysis above showed that firm performance has a non-statistically negative impact on the CoC. This implies that the higher the firm size is, the lower the KE. These findings are consistent with prior studies, which concluded that firms with more efficient use of resources attract lower CoC.

4.7 Summary

This chapter presented the results, focusing on the appropriate model to be used between the fixed effects and the random effects specification LS model, results of the Hauman test. The results on the research models discussed in Chapter 3 were presented, and each model was aligned to each research question laid out in Chapter 1. Both the regression models run in this study could explain the relationship between the input and output variables with 97% approximation, making them valid for employment in this study. The diagnostic results were discussed with corrective measures where applicable. Afterwards, the summary of the descriptive results and Pearson's correlation analysis were discussed. Finally, the analysis of the regression models' results was discussed for each research question. The response to the first research question was that carbon emissions have a non-statistically negative relationship with the CoC, and the response to the second research question was that firm performance has a non-statistically negative impact on the CoC.

The chapter that follows provides a summary of the results and conclusions of this study. It speaks to the constraints of this study and provides recommendations based on the findings of the study. The chapter also makes suggestions for subsequent studies.

CHAPTER 5: SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

5.1 Introduction

This study investigated the relationship between carbon emissions and the cost of capital. It also investigates how firm performance affects the cost of capital. This chapter provides a conclusion on the study, which draws a link among the different chapters of this study. The chapter also discusses limitations and presents recommendations of the study and suggestions for subsequent studies.

5.2 Summary of the Study

This study set out to ascertain how firm performance and carbon emissions impact the cost of capital with a focus on the mining firms listed on the JSE. The stakeholder, legitimacy, slack resource, and voluntary disclosure theories were evaluated to obtain an understanding of the causal association between firm performance, carbon emissions, and the CoC. The legitimacy theory was the most suitable for the study as it provided the theoretical foundation for firms providing discretionary disclosures, and it assisted in establishing whether carbon emission disclosures reflect and deliver to various stakeholders an overall picture of the firm's performance and legitimacy through the provision of non-financial and financial information. The theory further emphasises firms' operating responsibly for themselves and for the greater public, as it highlights the significance of public acceptance in making certain that a firm continues to survive (Baldini et al., 2018; Olateju et al., 2021; Uwuigbe et al., 2018). Engaging in sustainable practices, including disclosures of carbon footprints and reduction of emissions can be a great way for firms to gain a legitimate status and legitimise the actions of the firm (Olateju et al., 2021). The study utilised the quantitative research method and the panel regression methods to meet the research objectives and answer the research questions. Secondary data, which covered the period 2018 to 2022, were obtained and analysed.

5.2.1 Objective 1: To examine the impact of carbon emissions on the cost of capital for the JSE listed firms.

Based on the results of the LS-Least Squares regression model, it can be concluded that carbon emissions have a non-statistically significant negative association with the cost of capital. This implies that the higher the carbon emissions intensity, the lower the cost of equity capital. These

findings are consistent with previous studies, which concluded that firms with more resources to invest in environmental initiatives to improve carbon emissions intensity attract lower cost of capital. The results of the study show that carbon information disclosed has a negative association with the cost of capital, which means that carbon information disclosed can decrease the cost of equity capital (Li et al., 2017).

5.2.2 Objective 2: To analyse the effect of firm performance on the cost of capital for the JSE listed firms.

Based on the results of the LS-Least Squares regression model, it was concluded that firm performance has a non-statistically significant negative impact on the cost of capital. This implied that the higher the firm's size, the lower the cost of equity capital. These findings are consistent with previous studies conducted, which concluded that firms with more efficient use of resources attract lower cost of capital. The results of the study show that firms with greater performance are more inclined to have a lower cost of capital than those with poor performance (Drobetz et al., 2018; Myers and Majluf, 1984).

5.3 Conclusions

This study examined the impact of carbon emissions on the cost of capital and the effect of firm performance on the cost of capital. The study was motivated by the on-going discussions about sustainability reporting and its benefits for the reporting firms and all stakeholders. The overall results of the LS regression models show that both carbon emissions and firm performance have non-statistically significant negative impact on the cost of capital. However, owing to the non-statistically significant results, a few to no inferences can be drawn.

5.4 Recommendations

The results of the study show that research on the impact of carbon emissions and firm performance on the cost of capital can benefit the reporting firms and various stakeholders. It is based on this conclusion that the following recommendations are made:

- Conducting long-term studies to assess how changes in carbon emission policies affect firms' cost of capital over time; this can provide insights into trends and causal relationships.

- Conducting studies on different sectors and comparing them against each other on how different industries respond to carbon emissions in relation to their cost of capital.
- Investigating how the preferences for sustainability by capital contributors impact firms' cost of capital; doing an analysis on whether firms with lower carbon emissions receive preferential treatment in investment decisions is also recommended.
- Conducting studies to examine how ESG factors interact with carbon emissions to influence firm performance and the cost of capital

The above suggestions can deepen comprehension of complex correlations between carbon emissions, firm performance, and financial outcomes, which will ultimately assist informing policies and investment strategies.

5.5 Limitations of the Study

There were three limitations of this study. The first one was the nature of the sampling technique employed, which involved the preselection of mining firms listed on the JSE. The second was missing information that was identified on data collection and analysis resulting in the reduction of observations. The third was the lack of guidance on specific guidelines for reporting carbon emissions; as such, carbon emissions could not be compared effectively amongst the firms.

5.6 Suggestions for Subsequent Studies

This study examined the impact of carbon emissions on the cost of capital and the effect of firm performance on the cost of capital over a period of five years starting from 2018 to 2022. This study only considered the mining firms listed on the JSE and the five-year period owing to availability of resources such as time and data. A suggestion for future studies would be that the sample size be increased to cover all companies listed on the JSE and break down results per sector. Future studies may also evaluate ESG factors, expand literature in sustainability, and craft and use valuation models that incorporate carbon emission factors leading to better assessment of firm performance.

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7. APPENDICES
7.1 ETHICAL CLEARANCE

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

Ms Lieketseng Motalingoane (223134137)
School Of Acc Economics&Fin
Westville

Dear Ms Lieketseng Motalingoane,

Original application number: 00022451
Project title: The impact of firm performance and carbon emissions on the cost of capital for the Johannesburg Stock Exchange (JSE) listed firms

Exemption from Ethics Review

In response to your application received on , your school has indicated that the protocol has been granted **EXEMPTION FROM ETHICS REVIEW.**

Any alteration/s to the exempted research protocol, e.g., Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through an amendment/modification prior to its implementation. The original exemption number must be cited.

For any changes that could result in potential risk, an ethics application including the proposed amendments must be submitted to the relevant UKZN Research Ethics Committee. The original exemption number must be cited.

In case you have further queries, please quote the above reference number.

PLEASE NOTE:
Research data should be securely stored in the discipline/department for a period of 5 years.

I take this opportunity of wishing you everything of the best with your study.

Yours sincerely,

[redacted] (DAL:HDRC)

Prof Josue Mbonigaba
Academic Leader Research
School Of Acc Economics&Fin