Derivative-based hedging and its impact on firm value:
A study on the South African mining industry.

by

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Declaration

I certify that the minor dissertation submitted by me for the degree Master of Commerce in Finance at the University of Johannesburg is my independent work and has not been submitted by me for a degree at another university.

Boitumelo Letsuma

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Dedication

Mr. Johannes Tseisi "Papa" Ramapela

Ekare o ka be o le teng ka letsatsi lena, ho bona toro ea rona e phethahala.

Ke lebohela mantsoe a hao a n'ang khothatsa ho re ke tiisetse dithutong tsa sekolo.

Ke leboha Modimo ka di thapelo tsa hao, lerato, kutloisiso le bohlale ba hao.

Ke mo ke leng ka lebaka la tsona.

O tla dula dipelong tsa rona ka mehla eohle.

Robala ka khotso Ntate oa rona.

I wish you were here on this day to see our dream come true.

I am grateful for your constant encouragement to stay steadfast on the path of education.

I thank God for your love, your prayers, your wisdom and understanding. I would not be here without them.

You'll remain forever in our hearts. Rest in peace, Father.

Abstract

The South African mining industry is an integral part of the domestic economy and the global commodity markets. Evidence in previous studies suggests that the mining industry tends to have high levels of exposure to price risks. As such, it is important to understand whether risk management pursuits against price risks are helpful in preserving the value of the South African mining firms. Specifically, this study aims to understand the implications of managing price risks through derivative-based hedging and how it affects the firm value of South African mining firms. Three research objectives are used to fulfil the research aim, which are, firstly, to classify the mining firms as either hedgers or non-hedgers, using a hedge percentage criterion. The second research objective is to determine if a hedging premium (or discount) exists in the firm value of mining firms that choose to hedge, using the non-parametric Wilcoxon signed-rank test. The final research objective is to determine if the hedging premium (or discount) to firm value continues to hold in the presence of control variables that have been documented as contributors to firm value. A multivariate panel regression model is used to fulfil the final objective, against the Tobin's Q proxy for firm value. The research findings suggest that the South African mining firms tend to hedge against price risk 48% of the time on average. Furthermore, the firms classified as hedgers use derivatives to hedge against price risk 70% of the time, while firms classified as non-hedgers only use derivatives to hedge against price risk 20% of the time, on average. There were no significant differences observed between the firm value of the hedging firms and the firm value of the non-hedging firms, using the Tobin's Q proxy. Furthermore, when subjected to control variables in the multivariate panel regression model, the relationship between derivative-based hedging and firm value failed to hold, as derivative-based hedging was found to be insignificant in affecting firm value. However, the variables that were found to affect the firm value of the mining firms were the debt-to-equity (D/E) ratio, the firm investments, the firm size, the management shareholding, and the return-on-assets (ROA).

Key words: Derivatives, risk management, hedging, firm value, Wilcoxon signed-rank, panel regression.

Table of Contents

List of Tables

List of Figures

List of Annexures

List of Acronyms

ANOVA	Analysis of Variance Model
AUD	Australian Dollars
BIS	Bank for International Settlements
BRICS	Brazil, Russia, India, China, and South Africa
CFAI	Chartered Financial Analyst Institute
CSR	Corporate Social Responsibility
D/E	Debt-to-Equity
EBIT	Earnings Before Interest and Tax
ERM	Enterprise Risk Management
EUR	Euros
EVA	Economic Value Added
FDI	Foreign Direct Investment
FE	Fixed Effects
GDP	Gross Domestic Product
GMM	Generalized Method of Moments
IAS	International Accounting Standards
IASB	International Accounting Standards Board
IFRS	International Financial Reporting Standards
IPO	International Public Offering
JPY	Japanese Yen
JSE	Johannesburg Stock Exchange
MINT	Mexico, Indonesia, Nigeria, and Turkey
MVA	Market Value Added
NPV	Net Present Value
OTC	Over the Counter
PGMs	Platinum Group Metals
POLS	Pooled Ordinary Least Squares Model
RE	Random Effects
ROA	Return on Assets
ROE	Return on Equity
SA	South Africa
UK	United Kingdom
US(A)	United States of America
USD	United States Dollars
WACC	Weighted Average Cost of Capital
ZAR	South African Rand

Chapter 1: Introduction

"… if you hold inventory, non-hedging is gambling. You gambled that the price of oil would not drop, and you lost." – Miller (1997)

1.1. Introduction

The South African (SA) mining industry is an integral part of the country's economy, contributing billions to its gross domestic product (GDP), fixed investments and sovereign taxes (MacDiarmid, Tholana & Musingwini, 2018). The country's mining output continues to lead in its contribution to global resources, in terms of global production and global reserves. According to the Geological Survey (2019) of the United States of America (US), the production and reserves of manganese, chromium, and platinum group metals (PGMs) by SA mining firms are ranked as world leaders, accounting for 29%, 73% and 94% respectively across the globe. Thus, it is imperative to control and maintain the growth and impact of the mining industry, in order to encourage investment, development and sustainability. Hence, managers of mining firms are faced with the task of providing value to both existing and potential investors, as it has been stated that the core function of any company is to maximise shareholder wealth by creating value (MacDiarmid et al., 2018). Therefore, every mining firm needs to have a differential value creation strategy. This means they ought not to depend solely on exogenous factors such as commodity prices to enhance value to offer to investors.

The identification of factors that preserve and enhance shareholder value assists managers of mining firms in developing strategies and techniques that can optimise value creation for their shareholders (MacDiarmid et al., 2018). Such factors include financial performance variables such as revenue growth and earnings before interest, tax, depreciation, and amortization (EBITDA), which were found to positively contribute to the value of mining firms (MacDiarmid et al, 2018). However, these variables are affected by financial risks stemming from macroeconomic influences, which pose a threat to the financial performance of mining firms. Authors such as Armstrong, Fortenberry and Zapata (2005) and Broadstock, Cao and Zhang (2012) note that foreign exchange rates, interest rates and commodity prices are significant macroeconomic factors that have an impact on the financial performance of mining and energy firms. This financial performance in turn affects

the firm value offered to shareholders (Ibrahim, 2017). It is therefore important to manage the potential detrimental effects that these risk factors could impose on the financial performance of mining firms, since the risk factors have an impact on their firm values. Managers can therefore devise strategies to fulfil their mandate of maximising shareholder wealth, by protecting the firm values from the adverse effects of the identified risks. To achieve this, managers would need to first understand the extent to which exchange rates, interest rates and commodity prices affect the value of mining firms.

1.2. Background

The risk of exchange rate fluctuations has been categorised as one of the most common risks that are managed across the globe (Buyukkara, Baha Karan, Temiz & Yildiz, 2019). Similarly, interest rates are found to have a direct effect on a firm's level of performance (Kamruzzaman, 2018). Evidence of the impact of both interest rate and exchange rates has been observed in the mining industry located in emerging and developed markets. In a study by Sadorsky (2001), the impact of macroeconomic risk factors on Canadian oil mining companies was determined, and it was found that rises in both exchange rates and interest rates had a negative impact on the companies' stock returns. A similar result was presented in a study based on the Australian mining industry, in terms of exchange rates and interest rates (Kamruzzaman, 2018). According to Kamruzzaman (2018), rises in exchange rates resulted in negative stock returns on mining companies.

In as much as the rise in interest rates also exhibited a negative coefficient, the effect was not statistically significant on mining stock returns. However, contrasting findings on exchange rates were presented by Ma (2015), who observed how investment in Australian mining firms respond to the volatility of exchange rates. The author found that changes in exchange rate costs positively affect mining firm investments, where increases in exchange rate costs improve the level of investment in mining firms. According to Ma (2015), the findings stem from a high level of interest in the Australian mining exports from China, over the course of the mining boom. In mining companies based in emerging markets, the impact of exchange fluctuations has been said to be direr, as these companies tend to be price takers (Palavar, 2019). This means that they have limited power in offsetting the pressure of a low commodity price climate to their foreign buyers.

A contrasting view to Palavar (2019) is presented in studies within emerging markets. By using a linear model to determine the sensitivity of exchange rates on the equity returns of importing and exporting firms in India, Joshi (2016) found an insignificant relationship between the two variables. The author attributed the result to an efficiency of information, in that the companies' stock price returns reflect the on-balance sheet and off-balance sheet hedged positions of foreign exchange rate exposure. A similar study by Gursida (2019) presented similar findings based on companies in the Indonesian mining sector, where foreign exchange rates were not significant determinants of stock price returns. The author reasons that the findings reflect the non-linearity of the relationship between stock returns of mining companies and exchange rate fluctuations, since other variables contribute to the stock returns (Gursida, 2019).

In addition to interest rates and exchange rates, commodity prices are also a key macroeconomic factor that drives the performance of mining companies. As stated by Nangolo and Musingwini (2011), mining companies project future cash flows based on commodity prices as a key input. Evidence of this has been presented in emerging market studies in Indonesia (Robiyanto, 2019) and China (Broadstock et al., 2012). The respective authors found that commodity prices have a significant and positive relationship with the stock returns of the mining equities, and they are also highly sensitive to shocks in the prices of gold, silver, and crude oil commodities. Similarly, the findings in developed markets correspond with these results. According to Knop and Vespignani (2014), the profits of Australian mining companies substantially increased in response to commodity price shocks. Furthermore, Nangolo and Musingwini (2011) observed the correlation between commodity prices and their counterpart indices in different developed markets and found that a strong correlation existed between gold prices, silver prices and their respective counter indices over the long and short terms. It is therefore evident that interest rates, exchange rates and commodity prices have varying degrees of impact on mining companies.

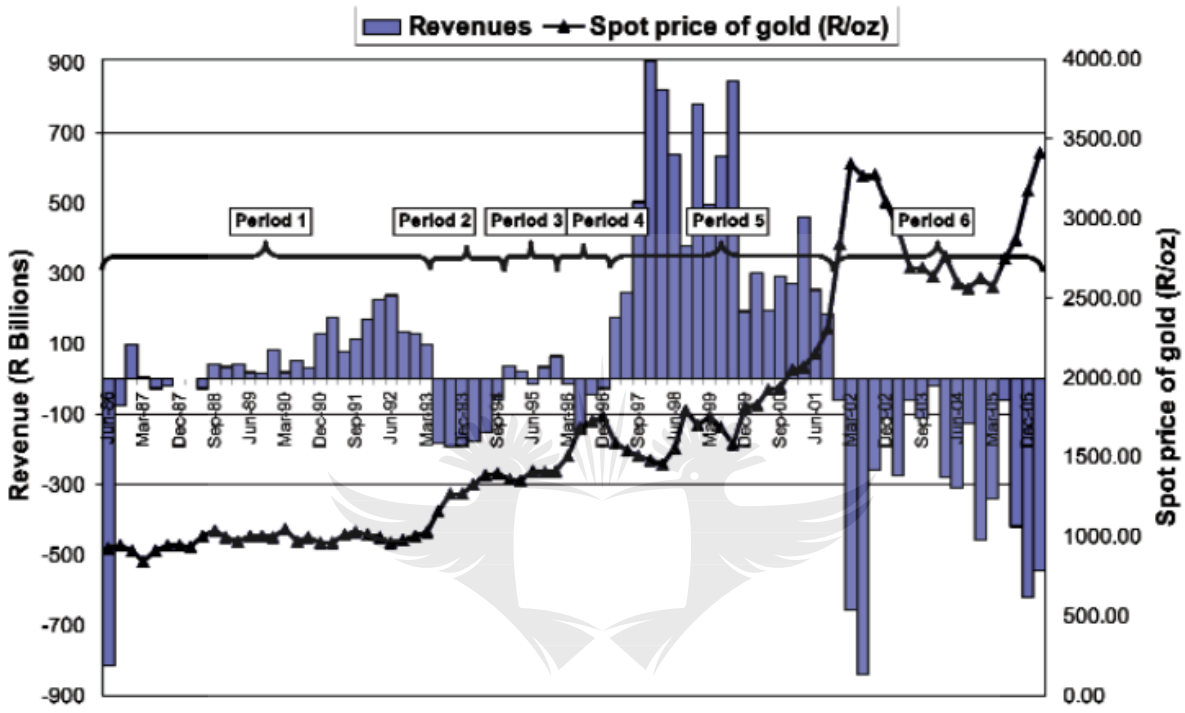
The companies do not have the power to control movements of all three financial risk factors that pose a threat to the financial performance of the companies. The volatility of these financial risk factors can result in mining firms possibly considering the hedging approach to mitigate against the potential adverse effects that the risks may pose on their performance and firm value. Hedging in the mining industry has largely been conducted

through the employment of derivatives, as hedging has been deemed the most important function of the derivatives market – particularly the futures market (Degiannakis & Floros, 2010). Managers of mining companies are faced with a dilemma in terms of their decision to hedge. On the one hand, a good hedging strategy is said to have a positive impact on the prospects of a mining company (Armstrong et al., 2005). Frankel (2011) reinforced this view by stating that the volatility of commodity prices justifies the decision for mining companies to hedge using derivatives, as it protects them from the downside risk of the commodity prices. Evidence of this has been presented by Bubere and Shihab (2013), who conducted an investigative study of hedging in Swedish mining companies and found that periods of high liquidity risk necessitated the undertaking of risk management by mining firms, through derivative based hedging. This is further reinforced by Smith and Stulz (1985), who indicated that the objective of hedging is to protect against the expected costs of financial distress.

In contrast, derivative-based hedging in the mining industry is still met with uncertainty by shareholders and market participants. Bubere and Shihab (2013) state that investors want exposure to the commodity market and consequently use mining companies as a proxy for this type of investment. If mining companies hedge, it could potentially limit the returns from the upward movements of the commodities produced by the mining companies. For example, managers can decide to employ the hedging approach on commodities, but managers are still faced with the prospect of commodity prices possibly increasing, such as the 2019 rally in the prices of palladium and platinum, where the PGMs increased by 57% and 7% respectively, in a year (Ampmex, 2021). In addition, SA mining companies such as Anglo-American Platinum, Impala Platinum and Sibanye Gold all reported significantly higher corporate earnings in 2019, and their stock prices soared to their highest levels in three years. All three companies attributed the high stock price returns and earnings gains to the higher commodity prices, as well as the weakening Rand exchange rate in their financial reports. The companies could have potentially foregone these benefits had they hedged against the volatility in commodity price and exchange rates using derivatives. This opposing view about hedging enlightens the level of uncertainty about its importance in the mining industry.

In SA, the history on the effects of derivative-based hedging on the revenues of the gold mining industry has been documented by Minnitt, Goodwin and Stacey (2007), which can be seen in Figure 1 below.

Figure 1.1: The profits and losses of revenue associated with the hedging activity for the South African gold mining industry (June 1986 to December 2006)



Source: Minnitt et al. (2007)

The gold mining industry in SA experienced significant losses amounting to approximately ZAR500 billion by hedging in the period between 2001 and 2006 (period 6) as the gold prices improved above the ZAR2 500/oz threshold. However, the preceding periods offered mixed findings, where periods of rising gold prices resulted in negative returns of companies who hedged their exposure (periods 2 and 4). In contrast, positive gains were incurred during periods of relatively stable gold prices (periods 1 and 3), while downswings of gold prices presented opportunities for excessive gains in revenue through hedging during period 5. Ultimately, it can be resolved that derivative-based hedging can be both beneficial and problematic during various stages of the commodity cycle for gold mining companies.

It is thus imperative to understand the implications of undertaking derivative-based hedging as a tool to manage financial risks and its resulting impact on the firm value of the overall SA mining industry. The reason behind this pursuit is that the firm value of any mining company

is based on the present value of its expected future cash flows (Barth, 2000). However, it has been established that the financial performance and the expected future cash flows of mining companies are functions of commodity prices, exchange rates and interest rates in different markets by authors such as Nangolo and Musingwini (2011), Joshi (2016), and Kamruzzaman (2018). These financial risk factors are not within the control of mining companies, which poses an external threat to the certainty of their cash flows and, consequently, their firm values. Managers of the mining companies can control the risks through the hedging process, but the question of whether this decision preserves future cash flows and enhances the value of the firms remains.

On the one hand, unhedged commodity prices expose mining companies to cyclical cash flows based on commodity price fluctuations, as shown by the line graph in Figure 1. As suggested by Broadstock et al. (2012) and Robiyanto (2019), this exposure can sometimes have detrimental implications for the firms' cash flows and their perceived market value, in the case of negative commodity price movements. However, investors are interested in receiving this type of exposure to commodity markets through mining companies (Bubere & Shihab, 2013). Additionally, hedging can be an obstacle in achieving excess cash flows during periods of high upside potential (period 6). On the contrary, hedging can assist the companies in offsetting their exposure to the negative movements of commodity prices – which could result in the attainment of positive cash flows instead, as seen during period 5 shown in Figure 1. It is hereby evident that the incorporation of hedging strategies in the SA gold mining industry is inconclusive in terms of its implications for the companies' cash flows, as well as their firm values. The observation of existing literature can assist in solving this dilemma.

1.3. Literature review

Literature concerning hedging and firm value has been pursued based on the classical finance theory on hedging from the Miller-Modigliani ((1958) theorem, which has been explored and modified into theories by many researchers and scholars over the past few decades. The theory states that if financial markets are perfect, corporate financial policy (including hedging policy) is irrelevant in affecting a firm's corporate value. The irrelevance of a firm's hedging policy on a firm's corporate value stems from the assumption that investors can hedge against risks on their own, by changing their holdings to offset any

exposure to adverse risk effects on their own investments. To challenge the "hedging irrelevance" theory posed by the Miller-Modigliani paradigm, Smith and Stulz (1985) presented rationales for hedging in a seminal paper. According to Smith and Stulz (1985), rationales for the value-enhancing capabilities of hedging on a firm can be explained by the ability of hedging pursuits in avoiding certain costs. Such costs include the cost of financial distress, expensive external financing, underinvestment issues, greater tax payments, or expenses to mitigate information asymmetries between shareholders and managers (Geyer-Klingeberg et al., 2019).

Further research that enriched the firm value-enhancing argument of corporate hedging was conducted by Froot, Scharfstein and Stein (1993) and Gay and Nam (1998). According to Froot et al. (1993), hedging can be beneficial if external costs of finance are more expensive than internal funding sources. This is explained by the logic that hedging causes stability of cash flows, thus allowing for: improved planning for future capital requirements; lower expected tax liabilities; lower need to access external capital markets; higher expected after-tax cash flows; and an improved capacity for debt financing (Baker & Filbeck, 2018). An additional benefit to hedging is its ability to preserve internal funds by insulating firms from potential losses stemming from external risk factors (Gay & Nam, 1998). Therefore, value is created by firms who engage in risk management pursuits such as hedging, as this is said to indirectly improve management decisions concerning firm operations and investments (Smith & Stulz, 1985).

The contradictions in early theory concerning the capability for risk hedging to enhance value has probed researchers and scholars to determine the strength of the relationship between hedging and its ability to enhance value. A prolific amount of research has been explored in this field, focussing solely on non-financial firms in various markets. Consequently, researchers such as Allayannis and Weston (2001) conducted one of the first studies examining the impact of hedging through foreign currency derivatives on the market value of several non-financial firms in the USA, using Tobin's Q as a proxy for firm value. In tandem with arguments from Smith and Stulz (1985), the authors found a conflicting view to the risk management theory derived from the Miller-Modigliani paradigm. The results of their study showed that the employment of derivatives as hedging tools had a significantly positive impact on the market values of the firms. Staying within the developed market

context, Bessler, Conlon and Huan (2018) also conducted a similar study investigating the extent to which hedging initiatives have an impact on the value of non-financial firms in the United Kingdom (UK). The authors found that a hedging premium existed in firms that employed derivatives for corporate hedging – particularly those who hedged against foreign exchange rate risk.

However, a different result has been observed in emerging markets. In Turkey, Ayturk, Gurbuz and Yanik (2016) examined non-financial firms and found that whilst the majority of the firms used derivatives to mostly hedge against currency and commodity risk, their efforts did not result in an enhanced firm value. A hedging premium only existed when generalized method of moments (GMM) estimators were included in the observation. However, inasmuch as Lau (2016) also found that market makers provided a firm discount to users of derivatives in Malaysia, the author also found that the use of the financial instruments for hedging had a significant and positive impact on other financial performance ratios, such as the return on assets (ROA) and the return on equity (ROE) of Malaysian firms. A comparable emerging market study was conducted, based on SA's Top 40 non-financial firms, by Lambrechts and Toerien (2016) and including other key drivers of firm value such as the ROA, ROE, economic value added (EVA), and market value added (MVA). The findings were in tandem with emerging market results, in that the employment of derivatives as hedging tools did not result in a firm value add. This further reinforces the derived Miller-Modigliani corporate hedging irrelevance theory. The authors do, however, note that the scope of knowledge in the SA context is limited and suggest that further research be conducted on the topic.

Most studies relating to hedging and firm value have focussed on non-financial firms in both developed and emerging markets, as shown by Aretz, Bartram and Dufey (2007), Gómez-González, Rincón and Rodríguez, (2012), Krause and Tse (2016), dos Santos, Lima, Gatsios and de Almeida (2017), and Alam and Gupta (2018). However, another branch of research has emerged to extend the study to focus solely on specific industries within these markets. In the resources industry, research on the derivative-based hedging effects on firm value was conducted based on gold mining (Jin & Jorion, 2007), as well as the oil and gas industry (Lookman, 2004). Both studies based their research on developed markets in the USA, including Canada, and found a non-causal relationship between hedging and firm value or

market value. The reasoning behind the findings is consistent with the hedging irrelevance paradigm from the Miller-Modigliani argument. In the US gold mining industry, Jin and Jorion (2007) reasoned that the market for commodity prices is efficient enough, to such an extent that investors are able hedge commodity price risk for themselves. Additional findings presented by Lookman (2004) suggest that a hedging premium to firm value can only occur if oil and gas firms have diversified segments, as commodity risk is secondary in diversified resource firms. However, the exposure to commodity price in undiversified resource firms is primary, which makes them forfeit their premium on firm value if they hedge.

In emerging markets, further industrial studies on the topic concerning the impact of hedging on firm value have been based on industries outside the mining and materials industries. In China, Zou (2010) conducted a study based on the implications of insurance hedging for firm value through property insurance. The use of property insurance as a hedging tool was found to have a positive and significant effect on corporations who used it. Furthermore, this type of hedging was found to have induced a 1.5% premium on the firm value of the Chinese corporations observed. Another study was conducted by Li, Wu, Ojiako, Marshall and Chipulu (2014), where the authors focussed on how firm values of Chinese insurance companies are affected by enterprise risk management (ERM) pursuits. The findings were inconclusive, in that the relationship between ERM and firm value yielded both positive and negative results, depending on the method of observation employed. However, ERM is not within the scope of risk management in accordance with the current theoretical framework in terms of theories presented by Miller and Modigliani (1985), Smith and Stulz (1985), and Froot et al. (1993).

1.4. Research problem

It is evident from the review of literature that in emerging markets, the exploration of the relationship between corporate hedging and firm value is limited in terms of its focus on specific industries. Furthermore, there is a limited scope of knowledge about such a relationship in the SA mining industry. It is important to pursue such a study on the SA mining industry as there is a lack of consensus on the benefits and value-enhancing capabilities of risk management practices such as hedging in the industry. On the one hand,

Maier (2013) suggests that risk management entails the incurrence of substantial costs in the SA mining industry, which could diminish value offered to investors and stakeholders.

The argument of diminished value from price risk management is further revealed by Armstrong, Galli, Lautier and Ndiaye (2009). According to Armstrong et al. (2009), hedging was seen as a limitation on the upside potential of gold mining firms during periods of high gold prices, which resulted in the gold mining firms dropping their derivative-based hedge books. This ensured that the mining firms could exploit the upside potential of high gold prices. In such instances, hedging against price risk exposure for gold mining companies would have limited the returns on the upside potential of commodity prices, which might have also diminished shareholder value. In a contrasting argument concerning the importance of hedging, Maier (2013) believes that risk management gives rise to a better understanding of the companies' risk profile, while maximising shareholder value. Although the mitigation of key risks facing companies is deemed to be important, there is a lack of clarity and consensus on the benefits and value enhancing capabilities of risk management practices like hedging in the industry.

According to Correia, Holman and Jahreskog (2012), commodity- producing companies in SA, including mining companies, continue to manage financial risks through derivative-based hedging. There is still uncertainty in terms of the extent to which hedging against financial risks affects the value offered to investors in the overall SA mining industry. Therefore, the significance of the relationship between risk management through derivative-based hedging on the firm value of SA mining companies will be determined in this study.

1.5. Research aim and research objectives

The aim of the study is to establish the effect of derivative-based hedging on the firm value of SA mining companies. To investigate the main aim, the following objectives will be used in assessing the relationship:

a) The first objective is to classify the South African mining firms as either "hedgers' or "non-hedgers".

b) The second objective is to determine if a hedging premium (or discount) is awarded to mining companies that hedge against the adverse effects of the identified price risks.
c) The third research objective is to determine if the hedging premium (or discount) to firm value continues to hold in the presence of control variables that have been documented as contributors to firm value.

1.6. Significance of the study

The findings of this study will not only help in fulfilling the research problem, but several stakeholders would also benefit from the research outcome. Such stakeholders include risk managers and decision makers in SA mining companies who have a mandate to create value for investors, as well as institutional and private investors seeking investment opportunities in SA mining companies that create excess value for their investors. Analysts who make recommendations to clients concerning SA mining equities could also benefit from this study. The last potential benefactors of this study would include commodity advisory and consultancy firms who provide expert advice and insights on treasuries, and commodities to SA mining companies.

1.7. Ethical considerations

The research will be subjected to the following ethical values:

Integrity: the findings that will be presented in the study will need to be reliable and true, without any omission or false representation of findings. The study will be designed in a manner that will appropriately fulfill the research aims and objectives.

Objectivity: the research will be conducted to promote objectivity. Therefore, it will be free from biases from the author. Only facts that have been deemed true through research regarding the subject matter will be presented in the paper.

Conflicts of interest: the research is conducted purely for scholarly purposes, and the author has no vested interests in the SA mining industry or any party that would hinder her judgement on the research findings.

1.8. Structure of study

The following outline will be followed in the pursuit of the study. A literature review will be presented in the next chapter to enable the reader to gain a contextual framework of the proposed research topic. Chapter 3 outlines the methodology that will help in fulfilling the research aim and objectives. The outcomes of the research findings will be presented in Chapter 4, which will be followed by a conclusion of the study in Chapter 5.

1.9. Conclusion

This chapter provided a background of the SA mining industry, as well as the risks that need to be addressed by managers of the firms. It is evident that financial risks are important factors affecting the value of companies in the industry. The study improves the limitation of empirical research in emerging markets regarding how the management of these risks affects firm value in the industry, specifically with regards to derivative-based hedging.

Chapter 2: Literature Review

"It takes a great deal of history to produce a little literature" – Henry James (1989).

2.1. Introduction

Derivative-based hedging is considered an important component for commodity-producing firms. The significance of this is drawn from an opinion by Miller (1997), who expresses that commodity-producing firms might incur losses if they do not hedge against commodity price risk. He further iterates that such firms should consider themselves gamblers since they are inadvertently taking a bet that the price of the produced commodity will not drop. Outside of commodity price risk however, commodity-producing firms also tend to hedge against other market risks, such as interest rate risk and foreign exchange rate risk. According to Sadorsky (2001), hedging against these risks is conducive to cash flow management in the mining industry. Other literature further suggests that the value of a firm could potentially be enhanced through the incorporation of hedging. Therefore, the aim of this chapter is to provide a contextual framework through literature in relation to the claim that hedging is a value-enhancing pursuit for firms. The exploration of theory is in line with the study that will be presented in the subsequent chapters. The layout of the literature in this chapter will follow the sequence set out below:

Firstly, the chapter will present the background and definitions of key concepts incorporated in the study, namely derivatives and hedging. Firms in the commodity sector commonly make use of derivatives for the purpose of hedging and this has been found to help in securing future prices of commodities, which are further influenced by interest rate and exchange rate fluctuations (Akram, 2009). Furthermore, hedging is also considered an important function of the derivatives market in various industries (Goldenberg, 2014). Therefore, an understanding of the derivatives market, its functions, and its importance in the process of hedging in a firm will initially be presented.

Secondly, general finance theories will be explored to understand the concept of firm value. Firm value will be defined in the context of its importance in the context of shareholders and stakeholders. The importance of hedging in influencing firm value will then be highlighted using the two theories underpinned by shareholders and stakeholders; these are the shareholder primacy theory and the stakeholder theory. In addition, the agency theory

will be used to merge these two theories of firm value together. From the general corporate finance theories on the firm, an expansion on the determinants of derivative-based hedging and how it influences firm value in each context will be presented. The chapter will conclude with a summary of the presented literature.

2.2. Exploration of key concepts: derivatives

The theoretical landscape on which the claim that derivative-based hedging is a value-enhancing pursuit for firms has been based on a combination of corporate finance theories. With the contrasting findings on the claim being presented by authors in different markets, it is important to understand what this means, which can be done by firstly understanding the background of the derivatives market and how derivatives have been incorporated into the hedging process.

2.2.1. The global derivatives market

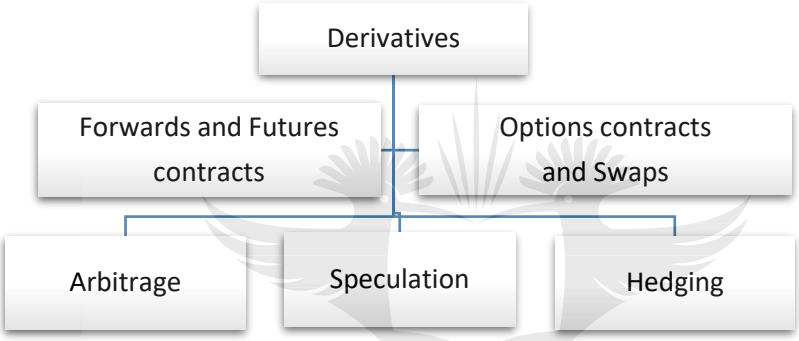
Derivatives have reached many milestones before becoming the sophisticated instruments that we see being traded on exchanges across the globe today. As shown in Annexure A, derivatives have moved from being exchanged by using clay tablets written in cuneiform script, to being traded on various platforms globally. According to the Bank for International Settlements (BIS) (2019), the worldwide derivatives market accounts for a notional amount of 108 trillion US Dollars (USD), while the over the counter (OTC) market is worth USD 640 trillion. The derivatives are largely denominated in USD, followed by Euros (EUR) and Japanese Yen (JPY).

In the SA derivatives market, the first type of a derivatives exchange was established through Rand Merchant Bank's central clearing house, which also acted as a market maker for derivatives (Adelegan, 2009). The company mainly traded bond and equity futures contracts and is now identified as "JSE (Johannesburg Stock Exchange) Clear". In recent times, the SA derivatives market has improved substantially in terms of its product offering, which has increased to about 1 000 derivative variations to meet both local and global demand (JSE, 2020). In addition, the derivatives market reach of the JSE has also improved from previously only turning over USD 6 trillion in 1995, to turning over USD 34 trillion in OTC derivatives in 2019 (BIS, 2019). Considering how large the derivatives market is, it is important to unravel what derivatives are and what their functions entail.

2.2.2. Definition of derivatives, derivative forms, and derivative uses

Derivatives are financial instruments that derive their value from the value of existing underlying assets (McDonald, 2014). The underlying assets are usually items that can be found being traded on an exchange, such as commodities, foreign exchange rates, bonds, interest rates and equities. However, derivative instruments can also derive their value from other variables which are not traded in exchange, such as the weather and electricity (Hull, 2015). The four main types of derivatives that exist based on underlying assets can take on the form of a forward contract, a futures contract, an option, or a swap, as shown in Figure 2.1. below:

Figure 2.1: Overview of derivative types and their uses



Source: Moosa, 2010

The futures and forward contracts are similar in that they are both contractual agreements of exchange of the underlying assets at a future date. The difference lies in the standardisation aspect, where futures contracts are traded on an exchange and the contract terms are standardised in relation to the price, quantity, quality, and timing of the exchange of the underlying assets. In contrast, forward contracts are instruments that are traded OTC and the contractual terms can be negotiated between the counterparties (Hull, 2015). Furthermore, futures contracts are settled daily, require more margin, and are said to be more liquid, while forwards tend to not display the same characteristics (Chen & Park, 1985). The disparities between the two can be found in Annexure B. In addition, options contracts are derivatives that offer the buyer the right, but not the obligation, to either buy or sell the underlying asset at a predetermined price on a specified day. Options can come in the form of either a call or a put option, where the former provides the holder with the right (not the obligation) to buy, while the latter provides the holder with the right (not the obligation) to sell the underlying asset at a predetermined strike price (Hull, 2015). A further

distinction of an option lies in its classification, where it can be classified as either an American option or a European option. The distinction between the two lies in the timing of the execution of the right to either purchase or sell the underlying asset. As stated by Ramaswamy and Sundaresan (1985), an American option can be exercised either on or before the predetermined date at the specified price, whereas the European option can only be exercised at the contract's expiry date (Abdou & Moraux, 2015).

According to Stentoft (2004), a large proportion of options that are traded on various exchanges fall within the American-style option category. However, the majority of the studies on options have concentrated on European options for simplicity as American options are deemed to be more complicated, and its intricacies stem from their exercisability (Jarrow, 1994). Another complicated derivative form is the swap, which is defined by the CFA Institute (2019) as an OTC instrument that enables market participants to exchange or swap future cash flows. The exchange occurs when a party to a swap contract exchanges his fixed cash flow for a variable cash flow of the same underlying asset with another counterparty. However, if the contract is a basis swap agreement, the exchange of cash flows would be based on two variable underlying assets, such as differing interest rates. The swap market is not as big as the forward and the futures markets, but a plethora of research exists that relates to swaps. The studies are based on the variety of swaps that exist in the market, such as interest rate, currency and volatility swaps, as shown by Boukrami (2003), Boenkost and Schmidt (2005) and Swishchuk and Vadori (2014). However, the most prevalent theme concerning swaps is centred around the infamous credit default swaps, whose misuse were responsible for one of the biggest black swans that caused widespread panic across the globe in the 2007/2008 financial crisis.

Other derivatives that are found in the market are hybrids of the basic four which can be seen in Annexure C (Fabozzi & Markowitz, 2011). The derivatives variations that now exist can be used to fulfil the needs of numerous market participants. As shown in Figure 2.1. above, this could be to either create arbitrage opportunities, speculate into the future or to simply hedge against price risks. The first concept of arbitrage can be explained as the process of gaining risk-less profit by simultaneously buying and selling an underlying asset to take advantage of the discrepancies that exist in its price in different markets (Shapiro, 2002). As with arbitrageurs, speculators have a motive to make profits, but the difference is

that speculators take on more risk to attain the profits. According to Islam and Chakraborti (2015), speculators generally take positions based on their anticipation of future underlying asset prices and therefore take on more risk to potentially make these profits.

In diametrical contrast to both speculators and arbitrageurs, hedgers aim to avoid risks by attempting to eliminate their risk exposures on underlying assets, which is done by offsetting their existing positions with an equal position in the opposite direction (Moosa, 2010). All the uses of derivatives complement one another, without which certain roles would cease to exist (Moosa, 2010). For instance, arbitrage theory is grounded on the assumption of an efficient market, where prices in all markets represent all existing information about systemic and systematic risk. Therefore, any discrepancies in price between similar commodities or exchange rates will be erased by profit-seeking economic agents known as arbitrageurs (Tun, 2020). This enables hedgers to have the confidence that the market will remain efficient, enabling a level of certainty in the market which firms can use to manage risk. However, this does not mean that the volatility inherent in commodity and financial markets is limited. As stated by Acharya, Babu and Mahalik (2009), price volatility in various markets is the driving force behind hedging against risks.

In emerging markets, a few researchers have explored the idea of how hedging against such price risks affects the firm value of non-financial firms. The findings by Lau (2016) suggests that firms in Malaysia derive a discount in firm value when derivatives are used in their hedging processes. Furthermore, research by Ayturk et al. (2016) suggests that the firm values of Turkish firms are not affected by their decision to hedge against price risk. In SA, such a study has been conducted by Lambrechts and Toerien (2016), based on a combination of the country's Top 40 non-financial firms in different industries, including financials, pharmaceuticals, telecommunications, and resources. According to the authors, the use of derivatives to hedge against risks did not result in a firm value add for the analysed firms. However, the extent to which the process of hedging affects the value of firms within the SA mining industry is not well known, even though the industry is a crucial component in the local economy and global markets. The industry is a top exporter of global commodities as shown in Table 2.1., while simultaneously accounting for 18% of the market capitalisation of the JSE (JSE Mining Indaba, 2019).

Table 2.1.: Major Net-Import Sources for the United States of America in 2018

Commodity	Country Import Rankings			
	1st	2nd	3rd	4th
Garnet (Industrial)	Australia	India	South Africa*	China
Abrasives, Silicon Carbide (Crude)	China	Netherlands	South Africa*	Romania
Gemstones	India	Israel	Belgium	South Africa*
Fluorspar	Mexico	Vietnam	South Africa*	China
Manganese	South Africa*	Gabon	Australia	Georgia
Titanium Mineral Concentrates	South Africa *	Australia	Canada	Mozambique
Platinum	South Africa *	Germany	United Kingdom	Italy
Chromium	South Africa*	Kazakhstan	Russia	-
Palladium	South Africa*	Russia	Italy	United Kingdom
Vermiculite	South Africa*	Brazil	China	Zimbabwe

** Highlights the South African ranking of the commodity supply to the USA.*
Source: Author compilation based on U.S. Geological Survey (2019)

Therefore, in view of the importance of the industry on a local and global scale, understanding how firms in the industry are affected by derivative-based hedging is important for various stakeholders, especially potential investors. This can help them make more informed decisions about the value of their investments when considering making investments in SA mining firms that employ derivative-based hedging as a risk management strategy. However, hedging cannot be explored without first unravelling what it implies. Therefore, the concept of hedging will be explained further in the next section.

2.3. Hedging concepts and disparities between hedging strategies

Hedging is defined by Kolb (1995) as a transaction that is designed to offset some existing or anticipated risks. Vaughn (1997) expands on this definition by stating that hedging is a method of risk transfer which is accomplished by buying and selling an asset for future delivery, whereby dealers and producers of the assets protect themselves against a decline or an increase in the market price of the assets. Hedging can therefore be used to describe a risk management strategy. The characteristic of reducing and eliminating risks has made hedging analogous with providing insurance (Downey & Scott, 2020). The difference between insurance and hedging will be explained below.

2.3.1. The difference between hedging and insurance

According to Baker and Filbeck (2018), the difference in the two risk management strategies lies in each strategy's capacity to reduce or eliminate specific types of risks relating to three risk categories affecting companies. The three risk categories include credit risks, pure risks, and price risks. Firstly, credit risk is the risk that firm debtors will default on their obligation to pay what they owe to the firm. Operational systems such as fin-tech and client relationship management systems are used to pre-empt credit risk and therefore help in mitigating against it (Gomber, Kauffman, Parker & Weber, 2018).

The second risk, specified as pure risk, refers to risks surrounding personal, property and liability risks (Kagan and Berry-Johnson, 2021). The pure risks are said to result in two outcomes, which can be a no loss or total loss situation, which is usually indemnified by using insurance. The final risk affecting firms is price risk, which encapsulates the key risks facing various industries and economies, which are commodity price risk, exchange rate risks and interest rate risk (Baker & Filbeck, 2018). The effect of these factors is illustrated by Adesanmi (2018), who investigates how interest rates, exchange rates and commodity prices affect emerging markets by examining their effect on MINT countries (Mexico, Indonesia, Nigeria and Turkey). The author finds that stock market returns in Mexico, Indonesia and Turkey are primarily driven by exchange rates and interest rates, while the Nigerian stock market returns are more sensitive to changes in commodity prices. One could infer that the findings in Nigeria are a result of the country's key exportation of the oil commodity, thereby being more affected by the changes in commodity prices.

Another study which aims to find the sensitivity of emerging market stocks in relation to commodities during crisis periods was conducted by Mensi, Hkiri, Al-Yahyaee and Kang (2018). By analysing the response of BRICS countries (Brazil, Russia, India, China, and SA), the authors find a high correlation between the countries' stock price returns and crude oil in the early phases of crisis periods. In contrast to the crude oil price reaction, the gold commodity yielded a lower price sensitivity against the BRICS stock price returns, indicating gold as a good hedging tool against stock market volatility during crisis periods for these countries. It is therefore evident that the stock market returns of noteworthy countries in emerging markets are affected by price risks, which are interest rate, exchange rate and commodity price risks. As such, price risk is mitigated against through hedging. Therefore,

insurance and hedging are not the same, as their disparity lies in their reduction of different categories of business risk. The pure risk category is mitigated through insurance, while price risk is reduced through hedging. Considering that hedging also helps in mitigating against risks that have been identified as key risks affecting the mining industry (i.e., price risks), it provides a good basis to explore further in terms of the different hedging strategies where it can be applied.

2.3.2. Distinction between operational and financial hedging

The process of hedging can be achieved through one of two conducts, either through operational hedging or through financial hedging. Operational hedging is defined by Boyabatli and Toktay (2004) as the course of action that protects the firm against risk through operational activities that do not involve the employment of financial instruments. An example of this would be to locate a firm's operations in the country where it receives a significant portion of its revenues. As explained by Laing, Lucey and Lűtkemeyer (2020), such a strategy reduces the adverse effects of changes in foreign exchange rates and foreign demand, since the respective changes would be offset by similar changes in the value of production costs. Furthermore, this provides reasoning for companies to embark on foreign direct investment (FDI) pursuits. The notion is supported by Kim, Mathur and Nam (2006), who state that operational hedging can be done through geographically diversifying a company's operations.

In addition, an operational hedge can also be achieved by creating a "natural hedge", where the denomination of revenue streams and financial costs are aligned (Boyabatli & Toktay, 2004). Such an instance can be witnessed from the debt restructure that was undertaken by the SA based multinational pharmaceutical company, Aspen Pharmacare in 2016. The company's debt was initially solely denominated in USD, while it received most of its international revenue in EUR, Australian dollars (AUD) and ZAR. This mismatch between revenue streams and debt resulted in an incurrence of additional debt when the local currency fluctuated against the USD, as there was not enough USD on hand for the firm to offset the downswing in the USD/ZAR exchange rate. Hence the restructuring of debt from USD into AUD, EUR and ZAR provided a beneficial operational hedge and placed the company in better alignment with the key currencies from which it received its revenue

(Aspen Pharmacare, 2016). This instance serves as evidence of how operational hedging contributes to minimising risk and reducing volatility of a firm's cash flows.

Another form of hedging is financial hedging which is derivative based. This form of hedging aims to reduce risk by taking a risk-offsetting position in the derivatives market. As findings by Bodnar, Hayt, Marston and Smithson (1995) imply, the key objective of hedging is to minimise against possible fluctuations in cash flow. One way of illustrating this is by considering an oil producer who has an existing long position in oil. If they were to consider the recent oil climate, where the demand for oil reduced significantly amidst the Coronavirus (Covid-19) pandemic which has limited movement across the globe, they would anticipate a potential decline in the oil price. The seller would close off their exposure on the long side by taking a derivative position in the opposite direction, thereby going short in the oil market in order to lock in an oil price or "hedge" against the risk that the price may decrease. This would significantly reduce their risk exposure in the oil market. According to Kim et al. (2006), companies tend to take the derivative-based hedging approach if they have not operationally hedged their exposure to the risks that are in tandem with their amount of export sales.

2.3.3. Arguments on the importance of operational and financial hedging

The importance and effect of the two types of hedging strategies have been studied by many researchers and scholars. In the US airline industry, Treanor, Simkins, Rogers and Carter (2014) analyse the importance of jet fuel hedging using financial and operational hedging. While they find both methods of hedging to be effective in reducing the airlines' exposure to jet fuel price volatility, operational hedging was deemed more important in attaining lower exposure to price risk. However, contrasting findings are presented by Berghöfer and Lucey (2013), who consider the impact of jet fuel price hedging and find that neither operational nor financial hedging is effective in reducing price risks for global airlines.

The discrepancies in the two findings could be based on country-specific factors, as the latter study included airlines in European and Asian markets, while the former study only related to the US airlines. A different industry where the interaction between operational and financial hedging is analysed is the financial industry. By using acquisitions as a proxy for operational hedging, Hankins (2011) finds that this form of hedging significantly reduces the

tradable exposures of bank holding firms. Furthermore, the author finds a steep decline in financial hedging when operational hedging is increased through acquisitions, indicating an inverse relation between the operational and financial hedging in the bank holding industry. It can therefore be said that the implementation of operational hedging is effective in reducing price risks in different industries across the globe.

However, operational hedging is said to be less important for commodity-based companies as commodity price is more uncertain than quantity output (Chowdhry & Howe, 1999). This notion has been contested by various scholars. Wong (2007) explores these two concepts and finds that operational hedging is inferior in affecting the output of a firm, which reinforces the claim. In contrast, Laing et al. (2020) state that an operational hedge is more effective in reducing foreign exchange risk exposure over the long run, while financial hedging is found to have a better efficacy on exchange rate risk over the short-term. Similarly, Pantzalis, Simkins and Laux (2001) find that operational hedges that are well-constructed tend to lead to lower currency exposures for companies that either have a positive or negative exposure to risk. However, by observing the impact of financial and operational hedging in the oil and gas industry, Laing et al. (2020) discover that commodity price exposure can only be reduced by financial hedging and not operational hedging. These findings imply that financial hedging is a more effective means of hedging against commodity price risk, making it more appropriate for commodity price risk mitigation purposes. While both financial and operational hedging have differing levels of importance in various industries, some literature suggests that both hedging strategies can either be combined or used interchangeably.

2.3.4. The interactive relationship between operational and financial hedging

Insofar as operational and financial hedging are viewed as two separate means to an end in terms of reducing risk, Kouvelis, Pang and Ding (2018) suggest that the two types of hedging strategies can be conjoined in achieving this objective. According to Lim and Wang (2007), operational and financial hedging are complementary components of hedging; this sentiment is also supported by Kim et al. (2006). However, existing research on the complementary relationship between operational and financial hedging is inconclusive. On the one hand, Treanor (2008) observes this relationship in the airline industry and finds that the airlines that operationally hedge are also more likely to financially hedge using

derivatives. In contrast, other authors find that operational and financial hedging play a more substitutive role with each other in the risk reduction process. By observing these two forms of hedging in gold mining firms, Petersen and Thiagarajan (2000) found that the firms which operationally hedge across their different production lines are less likely to also incorporate financial hedging in reducing risk, while the opposite is true for the firms that are not operationally hedged. Regardless, other literary findings suggest that firms can operationally hedge away the majority of their risks, while integrating financial hedging to improve on managing the remaining risks (Guay & Korthari, 2003).

An additional finding on operational and financial hedging is presented by Choi and Jiang (2009). According to the authors, the exchange rate risk exposure of non-multinational firms is higher, while the exchange rate risk exposure of multinational firms is lower in comparison. This is mainly due to the ability of multinational firms to operationally hedge their risk across their international subsidiaries. The sentiment on the multinational hedging through international subsidiaries is shared by Kim et al. (2006), who find that multinational firms are less likely to financially hedge against exchange rate risks. This further reinforces the complementary relationship between operational and financial hedging in firms from a multinational context. Therefore, hedging in the foreign exchange markets using derivative-based hedging is more important for non-multinational firms that are exposed to exchange rate risks. This is because the non-multinational firms do not receive foreign currencies that can be used as a natural hedge to operationally hedge against global exchange risk exposures.

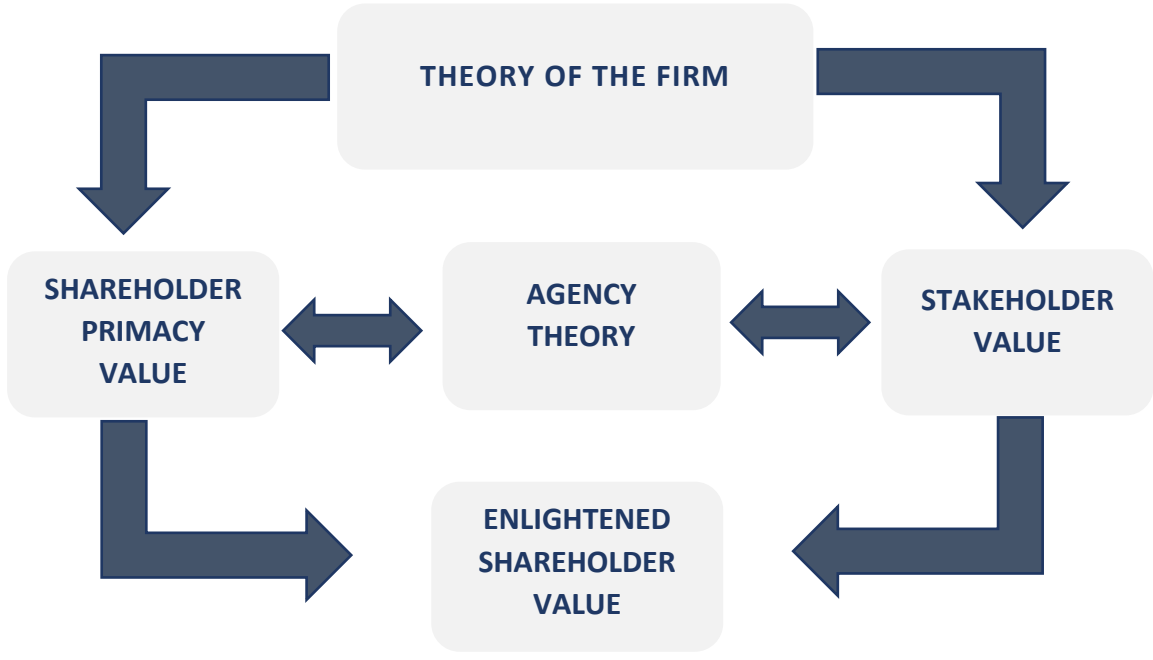
Price risk is still a factor which affects both developed and emerging markets. As global investors seek investment opportunities in emerging markets, they are still concerned about the risks inherent in them (Umoetok, 2013). The management of these risks is important as it enables stability and reliability of the firms. Most research in this area has been conducted to illustrate how hedging against risk affects the firm value of firms in developed markets. While some research has been conducted to focus this relationship on emerging markets, it is still relatively limited, especially in terms of industry-specific studies. Therefore, it is important to understand the effect of risk minimisation pursuits like hedging, in terms of how they impact the value industries in emerging markets. As such, this study focusses on the effect of hedging on the SA mining industry. As expressed by Dionne, Chun and Triki

(2019), managing risks through hedging results in firm value maximisation. Several studies have explored the effect of managing risks through financial hedging on firm value maximisation, and the results have been inconclusive in both emerging and developed markets, as shown by authors such as Aretz et al. (2007), Jin and Jorion (2007), Lookman (2004), Gomez-Gonzalez et al. (2014), Krause and Tse (2016), dos Santos et al. (2017), and Alam and Gupta (2018). Since hedging serves as an important component of corporate finance in terms of its influence on firm value, various general theories in the field of finance and investment management have been used to explain this phenomenon. Therefore, starting with the theory on firm value, the following section will incorporate general finance and investment management theories to explain the impact of derivative-based hedging on firm value.

2.4. General finance theories relating to the impact of derivative-based hedging on firm value

The previous section outlined the two different forms of hedging, with a specific focus on financial hedging, which is derivative based. Considering that the aim of this research is to investigate the impact of derivative-based hedging on firm value, it is important to also define and explain the concept of firm value. The elaboration on the firm value concept will be explained in terms of the general finance theories concerning the firm, as outlined in Figure 2.2 below.

Figure 2.2: The fundamental theories which encapsulate the theory of the firm, in relation to firm value.



Source: Author compilation

The first finance theory that will be used in defining and explaining the firm and firm value is the shareholder primacy theory, which will be followed by the stakeholder value theory of the firm. Considering that both theories can be interlinked by means of agency, it is also necessary to explore the agency theory, which plays a crucial role in the firm. From these definitions of the firm, a further exploration on how derivative-based hedging affects the firm will be conducted as per the definitions provided by the shareholder primacy, the agency, and the stakeholder theories of the firm.

2.4.1. The Shareholder Primacy Theory of the firm

The shareholder primacy theory of the firm emanated from "The Great Debate" between Adolf Berle and Merrick Dodd, as documented in the Harvard Law Review of 1932 (Stout, 2012). On the one hand, Berle supported the notion that the lawful purpose of the firm is to serve shareholder interests as they are the primary owners of the firm. The theory was later developed by Friedman (1970), who won a Nobel Prize after publishing what the theory entails in the New York Times Sunday Magazine. According to Friedman (1970), the existence of a firm is defined by its submission to primarily satisfy the interests of shareholders, since the shareholders own the company. Therefore, its sole purpose is to generate wealth for shareholders by any legal means necessary (Jensen & Meckling, 1976). This argument has largely been criticised by various scholars, who support the stakeholder value theory of the firm. According to Stout (2012), the premise presented in the shareholder primacy theory provides a distorted function of a firm, as its adoption places the interests of other parties, such as corporations, managers, investors, and the public, in harm's way. The interests between these parties and shareholders are married through the agency theory.

2.4.2. A brief overview of the Agency Theory

The agency theory emanated from an argument by Jensen and Meckling (1976), who suggest that a misalignment of interests between shareholders and managers could potentially result in the reduction of the shareholders' utility, in terms of maximizing shareholder wealth (Laplume, Sonpar & Litz, 2008). The first application of the theory is based on positivist propositions, which are centered on how governance structures can be used to combat against the dissimilarities of interests between the principal and the agent in an agreement or contract. Complementarily, the principal-agent application of the agency

theory is focused on relationships and the impact of “moral hazard” and “adverse selection” in contracting conditions. This means that the principal would need to come up with a contract that would be the most efficient for both parties, considering factors such as varying degrees of certainty, goal conflict, information asymmetries, task probability, risk aversion, contract length and task programmability (Fontrodona & Sison, 2006). The examination of these factors would determine whether a behaviour-based approach or an outcome-based approach should be used in the origination process of a contract between the principal and agent (Lee, 2013). Considering that derivative-based hedging is based on contractual agreements between a firm and its managers and external capital providers such as shareholders and debt providers, the underlying factors of the agency theory are to be considered in the hedging process.

While an abundant amount of research concerning the firm and its value has been based on the premise of the shareholder primacy theory which focuses on wealth maximisation, an antagonizing branch of research concerning the firm’s purpose suggests that firms need to consider the interests of other key stakeholders. The focus on stakeholders outside the traditional shareholder framework of firm value was introduced by Freeman (1984), who classified the firm’s purpose under the stakeholder theory.

2.4.3. The Stakeholder Theory of the firm

Based on the theory proposed by Freeman (1984), the agency theory comes into play by extending the purpose of the firm to stakeholders, as explained by the stakeholder theory. The stakeholder theory recognizes the firm as a nexus of multiple principal-agent relationships that presumably drive both shareholder and firm value (Fontrodona & Sison, 2006). The principal in this instance would be the company itself and the agents include parties such as debtors, clients, employees, shareholders, and managers. Each stakeholder’s interests are dependent on the success or maximised value of the firm, which makes it important for the firm to merge the different interests of each stakeholder (Harrison, Barney, Phillips & Freeman, 2019). As such, both the stakeholder and shareholder interests could be potentially preserved or enhanced if a company hedges against risks that could have adverse effects on the value of the company. It is for this reason that the implications of hedging on firm value will be explained, based on the shareholder primacy theory and the stakeholder theory of a firm.

2.5. The entailment of derivative-based hedging on firm value as defined by the general finance theories

The management of risk through hedging has been said to provide value-enhancing incentives for a firm (Allayannis & Weston, 2001). However, the ownership of these firm value incentives has been a much-debated issue in relation to the purpose of a firm. In the preceding sections on the general finance theories of the firm, firm value was explained in terms of its definition based on the shareholder primacy and stakeholder theories. Therefore, in this section, starting with the shareholder primacy theory of the firm, the effect of hedging on a firm will be highlighted in relation to how it enhances value for both factions of the firm, which are the shareholders and the stakeholders.

2.5.1. The impact of hedging on firm value based on the Shareholder Primacy Theory of the firm

Many studies have based the firm value-enhancing capabilities of hedging on the shareholder primacy theory of the firm. This theoretical paradigm emanates from the financial economics approach to risk management, which is based on the corporate finance theory that was proposed by Miller and Modigliani (1958). The theory suggests that the corporate structure of an organisation is irrelevant to its firm value in both perfect and imperfect market conditions. This implies that decisions made by management are not beneficial to the firm's value in from a corporate finance context. The theory has been explored and modified into theories by many researchers and scholars over the past two decades. One such outcome is the hedging propositions, which suggest that management decisions such as risk hedging do not equate to an improved firm value in organisations, under perfect market conditions (Klimczak, 2007).

The unaffected firm value argument is based on the irrelevance of certain costs in the Miller-Modigliani trade-off theory, where certain costs are deemed unimportant in affecting a firm's value. Such costs include agency costs, bankruptcy costs, external capital markets and debt capacity issues, financial distress costs, information asymmetries, tax benefits, optimal capital structures and underinvestment problems, as described by various authors like Smith and Stulz (1985), Froot et al. (1993), and Graham and Rogers (2002). Literature concerning the implications of these costs for firm value will be explained further.

A large amount of research has been conducted to attest as to whether the Miller-Modigliani irrelevance theory holds in affecting shareholder value. However, the findings have been inconclusive as some authors find evidence which support the theory, such as Lookman (2004) and Lambrechts and Toerien (2016). In contrast, other authors, such as Allayannis and Weston (2001), Carter et al. (2006), and Bessler, Conlon and Huan (2018) contest the theory by presenting findings that oppose the notion that hedging is not a value-enhancing management decision. Additionally, other authors find that hedging is value enhancing for firms only during periods of high volatility (Aretz et al. 2008). The authors who contest the notion by Miller and Modigliani (1985), support theories set out by early researchers determining of the effectiveness of hedging in enhancing firm value. These theories consist of agency factors that enable the effectiveness of hedging on firm value and will be examined in the following subsections.

2.5.1.1. Examination of factors determining the effectiveness of hedging in enhancing firm value, in accordance with the shareholder primacy theory of the firm.

According to researchers such as Smith and Stulz (1985), Froot et al. (1993) and Graham and Rogers (2002), certain agency costs cannot be ignored in determining the impact of management decisions on firm value. By considering these agency costs, the firms could find firm value-enhancing properties of hedging. Therefore, starting with agency costs such as information asymmetries, literature concerning the irrelevance theory of hedging in affecting firm value based on the Miller-Modigliani argument will be explored further in the subsections that follow.

Information Asymmetries

A seminal paper that contributed to the development of the classical finance theory of risk management and hedging was presented by Stulz (1996). According to Stulz, there are two pillars embedded in the risk management theory of hedging, namely market efficiency and diversification. The first pillar of an efficient market is described as a market where the price of any investment is a thorough representation of all the information that is available about it. If the information is freely available to the public about a firm, it would not be easy for the investment to be mispriced in the market as it would incorporate all existing information concerning it. Therefore, according to DeMarzo and Duffie (1995), as well as Stulz (1996), when information about the hedging practices of a firm is made public, it reduces the

information asymmetry about a firm between management and key stakeholders, especially shareholders.

Early literature supports the view that the hedging practices of a firm are an indication of a firm's level of financial distress. A study by Fernando, Hoelscher and Raman (2020), presented findings which support the early literature, as they observe that gold mining companies tend to undertake hedging when they are under financial distress. According to DeMarzo and Duffie (1995), information about hedging tends to affect shareholder decisions to either maintain their stake in the company or not. The authors attribute this reason to the findings which suggest that managers are more likely to hedge accounting risks as opposed to economic or market risk, as it will influence shareholder perception.

However, this study was presented at a time when disclosure of derivative-based hedging was not required. Since then, the International Accounting Standards Board (IASB) introduced IFRS 7 in August 2005, where the measurement of financial instruments such as derivatives was changed to provide investors with a fairer representation of their value, as well as their hedging usage (Ramirez, 2015). The disclosure requirements of derivative-based hedging have continued to be amended in periods between 2005 and 2019 to incorporate the new IFRS 9. This came about as a result of concerns expressed by industry professionals such as the Chartered Financial Analyst (CFA) charter holders. In a survey on Global Market Sentiment Survey conducted by the CFA Institute in December 2014, the CFAs express that the previous standards governing the hedging disclosure of derivatives were inadequate in expressing the risks associated with their implementation within firms. In addition, CFA professionals in China and India signalled the disclosure and use of derivatives as one of the most serious ethical issues concerning global markets – after fraud and market trading malpractices (CFA Institute, 2013).

The amendments in disclosures of derivative-based hedging have contributed to combatting against information asymmetries between managers and shareholders, which has encouraged studies that have enlarged the body of knowledge on whether informational asymmetries are a true determinant of firm value when firms hedge using derivatives. One such study was pursued by Ameer (2010), who aimed to find the determinants of corporate hedging in Malaysian firms. The authors found that smaller firms are more susceptible to more information asymmetries, amongst other things, such as higher financing costs. The

high financing costs and high information asymmetries are said to induce the need for the smaller firms to hedge against risks. However, according to Choi, Mao and Upadhyay (2013), higher information asymmetries are not such a bad thing for firms who hedge. By observing the effect of higher information asymmetries in firms that hedge within the US Biotech industry, the authors find that the firm values of the companies are significantly enhanced. Furthermore, the Biotech firms which had higher information asymmetries showed better growth prospects.

This contrasts with findings presented by Qiao, Xia and Zhang (2020). The authors investigated the impact of hedging on the firm value of Initial Public Offering (IPO) firms, and whether the information asymmetries are a significant contributor to the firms' value enhancement or reduction. The authors ascribe IPOs to high information asymmetries as they are still new to the market. As such, the authors find that hedging reduced the level of information asymmetries. Furthermore, by using under-pricing as a proxy for firm value, the authors find that hedging reduced the under-pricing, thereby contributing to a higher firm value of the IPOs. Additional benefits of hedging for the IPO firms were found to be reduced idiosyncratic volatility, enhanced aftermarket liquidity and better long-term performance. A supplementary study presented by Fauver and Naranjo (2010) supports these findings concerning the impact of informational asymmetries. By using Tobin's Q as a proxy for firm value, the authors studied how derivative-based hedging influenced the firm value of US firms.

The findings indicated that hedging enhanced the firm value of the firms, however, this effect ceased to exist when these firms had worse information asymmetries - amongst other agency issues. Therefore, the different researchers and scholars present findings that seem to have consensus which indicates that hedging reduces the information asymmetry between managers and shareholders, which in turn contributes to a higher firm value. This suggests that shareholders tend to value firms that are more transparent with information, which makes for an efficient market, in line with the early theory presented by DeMarzo and Duffie (1985). The information about a firm's hedging activity has been said to be an indicator of whether a firm is financially sound or under financial distress. The implications of hedging and costs of financial distress on a firm will be reviewed in the following subsection.

Financial Distress costs

In a seminal paper aiming to find the factors determining the effect of hedging on firm value of different companies, Smith and Stulz (1985) found that hedging reduces the costs of financial distress, which in turn improves the firm value. The authors supported this statement by stating that hedging reduces the probability of incurring additional financial distress costs, which reduces volatility and enhances firm value. The statement presented by the authors encouraged further studies to determine the relationship. Early studies on this relationship date back to the late 20th century and early 21st century, where different authors, such as Gay and Nam (1998) and Howton and Perfect (1998), presented findings on whether financial distress costs encourage firms to hedge. By using financial leverage as a proxy for financial distress, the different authors found a positive and significant relation between the probability of incurring financial distress costs and the decision for firms to pursue hedging strategies.

In attempting to find out if the opposite is true, Magee (2013) studied the effect of foreign currency hedging on the probability of financial distress costs. Instead of using financial leverage as a proxy for the probability of financial distress, the author used a Merton's structural default model. The findings of the study revealed that the lower probabilities of financial distress probed firms to hedge more, which is contrary to the suggestion made by Smith and Stulz (1985), as well as the findings presented by early supporting authors. However, by using the same measures in terms of finding out the relationship between foreign currency hedging and the probability of financial distress costs, Bhagawan and Lukose (2017) warranted the claims by all the early authors. According to Bhagawan and Lukose (2017), firms used more foreign exchange currency derivatives to hedge in the event of higher probabilities of financial distress costs and if firms had higher exposure to foreign currency risk. Additional findings by Haushalter (2000) indicated that firms with high debt levels tended to hedge more as they had a better incentive to hedge, since hedging reduces the costs of potential financial distress.

Another branch of literature aiming to address hedging and financial distress costs is based on the types of firms which hedge costs of financial distress. A study by Liu, Zhang and Chen, (2014) aimed at finding the extent of hedging by firms which were classified under different levels of financial distress. The authors analysed the relationship between the volatility of

returns of Taiwanese companies and their optimal hedge ratios. It was found that companies on the far ends of the "financial distress" spectrum (extremely distressed and non-distressed) had a negative relation with their optimal hedge ratios. This means that highly distressed and highly stable Taiwanese companies hedged less. In contrast, companies that fell in the middle part of the spectrum in terms of being financially distressed were found to hedge more, as their relation to their respective optimal ratios was positive.

In the mining industry, a similar study was presented by Adam, Fernando, and Salas (2017), where the authors investigated the reasons behind selective hedging in the Indian gold mining industry. According to the authors, selective hedging was undertaken in accordance with the extent to which the company was financially distressed. In addition to being financially distressed, the smaller gold mining firms were found to hedge more than the bigger ones. The greater hedging in smaller firms implies that they have a higher probability of being financially distressed. The susceptibility of financial distress by smaller firms is examined by Jahur and Quadir (2012), who initially stated that smaller firms in Bangladesh are good contributors to the economy as they create employment and thus contribute to the GDP.

At the same time, smaller firms were found to be more prone to incurring financial distress costs as they were more vulnerable to internal management issues and macroeconomic crises. These findings on small firms provide context as to why smaller firms would hedge more, as found by Adam et al. (2017). Therefore, it can be said that the probability of financial distress costs is a potential reason or determining factor in a firm's decision before engaging in hedging pursuits. More literature assumes that an additional determinant of pursuing hedging strategies is the potential for firms to reduce the agency cost imposed by taxes. The tax benefit of hedging will be reviewed in the next subsection.

Tax Benefit

Another factor that has been identified as a motivation for hedging is recognised as a company's corporate tax structure, which makes it advantageous for firms to take positions in the derivatives market (Smith & Stulz, 1985). According to Stultz (1996), a hedging strategy that reduces the risk of fluctuating taxable incomes can reduce the variability of

pre-tax firm values, which in turn reduces the expected fluctuation in the corporate tax liability. As a result, the expected post-tax value of the firm would be more stable. Furthermore, the reduced probability in the costs of financial distress which stem from the hedging effect improves the debt capacity of a firm (Wahl & Brohll, 2007). According to Leland (1998), the improved debt capacity encourages firms to increase their financial leverage, which also increases the interest payments that a firm must make on their increased debt obligations. The increased interest payments provide a wider tax shield for the firms, which reduces the amount of tax that firms need to pay. Graham and Rogers (2002) found evidence supporting this, where the firms that hedged increased their debt capacity by 3%, and this resulted in an improved tax shield of 1.1%.

The benefit of a reduced tax obligation is further restated by Graham and Smith (1999), who mention that hedging incentivises a firm by reducing its expected tax liabilities. However, the theory on tax benefits only holds if the costs of hedging are inexpensive (Smith & Stulz, 1985). This sentiment is echoed by Graham and Rogers (2002), who find that hedging is a valuable pursuit when costs of hedging are smaller than the tax benefits. These tax benefits of hedging have been explored by a limited number of researchers. Such a study was explored by Graham and Smith (1999), who also presented findings in line with Smith and Stulz's (1985) theory, where hedging significantly reduced the tax liability of firms whose tax function is convex, which further provided them with an incentive to hedge. Another hedging incentive that the authors found was that the taxable income volatility of firms with a convex tax function was stabilised by 5% through hedging, which in turn resulted in a taxable income saving of 5.4% on average.

However, Guay (1999) found that tax convexity is not a very common trait of many firms, which may hinder them from receiving this tax benefit of hedging. This still contradicts the findings presented by Graham and Smith (1999), whose sample consisted of 75% of firms which had convex tax functions. Even so, Graham and Rogers (2002) agree with Guay (1999), in that they fail to find evidence that suggests that hedging reduces tax liabilities when the tax function is convex. In addition, research undertaken by Wahl and Brohll (2007), investigates the impact of corporate hedging through derivative futures and how it affects ordinary income tax and unified income tax. The authors find that firms tend to engage in higher risk projects in response to increased tax rates, which reduces the tax

hedging benefit in firms. Furthermore, while corporate hedging is tax sensitive, higher risks could reduce the tax-induced hedging incentive of a firm if it were to change its hedging position through derivative futures contracts.

Lastly, an article presented by Dorfman, Harter and Valestin (2013) aimed to provide guidance to US-based firms on how to derive tax benefits when using derivative contracts to hedge against risks, considering the new Dodd Frank Act in the USA. One way they suggest of achieving effectiveness is to use an agency registered with the Commodity Futures Trading Commission to enter into derivative hedge positions. This is advised because such a transaction will not be subject to tax, which reduces the hedging expense for firms, further contributing to better profitability in the company and promotes firm value enhancement. Furthermore, the reduced hedging expense is in line with the condition in the theory presented by Smith and Stulz (1985), in that hedging can enhance firm value if the costs of hedging are relatively lower than the tax benefit. In addition to the tax benefit, hedging is said to enhance firm value by improving debt capacity of a firm, and this will be reviewed in the next section.

Debt Capacity

Past literature by Bessembinder (1991) and Froot et al. (1993) attributed the potential for a firm to free up debt capacity as a determining factor to engage in hedging activities. Since hedging is aimed at reducing a firm's risk exposure, it directly affects the cost of debt required by debt providers by reducing it (Cooper & Mello, 1999). The idea of a reduced cost of debt is reinforced by Ni, Chu and Qiang (2017), who state that costs of debt are a convex function of a firm's debt levels and likelihood of financial distress. Thus, the reduction of default risk through hedging would equally reduce the cost of borrowing. In addition, many researchers and authors have tried to establish whether the idea of improved debt capacity through hedging holds as a determining factor for a firm's decision to hedge.

A study that was undertaken by Graham and Rogers (2002) investigated the idea that hedging improves tax incentives and debt capacity of a firm and found supporting evidence which suggests that hedging improves a firm's debt capacity. Furthermore, Ni et al. (2017) also found evidence suggesting that financial hedging reduces borrowing costs and increases a firm's debt capacity. However, contrasting findings are presented by Dionne et

al. (2019), who based their study about the relationship between hedging and debt capacity on an original estimation technique. The authors did not find a link between hedging and an improved debt capacity in the observed firms. These findings imply that a different model of observing the relationship between hedging and debt capacity could steer the results against existing literature.

From an internal debt issuance perspective, Shin and Pyo (2019) review how hedging strategies can be used for financing under low debt capacity conditions. According to the authors, a firm can simultaneously use forwards and futures derivative contracts to hedge against high-risk debt issuances. The additional internal debt issuance at low debt capacity levels was found to be a firm value-enhancing initiative when the debt was hedged correctly. Considering that the internal debt capacity and internal debt issuance has been reviewed in the hedging context, the firm value-enhancing effect of hedging based on external capital agency issues will therefore be explored in the following subsection.

External Capital

The undertaking of new projects can be a capital-intensive pursuit for firms, which also increases a firm's cost of capital as required by debtholders and shareholders. However, a theory presented by Smith and Stulz (1985) suggests that hedging can reduce a company's need for external sources of capital. The limited dependence on external capital is an assumption made by Froot et al. (1993). According to the authors, hedging potentially stabilises a firm's cash flows and can allow for it to be diligent enough to internally fund its own profitable projects that would help enhance firm value. Internal funding sets a limitation on the level of influence that capital markets have on the firm's investment decisions. As such, studies have been conducted by different researchers and scholars on the implications of hedging for the different firms' levels of dependence on external financing.

While approving the theory that hedging results in a reduction of financial distress costs, Gay and Nam (1998) also find that hedging can significantly reduce a firm's required capital from external markets. Furthermore, Adam (2002) also provides an illustration on how hedging firms are slightly less dependent on external financing. The findings in the author's study on how derivative-based hedging influences a firm's financing decisions depict that

firms who hedge require 14% less external capital on average for their projects. On the other hand, firms that did not hedge were found to require external capital 100% of the time. However, a study by Davies, Eckberg and Marshall (2010) on Norwegian firms disproved this hypothesis by finding that hedging does not reduce costs of financial distress or reduce a firm's external capital requirements.

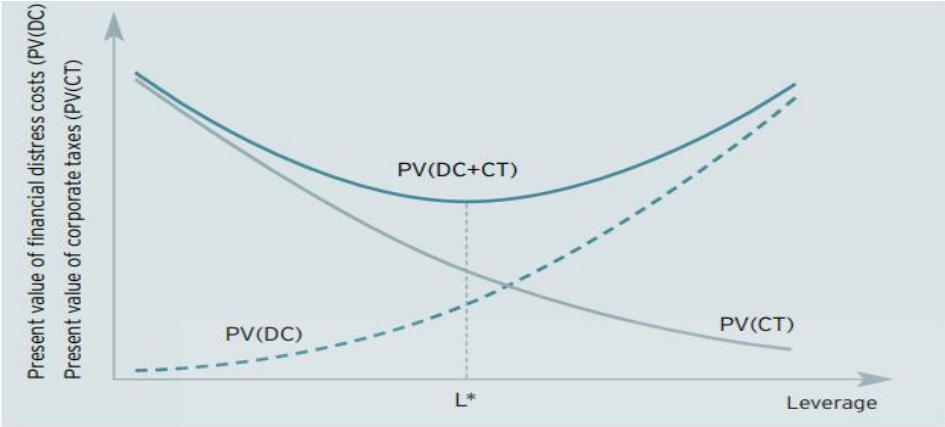
A more recent study by Baker and Filbeck (2018) states that the required return from providers of external capital makes external financing more costly than internal capital. This could result in a reduction in the attractiveness of an investment that would normally have a positive net present value (NPV) as the higher weighted average cost of capital (WACC) might make the investment unattractive. Therefore, internal funding reduces the implication of the increased cost of capital from external funding providers, which preserves the profitability of high-yielding projects. In turn, the preservation of profitability attained from the reduced dependence on the external capital enhances firm value. The capital structure of a firm is key in determining funding decisions for projects. However, according to Miller and Modigliani (1958), in the absence of all the agency costs, firm value is not affected by the optimal capital structure. Conversely, literature suggests that through hedging, a firm can enhance its firm value by improving its optimal capital structure. An expansion on this will be found in the next subsection.

Optimal Capital Structure

The literature mainly deduces that hedging decisions are primarily based on their potential to reduce a firm's cost of debt financing, i.e., costs of financial distress and corporate tax liability, while improving its debt capacity. Due to these derived benefits, Baker and Filbeck (2018) suggest that hedging can also assist a firm in determining its optimal capital structure or degree of financial leverage. This is reinforced by Leland (1998), who states that the optimal capital structure reflects both the tax advantages of debt and the exclusion of financial distress costs. The relationship has been explored in the oil and gas industry by Hahnenstein and Röder (2006), as well as Kim and Choi (2019). By examining the integrated effect of corporate hedging and capital structure on the value of oil and gas firms, Hahnenstein and Röder (2006) presented an illustration on how costs of financial distress costs and corporate taxes determine a firm's financial leverage (Figure 2.3). The optimal

level of financial leverage (L) is found in the center of the convex function of the combined present value of corporate taxes and the present value of financial distress costs,

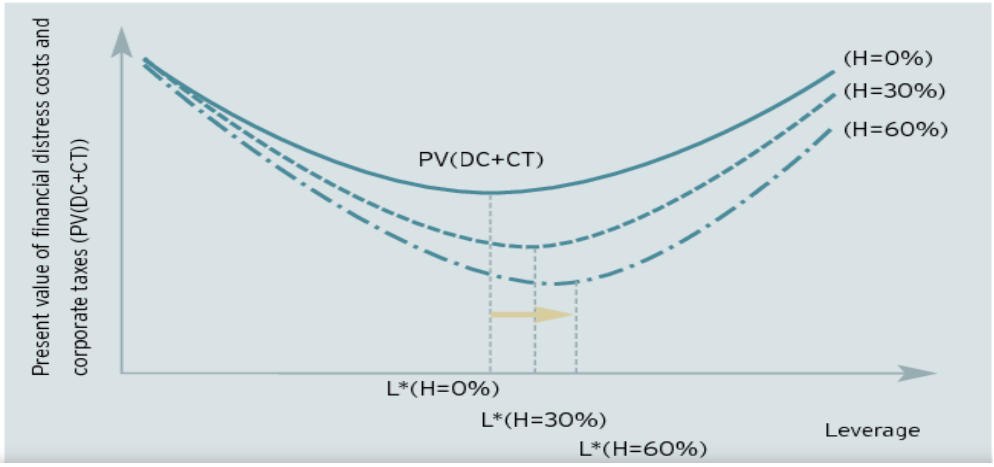
Figure 2.3.: Representation of the optimal degree of financial leverage, as a function of a firm's financial distress costs and corporate taxes



Source: Hahnenstein & Röder, 2006

where the tax benefit of additional leverage offsets the cost of financial distress. Considering the benefits of hedging relating to both the costs of financial distress and corporate taxes, the authors further posted ex ante evidence on how the integrated incorporation of hedging and optimal leverage affects shareholder value. The findings presented in Figure 2.4. propose that a marginal increase in the hedge ratios optimal to the degree of financial leverage can reduce the corporate taxes and financial distress costs. However, the authors propose that additional hedging would not be beneficial to firm value if the derivative-based hedging already covers the expected financial distress costs.

Figure 2.4.: Combined present value of financial distress costs and corporate taxes as a function of leverage L for alternative hedge ratios



Source: Hahnenstein & Röder, 2006

However, an alternative sentiment is provided by Amaya, Gauthier and Leautier (2015), who propose that fully hedging against financial distress costs is optimal for firms. However, the full hedge is only optimal up to a certain leverage threshold, after which a higher leverage ratio would result in a gamble. Ultimately, the authors find that a full hedge against risk is value enhancing for a firm since it improves the optimal leverage level, which lowers the firms' cost of capital. An additional study by Kim and Choi (2019) also explored the effects of derivative-based hedging on the capital structure of oil and gas firms, by using the firm's exposure to the respective commodity as a proxy for their price risk exposure.

The findings of the study suggest that hedging disproportionately increases the D/E ratios of the raw material producers (upstream), as opposed to finished goods distributors (downstream). The results could be an indication of how raw materials from upstream products are subject to more volatility. Thus, the increased cost of debt derived from the higher D/E ratio of upstream oil and gas firms might be used to provide a tax shield on the taxable income of the firms, while the hedging preserves the firm from financial distress costs. These combined benefits could result in an improved value for firms in the industry. Therefore, evidence presented by the authors suggests that hedging is value enhancing as it assists firms to realise their optimal capital structures. Theory proposes that an additional benefit to hedging is resolving the issue of underinvestment, which will be explored in the subsection to follow.

Underinvestment

Another agency problem that managers try to resolve through hedging is the underinvestment problem. The underinvestment problem is defined by Hayes and Kindness (2021) as the agency issue that arises when firms with high leverage are under financial distress. The financial distress places firms in positions where they solely focus on the needs of debt providers, such as fulfilling their debt obligations. The sole focus on debt holders further hinders firms from engaging in high-risk projects that could potentially provide high returns for shareholders. Baker and Filbeck (2018) explain that the excess returns from the additional projects would be used to fulfil the debt obligations when firms are under financial distress, which may hinder the benefit that equity holders would potentially receive from the riskier projects. Under such circumstances, managers forego the opportunity to invest in these high-risk and high-yielding projects, and under-optimise their

investment opportunities, leading to the underinvestment problem. Many authors in the late 20th century considered the question of how hedging might help with the underinvestment problem.

Early studies by Bessembinder (1991) and Myers (1997) proposed that since hedging helps in mitigating against potential costs of financial distress, it should therefore assist firms in solving the underinvestment problem. The authors found this relationship between hedging and underinvestment to be true, and further suggested that hedging influenced the enhanced firm value of companies by reducing underinvestment issues. Using the hedging hypotheses, more researchers investigated the relationship further, by presenting studies on hedging behaviour and the determinants of hedging in firms. According to Berkman and Bradbury (1996), hedging stabilises firm cash flows by reducing the volatility of firms' taxable income. In turn, the stability of cash flows encourages firms to optimise their investment opportunities, thereby reducing the underinvestment problem.

In addition, studies by Berkman and Bradbury (1996) and Choi et al. (2013) presented findings which suggest that firms with higher investment opportunities and better growth prospects tended to hedge more against risk. This implies that firms with better investment and growth prospects are more focussed on maintaining steady cash flows, which probes them to mitigate against risks that could inflict any adverse effects on their cash flows. However, contrasting findings are presented by Mian (1996) and Geczy, Minton and Schrand (1997), who did not find any links between hedging and growth prospects of a firm. The missing link between hedging and a firm's growth prospects indicates that the hedging hypothesis on agency costs such as underinvestment costs, does not hold under all circumstances. Firms could still possibly face underinvestment problems even when they do hedge.

Another branch of the research concerning the impact of hedging under alleviated underinvestment circumstances has been pursued in terms of how it affects the firm value of various companies. According to Choi et al. (2013), hedging helps reduce the underinvestment problem and enhances information asymmetries, which in turn contributes to the enhanced firm value of US Biotech firms. Similar findings were presented by Hagelin (2003), who examined the impact of currency risk hedging on firm value of Swedish firms. In line with early literature by Myers (1997) and Bessembinder (1993), the

author found that hedging reduces financial distress costs, which helps in combatting against the underinvestment problem, resulting in a positively enhanced firm value of the Swedish firms. Moreover, using different methods of observation, Davies et al. (2010) found evidence which supports the notion that reduced underinvestment problems through hedging helps maximise the firm value of Norwegian exporting firms.

Therefore, it can be said that in instances where hedging reduces underinvestment costs, the firm value of the companies is likely to be enhanced. Furthermore, this could reduce the problem between providers of external capital, as the stabilised cash flows from hedging would be adequate to help the company fulfil its debt obligations. Fulfilled debt obligations simultaneously allow room for firms to undertake riskier projects with positive NPVs, which enhances the profitable opportunities for shareholders of the company.

Overall, the firm value-enhancing capabilities of hedging have been explained in terms of the shareholder primacy theory. This is based on the ability for hedging to improve agency issues such as information asymmetries, financial distress costs, underinvestment issues, debt capacity, optimal capital structures, requirements of external capital and stabilising taxable income. Based on the shareholder primacy theory, the benefits of improved firm value by resolving these agency issues are attributable to shareholders, since firms are created for the sole purpose of maximising shareholder wealth, which translates to shareholder value (Friedman, 1970). The stipulated costs classified as firm value-enhancing factors can be categorised as agency issues of a firm, that could be resolved through the hedging process. Since these factors are based on the shareholder primacy theory of firm value, it is also necessary to also explore how hedging affects firm value from the stakeholder perspective of firm value.

2.5.2. The impact of derivative-based hedging on firm value as per the Stakeholder Theory of the firm

The stakeholder theory of the firm asserts that outside of shareholders, stakeholders also have interests in the firm. Therefore, any key decisions affecting firm value would inadvertently affect stakeholder interests. Considering that hedging has the potential to affect firm value, it is important to analyse how stakeholder interests are affected by the decision to hedge, which will be done by looking at stakeholders such as debt providers, employees, managers, clients, and suppliers.

2.5.2.1. Debt Providers

Providers of debt assist firms by increasing their leverage to assist in providing financing opportunities for a firm. However, if a company is unable to pay back the debt as it falls due, it may result in the company becoming financially distressed. The strong likelihood of defaulting on debt obligations gives rise to costs of bankruptcy (Purnanandam, 2008). For this reason, debt providers which support mining firms tend impose mandatory requirements for the companies to sell their products in the forward derivatives market. The intention of such contracts is to secure enough revenue streams and provide certainty of cash flows for debt providers (Benning, 2000). An example of such a debt requirement can be found in the integrated annual report of Goldfields mining firm. The firm states that debt servicing requirements by debt providers are a secondary reason why they undertake hedging for their risk exposures to the gold price, the oil price, and the currency price risks (Goldfields, 2019).

Hedging does not only benefit the debt holders, but the firm also receives a benefit, as hedge commitments are said to reduce the agency costs of debt (Beatty, Petacchi & Zhang, 2012). Furthermore, Beatty et al. (2012) explain that companies significantly reduce the interest payments of their debt when they maximise their debt covenants by hedging. It can therefore be said that hedging provides a double benefit for both debt providers and firms. When observing the relationship between the gold price exposure of mining companies and financial leverage, Tufano (1996) found that the relationship between the two variables was significant and positive. It can be said that mining companies that are highly exposed to commodity price fluctuations tend to have higher financial leverage. Thus, providers of debt rely on the success of the mining firms to ensure that they meet their debt obligations. Therefore, the maximization of firm value through the management of risks helps firms fulfill their debt obligations and fulfill the interests of debtor providers in the firms as key stakeholders (Baker & Filbeck, 2018). Fulfilling the interests of the debt providers has a ripple effect on the interests of company employees, which will be explored in the next subsection.

2.5.2.2. Employees

Employees are stakeholders that are instrumental in influencing the firm's success in its operations. In the mining industry, it has been noted by Van Hoek and Schultz (2014) that

while the industry may be technology and machinery intensive, the employees play a vital role in the success and growth of the mining organisations. By taking the interests of employees into consideration, the firm automatically mitigates against issues such as high staff turnover rates, strikes and low performance output. Furthermore, firms would need to remain solvent to continue securing employee jobs (Baker & Filbeck, 2018). However, securing jobs becomes a more difficult task for companies when they are more highly leveraged, which makes employees more susceptible to layoffs during periods of low demand (Van Hoek & Schultz, 2014). Furthermore, a study by Tufano (1996) suggested that firms which have high exposure to gold prices tend to have higher financial leverage. Hedging practices therefore assist in mitigating against risk of insolvency and financial distress in the company, which in turn assists in securing jobs for employees (Baker & Filbeck, 2018).

2.5.2.3. Clients and Suppliers

Firms are reliant on clients to increase their revenues and rely on their suppliers for the smoothing of their operations. In turn, the clients rely on the company for valuable goods and services, while suppliers rely on the firm to increase their own revenues. Baker and Filbeck (2018) believe that clients and suppliers care about whether the firm uses hedging strategies. According to Smith and Stulz (1985), the hedging strategies employed by companies assist in reducing risk which clients and suppliers are unable to diversify on their own, in relation to their respective interests in the company. The authors believe that hedging can only be of value to the firm if the cost of hedging is less than the total difference between the revenue attracted from clients and the costs incurred from operations, as well as from suppliers. Furthermore, a study by Hoffman (2011) explored the effect of hedging against currency and commodity price risks in the automotive industry. The authors found that hedging reduced the vulnerability of the supply chain between the automotive firms and their small-and-medium suppliers, and positively affected the original equipment manufacturers of the industry.

2.5.2.4. Managers

In addition to clients and suppliers, managers are also key stakeholders that have an impact on the company or firm, while the firm has a *vice versa* relationship with managers. Managers play an important role in helping to implement strategies that help fulfill the

vision and objectives of a firm through different management practices (Tapera, 2014). Such practices include leading, planning, organizing, implementing, monitoring, and assessing of policies, systems, employees, and controls that drive the company vision and objectives (Backman & Karlsson, 2020). The integration of all the functions of management helps increase firm productivity, which results in an increase in the survival probability of the firm. In hedging, one key element incorporated in the leadership function of management is decision-making, as managers ultimately make the decision to either hedge against risks or not.

According to Bartam, Brown and Fehle (2009), the decision taken by management to hedge against risk has an influence on the investors' perception about the manager's expertise and abilities. This perception is further reiterated by Adam, Fernando and Golubeva (2015), who find that the effect of corporate overconfidence in managers extends to hedging decisions. Therefore, hedging decisions can trigger behavioural biases, such as the managerial overconfidence bias, which results in higher management compensation (Geyer-Klingeberg, Hang, and Andreas, 2019). In addition, a study presented by Liu, Chen and Chen (2018) finds that an alignment of managerial interests and managerial overconfidence positively affects firm value. However, the relationship fails to hold when the firm undertakes improper investments which induce high cash flow sensitivities, thereby reducing firm value.

In contrast, hedging decisions made by a management team that is more difficult to monitor is said to increase firm value (Baker and Filbeck, 2018). Other management characteristics associated with firm value-enhancing capabilities when hedging is the superiority of the manager's tertiary education (Boubaker, Clark & Mefteh-Wali, 2020). By examining the association between CEO elite education and the effectiveness of firm hedging policies on firm value in France, Boubaker et al. (2020) show results which suggest that the education quality of a firm's CEO is directly linked to effective hedging through derivative usage, which directly results in an enhanced firm value. Firm value is found to only be enhanced when the CEOs from elite tertiary institutions use derivatives to hedge, despite the discipline of their studies.

Another factor that has been found to contribute to firm value is managerial compensation. Habib and Ljungqvist (2005) studied the relationship between managerial compensation and firm value, while incorporating a hypothetical firm in the study. The findings suggested that

a discount to firm value is realised in firms who do not adequately compensate their managers. The authors further recommend that management compensation should be aligned in a way that subjects it to the same risks that the firms face, as opposed to incentivising managers with stock options that are inadequately aligned with firm risks. The authors believe that such an alignment of interests would encourage managers in undertaking firm value maximising pursuits like hedging. This is further reinforced by Chaigneau (2018), who finds that the best type of incentive for managers is one that includes equity holdings of the firm, as it incorporates firm performance. The equity holdings enable the managers to share in the company's performance when value is maximised in accordance with shareholder preferences.

A contrasting view is presented by Nohel and Todd (2004), who are of the opinion that firm value is not a linear function of manager compensation. Therefore, the relationship cannot be simplified to "pay-performance" metrics, as increased manager compensation can have both harmful and beneficial outcomes for the firm. Another interesting finding has been presented by Florackis, Kanas, Kostakis and Sainani (2020). According to the authors, a new concept of risk substitution comes into effect when managers have unhedged positions of the company in their own personal portfolios. The risk substitution means that managers will forego highly profitable projects that are subject to firm-specific risks, and rather substitute the opportunity with less profitable projects which are subject to less market risk. The effect of taking on the less profitable project reduces firm value, as the substitution effect diminishes the effect of having the managers interests aligned with the firm. However, Baker and Filbeck (2018) believe that the risk substitution effect can be beneficial in maintaining the stability of the firm during periods of uncertainty. It can therefore be said that managers' compensation has its limitations in terms of influencing and affecting firm value.

It has also been said that if the interests of managers and shareholders are not in alignment, the firm may suffer as managers may use it to drive their own interests (Goergen & Renneboog, 2011), bringing about the agency problem. The agency problem stems from information asymmetries between managers and shareholders, as managers have better access to firm records and are therefore more informed about the position of the firm than shareholders. The information asymmetries between the two parties can be reduced

through initiatives that reduce earnings volatility, such as hedging (Baker & Filbeck, 2018). Furthermore, it is suggested that managers' compensation should be a function of the risks that they themselves have managed (Baker & Filbeck, 2018). This will further help shareholders understand what it is that managers have contributed to the enhancement of firm value. Overall, firms which aim to satisfy a wider range of stakeholder interests are found to hedge price or market risks more extensively than firms which aim to satisfy shareholder interests (Abo, 2004). The different degrees of hedging mean that firms which limit their extent of hedging are aligned with the shareholder primacy theory concerning the purpose of the firm, which was established by Friedman (1970).

In contrast, firms that hedge more follow the enlightened shareholder value theory presented by Jensen (2001). The enlightened shareholder theory is explained as the satisfaction of stakeholder interests in a sustainable manner, which in turn results in the maintenance and enhancement of shareholder wealth over the long term (Millon, 2010). According to Mudawi and Timan (2018), the enlightened shareholder theory is a bridge that holds together the interests of stakeholders, while not compromising on the interests of a firm's shareholders. Therefore, findings that are in line with the premise that hedging is an indicator of a firm's satisfaction of the enlightened shareholder value theory have been presented by Harjoto and Laksmana (2018). By using Corporate Social Responsibility (CSR) as a proxy for satisfying stakeholder interests, the authors found that satisfying stakeholder interests reduces excessive risk taking in a firm.

The limited risk taking could also mean that such firms would consider hedging a manner of reducing excess risks, to preserve the firm value as it relates to both the shareholder and stakeholder interests. This is essentially the preservation of firm value from an enlightened shareholder value perspective. According to Harjoto and Laksmana (2018), the enlightened shareholder value through the simultaneous satisfaction of stakeholder interests has a positive effect on firm value, which positively affects shareholder value. Thus, the enhanced firm value theory of the firm automatically satisfies the shareholder primacy theory.

2.6. Conclusion

Hedging theory has received a lot of attention over the past two decades due to the market risks faced by companies, such as commodity price risk, currency risks and interest rate risks which have been induced by country-specific policies, as well as several black swans such as

the dot.com bubble, the financial crisis, the recent trade war, and Covid-19. Even though the misuse of derivatives has been dubbed as the cause of the 2007/2008 financial crisis, firms continue to make use of them for hedging purposes. Theories pertaining to hedging and its benefits on firms have been derived from the Miller and Modigliani (1985) assumptions of perfect markets. The theories on the purpose of the firm have provided a basis for the research philosophies which were followed in presenting the literature review. The various paradigms embedded in the hedging theories that were explored have contributed to the ontology of the study, namely the stakeholder, shareholder, and agency theories. In addition, the differing findings that were presented under each theoretical paradigm enlightened the epistemology on the determinants of hedging and their effects on firm value, in the context of shareholders and stakeholders.

According to Geyer-Klingeberg et al. (2018), the discrepancies in the hedging literature concerning its impact on firm value are a representation of factors such as differences in data sources, country data, estimation techniques and the quality of the studies. Taking these factors into account, the data specifications and research models that will be used in fulfilling the research aim and objectives of the study will be stipulated in the research methodology chapter to follow.

Chapter 3: Research Methodology

"… you can have an enormous and complex data set, but if you have the right tools and methodology, then it will not be a problem"- Aaron Koblin (n.d.)

3.1. Introduction

In the preceding chapter, an overview of literature concerning the impact of hedging on firm value was conducted. The implications were largely drawn from the holders of value; how a firm's decision to hedge affects firm value for shareholders and stakeholders. Considering that the main aim of the study is to determine the effect of hedging on the firm value of SA mining firms, the purpose of this chapter will be to provide information on how the aim and objectives of this study will be fulfilled. Therefore, all aspects which encapsulate the research methodology will be expanded on. In this chapter, the research paradigm will initially be discussed, followed by the research design, the research data, the research models, as well as the issues of validity and reliability.

3.2. Research Paradigm

A quantitative research methodology will be used to fulfill the research aim and objectives. According to Bloomfield and Fisher (2019), quantitative research refers to the methodology that can be used to test the relationship between variables, while examining the effects and associations between them. Furthermore, the process of a quantitative research study is systematic, formal, and objective. By employing a quantitative approach, the research could either follow a positivist or post-positivist research paradigm (Davies & Fisher, 2018). The most appropriate and well-suited paradigm to use in this study is the positivist paradigm and its suitability is based on its characteristics.

According to Davies and Fisher (2018), the positivist paradigm in research assumes that only one reality exists, which requires a researcher to be impartial and objective in seeking the truth behind reality. In addition, a positivist research methodology would need to incorporate hypothesis testing of quantitative numerical data, from which a sole reality can be deduced. In view that the ontology of the positivist approach leads to one single truth, it makes for an accurate measure of reality regarding the study (Davies & Fisher, 2018). These characteristics are therefore suitable, considering that the aim of the study is to seek the

singular reality regarding the impact of derivative-based hedging on the firm value of the SA mining firms. The research design that will be used to understand this reality will be expanded on in the following section.

3.3. Research Design

This study, which aims to determine the relationship between hedging and firm value, implies that an experimental research design will be undertaken. Experimental research is described as a method which examines the relationship between a dependent and independent variable under controlled conditions (Bloomfield & Fisher, 2019). Furthermore, an experimental research design takes on the pattern described in Figure 3.1 below.

Figure 3.1: The process followed in an experimental research design.

Source: Bairagi & Munot (2019)

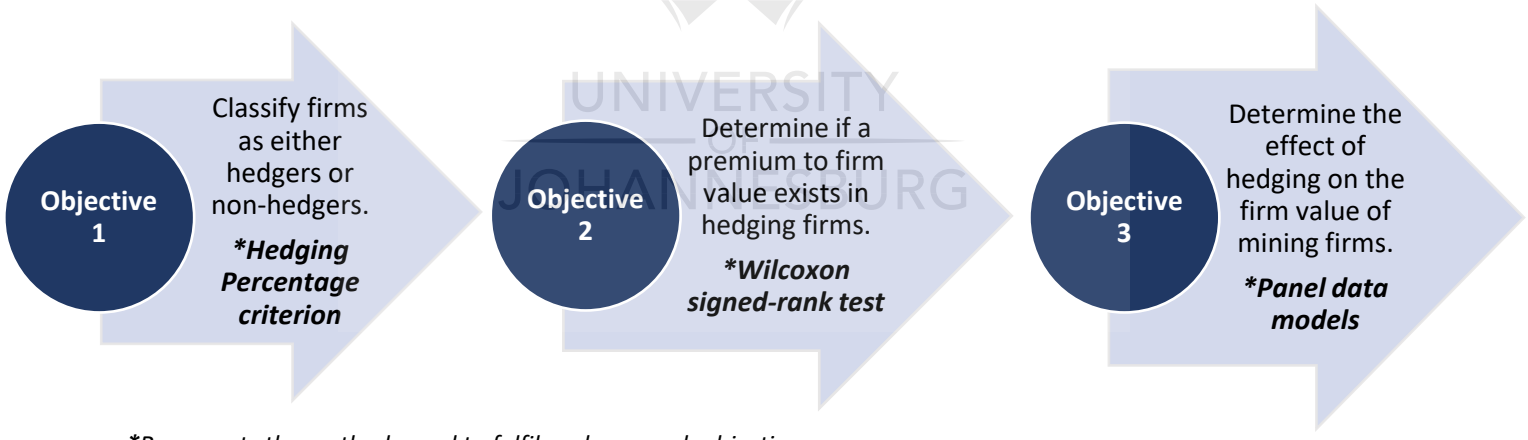
A variety of methods have previously been used to attain conclusive findings in similar studies. These methods include: the truncated regression; the panel regression method; the Logit method; and the Probit method. Another study used a mixed method combining the Fama-French three-factor time-series analysis, the single sector analysis and the GMM estimators. Based on the characteristics of these methods, the most appropriate method for this study would be the panel regression method. According to Keith (2019), a panel regression is used in the study of longitudinal data, which examines the time-series data (longitudinal) and individual data (cross-sectional). These characteristics of the panel model enable it to be more efficient than the pure cross-section and longitudinal data series. The efficiencies of panel data models stem from their ability to minimise the biases that can arise from such pure estimations, as well as their ability to better detect statistical effects than the pure estimations (Clower, 2021). Therefore, the model specifications of the panel model that will be employed in this study will be explained further in the following section.

3.4. Research methods

The research presented in the literature review will be used as a guideline on how the selected model will be specified. The method frequently used in literature is a panel data model, as seen in studies by Allayannis and Weston (2001), Jin and Jorion (2006), Zhang (2012), Lau (2016) and Lambrechts and Toerien (2016). The researchers initially use the panel data to conduct a study to observe the differences in the firm value proxies of the panel of hedging and non-hedging firms. The Analysis of Variance (ANOVA) model or the student's t-test is used to estimate these differences. A multiple regression is then estimated to determine the effect of hedging on firm value when it is subjected to control variables that are known to affect the firm value. A similar approach will be followed in fulfilling the objectives of this study, which can be seen in Figure 3.2. below:

Figure 3.2: Summary of research objectives and the methods that will be used in fulfilling them.

The research methods used in the fulfilling each of the research objectives will be specified in the next section relating to the model specifications.



**Represents the methods used to fulfil each research objective*

Source: Author compilation.

3.4.1. Model Specifications

The study is initiated by first classifying the SA mining firms as firms that either use derivatives to hedge against price risks, or firms that do not use derivatives to hedge against price risks. The classification of the firms will be done by using a percentage criterion

informed by the derivative-based hedging disclosures in the financial statements of the firms.

3.4.1.1. Classification of the South African mining firms: Hedge percentage criterion

The classification of the firms as either hedgers or non-hedgers is differentiated by using the dummy variables to compute a hedging percentage threshold. The threshold that each firm will need to exceed is a 50% hedge percentage, over the ten-year observation period. The hedging classification is based on each firm's explicit stance in each year on whether they have used derivatives to hedge against price risk in the notes to the financial statements. The explicit terms that will be used to search if hedging was undertaken in the financial statements of the mining firms are "derivative", "hedge", "put option", "call option", "zero-cost-collar", "swap", "forward" and "future." However, derivatives that are used for capital raising will not be included in the process of classifying firms as either hedgers or non-hedgers.

An example of the process followed in classifying a firm is: if a firm explicitly discloses that it has used any form of derivative to hedge against price risk exposure in the year 2010, this will qualify as hedging and will be counted as 1 in 2010. This search process will be repeated in each of the 10 years between 2010 and 2019. Consequently, the sum total of the hedges in the 10 years will be divided by 10 to yield a hedging percentage for each mining firm. The final classification of the firms as "hedgers" or "non-hedgers" will be based on the following criteria:

If "hedge percentage" is **< 50%** in 10 years between 2010 and 2019, then *"firm"* = **non-hedger**

If "hedge percentage" is **≥ 50%** in 10 years between 2010 and 2019, then *"firm"* = **Hedger**

The process of classifying the SA mining firms as either hedgers or non-hedgers will allow for the second research objective to be established, which will be explained in the next step of the research process.

3.4.1.2. Establishing the hedging premium: Wilcoxon signed-rank non-parametric test.

The next step involves an analysis of determining whether the mining firms that hedge have a significantly higher firm value than the mining firms that do not hedge, using the Wilcoxon signed- rank test. The differences in the characteristics of firms that hedge, in comparison to firms that choose not to hedge, will also be observed using the Wilcoxon signed-rank test. The test statistic (W) is estimated using the following steps described by LaMorte (2017), after classifying the hedging and non-hedging firms:

a) Compute the firm value differences between the panel of hedging firms and non-hedging firms.
b) Set the differences in the firm values to absolute figures.
c) Rank all the absolute figures in descending order. Ignore all figures with 0 values.
d) Sum up the ranks of differences that were initially negative.
e) Sum up the ranks of differences that were initially positive.
f) Select the lowest summed rank between the positive and negative values as the W-statistic (W-stats).
g) Using the number of observed differences (n), find the critical value of the Wilcoxon signed-rank test from its normal distribution table ($W@ \propto = 0.05$).

The significance of the differences will be determined using the following decision rule:

$$\mathrm{H}_0: \mathrm{Median}_{\mathrm{Hedgers}} = \mathrm{Median}_{\mathrm{Non-Hedgers}} \; (\mathrm{W-stat} > \mathrm{W}@ \propto = 0.05)$$

$$\mathrm{H}_1: \mathrm{Median}_{\mathrm{Hedgers}} \neq \mathrm{Median}_{\mathrm{Non-Hedgers}} \; (\mathrm{W-stat} \leq \mathrm{W}@ \propto = 0.05)$$

$$\text{Decision rule: if } \mathrm{W-stat} \leq \mathrm{W}@ \propto = 0.05; \text{ reject null hypothesis}$$

Following the determination of the hedging premium (or discount) to firm value from the univariate differences in the firm value of the mining firms, the final stage of the study determines the effect of hedging on firm value, using the panel data analysis model. The isolated effect of hedging is determined by including control variables that have been stated as having a significant impact on firm value in theory. Therefore, the specific estimation of the multivariate model determining the impact of hedging on firm value will be presented in the next subsection.

3.4.1.3. Determining the impact of hedging on firm value: Panel data analysis

The panel data analysis model is selected to estimate the relationship between hedging and firm value for the SA mining firms listed on the JSE Precious Metals Index, from a multivariate perspective. As such, there are three panel data estimations that need to be estimated to understand the effect of hedging on the firm value proxy. The three panel data estimations are the Pooled Ordinary Least Squares model (POLS), the Fixed Effects model (FE) and the Random Effects model (RE). The most appropriate model is selected by estimating the Redundant Fixed Effects test and the Hausman test. The specifications of the POLS, the FE and the RE econometric models are shown below, starting with the POLS model.

Pooled Ordinary Least Squares Model (POLS)

The POLS model estimates the relationships in a simple manner, where the heterogeneity in cross-sectional and time effects of a model estimate are not accounted for. The POLS essentially overlooks differences in the effects of timing and individual variables of the each of the individual mining firms included in the study (Chivandire, Botha & Mouton, 2019). The following equation is formulated based on the firm value dependent variable, against the hedging explanatory variable, with the inclusion of the miscellaneous control variables found in literature. The primary econometric equation is expressed in Equations 1 as follows:

$$\mathbf{TQ}_{it} = \beta_0 + \beta_1 \text{Hedge\_Dummy}_{it} + \beta_2 \frac{D}{E}_{it} + \beta_3 \text{Growth}_{it} + \beta_4 \text{MNGT}_{it} + \beta_5 \text{Invest}_{it} + \beta_6 \text{ROA}_{it} + \beta_7 \text{Size}_{it} + \mu_{it} \quad \textit{(Eq. 1)}$$

Where:

$i = 1;2;3\ldots12$ for each of the 9 SA mining and energy firms included in the study.

$t = 2010;2011;2012\ldots 2019$ observation period

β_y = the coefficient of the explanatory variable and the control variables

TQ = Tobin's Q

$$\text{Hedge\_Dummy}_{it} = \begin{cases} 1, & if\ hedge\ level\ of\ i > 50\% \\ 0, & if\ hedge\ level\ of\ i \leq 50\% \end{cases}$$

$\frac{D}{E}_{it}$ = Debt-to-Equity Ratio for capital structure

$$\text{Growth}_{it} = \frac{Sales_t - sales_{t-1}}{sales_{t-1}} \times 100$$

$$\text{Invest}_{\text{it}} = \frac{\text{Capital Expenditure}}{\text{Assets}}$$

$$\text{ROA}_{\text{it}} = \text{Return on Assets}$$

$$\text{LnSize}_{it} = \text{Natural Log of firm Asssets}$$

Fixed Effects Model (FE)

The FE model is different to the POLS model as it accounts for heterogeneity, or differences, within the cross-sectional units and the periods of the variables included in the model (Chihoho, Nyoni & Nyoni, 2020). The FE model essentially recognises that each of the SA mining firms are different, where the variables of each firm are subject to effects that are specific to different time periods, such as commodity cycles of the different years. However, the FE model controls for variables that do not differ over time by using time-invariant effects such as dummy variables. The benefit of an FE model is that it controls for possible omission biases in the estimated model, but its limitations lie in its inability to estimate the differences between the cross-sections. The FE model is specified in Equation 2 below, and to illustrate the differences or the heterogeneity in the FE models, the coefficients are denoted using α:

$$\mathbf{TQ}_{it} = \alpha_0 + \alpha_1 \text{Hedge}_{\text{Dummy}_{it}} + \alpha_2 \frac{D}{E}_{it} + \alpha_3 \text{Growth}_{it} + \alpha_4 \text{MNGT}_{it} + \alpha_5 \text{Invest}_{it} + \alpha_6 \text{ROA}_{it} + \alpha_7 \text{Size}_{it} + \beta_2 D_{2i} + \ldots + \beta_{12} D_{12i} + \delta_2 \text{DUM}_{2011t} + \cdots + \delta_{10} \text{DUM}_{2019t} + \mu_{it} \quad \textit{(Eq. 2)}$$

Where:

$D_{2i} \ldots \beta_{12} D_{12i} =$ the cross-section dummies for each of the SA mining and energy firms

$\delta_2 DUM_{2011} \ldots \delta_{10} DUM_{2019} =$ the time dummies for the years 2011-2019

$\mu_{\text{it}} =$ a combination of both the cross − sectional and time series error components

The dummy variable for firm 1 (D_{1i}) and the dummy variable for the year 2010 (DUM_{2010t}) are excluded to avoid the dummy trap stipulated by Chihoho et al. (2020).

Random Effects Model (RE)

In the same way that the FE model accounts for heterogeneity within the cross-sections of the panel data, so does the RE model. The difference lies in the RE model's ability to also

account for heterogeneity *between* the cross-sections of the panel data over different periods. According to Akbar, Aslam, Imdadullah and Ullah (2011), the intercept of an RE model is based on a random outcome, whose value is a function of a mean value and a random error term. The model of the RE model will be specified in equation 3 below, in relation to the firm value dependent variable.

$$\mathbf{TQ}_{it} = \alpha_0 + \alpha_1 \text{Hedge}_{\text{Dummy}_{it}} + \alpha_2 \frac{D}{E}_{it} + \alpha_3 \text{Growth}_{it} + \alpha_4 \text{MNGT}_{it} + \alpha_5 \text{Invest}_{it} + \alpha_6 \text{ROA}_{it} + \alpha_7 \text{EPS}_{it} + \alpha_9 \text{Size}_{it} + (\omega_i + \mu_{it}) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \textit{(Eq. 3)}$$

Where:

$\omega = \text{the cross} - \text{section error component with a mean and a variance of } 0$

Redundant Fixed Effects Test and Hausman Test

The most appropriate estimation method between the POLS, FE and RE is selected based on the outcomes of the Redundant Fixed Effects test (Likelihood Ratio) and the Correlated Random Effects test (Hausman test). The Redundancy test is initially computed to evaluate the best model between the POLS and FE methods of estimation. The decision rule of the Redundant Fixed Effects test is decided using the following process:

H_0: Cross − section and period Fixed Effects are redundant.

H_1: Cross − section and period Fixed Effects are present

Decision rule: If $p - \text{value of Chi. Square Statistic} < 0.05$; reject H_0

The rejection of the null hypothesis entails that the most appropriate estimation method is the FE, instead of the POLS model. In addition, the Hausman test would be computed on the RE model estimate, to help in selecting between the FE and the RE models. The following decision rule is used to determine the best model of estimating the effect of hedging on the firm value of the SA mining firms.

H_0: Random Effects model is appropriate

H_1: Fixed Effects model is appropriate

Decision rule: If $p - \text{value of the Chi} - \text{Square Stat} < 0.05$; reject H_0

The rejection of the null hypothesis entails that the most appropriate estimation method is the FE model. From understanding the models that will be included in this study, the research data used in the models will be expanded on in the following section.

3.5. Research Data

In this section, the research data will be explained in terms of the data sampling rules, the data sources, the research variables, as well as how the data will be prepared for the study.

3.5.1. Data sampling

The sample of firms that will be included in this study will be selected based on the convenience sampling method, with the following sampling rules:

- The firms will have to be listed on the JSE, specifically the JSE Precious Metals Index.
- They need to be primarily listed on the JSE and be headquartered in South Africa.
- Sample period – the research only includes data from the preceding 10 years. The observation period of the study will be a 10-year period starting on 1 January 2010 and ending on 31 December 2019.
- The frequency of the data will be on an annual basis, as the derivative-based hedging variables are mostly prepared and disseminated on an annual basis in the financial statements of the firms.

Based on these sampling rules, the sample of SA mining firms that will be included in this study are shown in Table 3.1. below:

Table 3.1: Sample of SA mining firms listed and their price risk exposure

Mining Company	Business Description	Market/ Price risk	
		Commodity Produced	**Exchange Rate Exposure**
Anglo American Platinum Ltd	Anglo American Platinum Limited is the world's largest primary producer of platinum, accounting for about 38% of the world's annual supply.	Platinum Group Metals	ZAR/Dollar
Anglo Gold Ashanti	Anglo Gold Ashanti is a global gold mining company with mines and exploration	Gold Price Brent Crude oil (by product)	ZAR/USD TZS/Rand BRL/USD

	projects in four different regions: Africa, Americas, Australasia & South Africa.		ARS/USD AUD/USD
DRD Gold Ltd	DRD GOLD is a South African gold producer and a world leader in the recovery of gold from the retreatment of surface tailings	Gold Price	USD/ZAR
Gold Fields	GOLD FIELDS is a dual listed diversified gold producing firm with operations in different countries	Oil Gold	AUD/USD
Harmony Gold mining	The third largest SA gold mining company, with operations in SA and Papua New Guinea	Gold Silver	USD/ZAR
Impala Platinum	A leading mining company in the business of mining, processing, refining, and marketing high quality PGM products safely, efficiently at the best possible cost	Platinum Group Metals	ZAR/USD
Northam Platinum Ltd	A primary producer of platinum group metals (PGMs), which are sold in the automotive, jewellery and other industrials.	Platinum Group Metals Chrome	USD/ZAR
Pan African Resources	A mid-tier African-focused gold producer who own and operate a portfolio of high-quality, low-cost operations and projects, which are in South Africa.	Rand Gold	USD/ZAR
Royal Bafokeng	A platinum group metals (PGMs) producer, mining the Merensky and ug2 reefs.	Platinum Group Metals	USD/ZAR

3.5.2. Data sources

The data of the variables concerning the sample of SA mining firms in Table 3.1. is sourced from two databases, which are IRESS and Equity RT. IRESS was previously recognized as INET BFA and continues to be a preeminent provider of economic and financial data, as well as

financial data analysis, focusing mainly on African market data and global market insights (Tracxn Technologies, 2022). On the other hand, Equity RT Equity RT is an innovative, rising provider of financial market data, whose aim is to advance the data analysis experience within the investment management research process (EquityRT, 2022). In addition to these two databases, the data specific to derivative-based hedging is extracted from the annual audited financial statements of the SA mining firms. The IASB introduced IFRS 9 and IAS 39 to accommodate the accurate measurement of financial instruments such as derivatives. Both IFRS 9 and IAS 39 changed to disclose information that would provide the public with a fairer representation of a firm's derivative values, as well as their intended purpose (Ramirez, 2015). The financial statements will therefore be scrutinized to find the accurate derivative positions, figures, and usage motives. The notes to the financial statements will be focussed on, especially the sections concerning the financial instruments and the market risks of the SA mining firms. The research variables that will be used are expanded on in the section below.

3.5.3. Research variables

The research variables included in the specified models that will be used to fulfil the research aims and objectives of this study will be expanded on in this section. The variables include the dependent variable, the explanatory variable, and the control variables.

3.5.3.1. Dependent variable: Tobin's Q

The firm value of the companies will be measured using the Tobin's Q as a proxy. The proxy is deemed as a good approach in determining firm value in mining industries because it is more transparent (MacDiarmid et al., 2018). Furthermore, it allows for the firm value estimate of each firm to be benchmarked and compared with other firms in an industry. The use of the Tobin's Q proxy is also in line with the firm value proxy used in most of the comparable studies in previous research. The following formula will be used to compute this dependant variable:

- Tobin's Q

$$\mathbf{Q} = \frac{\text{BV total assets} - \text{BV common equity} + \text{MV common equity}}{\text{BV total assets}}$$

Where BV refers to the book value and MV refers to the market value of the relevant corresponding components in the formula (Jin & Jorion, 2006).

3.5.3.2. Explanatory variable: Hedging dummy variable

In previous studies, the authors considered hedging as the independent variable and the proxy for hedging was mostly measured in two different ways. Researchers such as Graham and Rogers, (2000), Lambrechts and Toerien (2016) and Bessler et al. (2018) use the firm's net derivative position, by subtracting the derivative liabilities from the derivative assets. On the other hand, researchers such as Allayannis and Weston (2001) and Ayturk, et al. (2016) have used the notional value of a firm's derivatives to estimate the hedging proxy. A deviation from these proxies is seen in Jin and Jorion (2006), who use the Black-Scholes formula to estimate the delta of hedged positions for firms who use put and call derivative options, which is then added to the outstanding forward derivative contracts to estimate a proxy for hedging.

In all three versions of the hedging proxies, the outcomes are used as dummy variables to distinguish between the firms that hedge and firms that do not hedgers. The dummy variable for hedgers is measured using D = 1, while the dummy variable for non-hedgers is represented by D = 0. In this study, the dummy variable method for the hedging proxy will still be used. However, the proxy will be based on the hedging criterion that has been developed in section 3, which is specified as:

$$\mathbf{Hedge\_Dummy}_{\text{it}} = \begin{cases} 1, & if\ hedge\ level\ of\ i \geq 50\% \\ 0, & if\ hedge\ level\ of\ i < 50\% \end{cases}$$

Where:

i = 1;2;3…9 for each of the SA mining firms included in the study.

t = 2010;2011;2012… 2019 observation period.

3.5.3.3. Control variables

The final set of research variables included in the study are the control variables that are included in the multivariate models. These control variables will be expanded on below:

- Firm growth

$$\textbf{Growth}_{\text{it}} = \frac{\text{Sales}_{\text{t}} - \text{sales}_{\text{t}-1}}{\text{sales}_{\text{t}-1}} \times 100$$

Revenue growth is indicative of potential margins, which essentially affects firm value from a shareholder perspective. The firm growth is therefore important to be included in the estimation (Rappaport, 2006).

- Management Shareholding

$$\textbf{MNGT}_{\text{it}} = \text{Percentage of Management shareholding}(\%)$$

An alignment of managerial interests and shareholder interests positively affects firm value (Goergen & Renneboog, 2011 and Liu et al., 2018).

- External Capital

$$\textbf{D/E}_{\textbf{it}} = \frac{\text{Total Debt}_{\text{it}}}{\text{Total Equity}_{\text{it}}} \times 100$$

More debt induces wider tax shields, which helps the firm retain profits, contributing to firm value (Hahnstein & order, 2006). Hedging reduces a firm's capital requirements (Gay & Nam, 1999)

- Firm Investments

$$\textbf{Invest}_{\text{it}} = \frac{\text{Capital Expenditure}_{it}}{\text{Assets}_{\text{it}}}$$

The investment opportunities undertaken by a firm, presents it with the opportunity to gain future cash flows. As a result, value investors are likely to add a premium to firm value (Lew, 2015).

- Profitability

$$\textbf{Return on Assets}_{\text{it}} = \frac{\text{Net profit}_{\text{it}}}{\text{Assets}_{\text{it}}} \times 100$$

Investors are willing to pay a premium for a stake in a firm that is more profitable (Allayannis & Weston, 2001)

- Firm size

  $$\mathbf{LnAssets}_{it} = \text{Log}(\text{Assets}_{it})$$

  The size of the firm contributes to its exposure to systematic and unsystematic risks. Additionally, larger firms are more likely to use derivatives to hedge (Bartham, Brown and Fehle, 2009).

Integrating all the described dependent, independent and control variables will help in fulfilling the research aims and objectives of the study. The research outcomes are required to be valid and reliable, and such research issues will be explored in the following section.

3.6. Issues of Validity and Reliability

The quality of the research output is measured by its validity and reliability. According to Heale and Twycross (2015), a study that is valid is one which ensures that the methods, models, and relationships between variables are accurately measured. The authors further develop a framework which can be used as a benchmark against a study, to verify that it can be deemed as valid. The benchmarks used to measure validity include the construct validity, the content validity, and the criterion validity. These three measures will be defined and used as a compass to enforce validity of this study.

The construct validity is defined as the ability of research instruments to accurately measure a set of hypotheses (Farideh, 2003). In this study, hypotheses will be considered in assuring that construct validity is met. Therefore, research propositions will be developed in this study using hypotheses observed within existing literature. In addition to construct validity, the content validity will also be considered. According to Korb (2013), the content validity aims to confirm if all the relevant content is included in a study. This study aims to comply with the content validity benchmark, by accounting for the relevant market risks faced by SA mining firms. Secondly, the firms selected for observation are listed, and their information is published in accordance with reliable reporting standards such as IFRS and IAS. Furthermore, the published financial statements all adhere to these reporting standards, enabling the findings of the research to be comparable. In this regard, the content validity measure is satisfied.

The final measure of validity is the *criterion validity* which measures how well an instrument is related to other instruments that measure similar variables (Heale & Twycross, 2015). According to Korb (2013), the criterion validity can be measured by correlating the instrument with other variables that are closely aligned with the instrument itself. Therefore, the criterion validity standard will be considered in this study by also including control variables that are known to affect firm value, in understanding the relationship between hedging and firm value. By so doing, the correlation between the firm value proxy and these control variables will be observed, as is required by the criterion validity standard. The control variables include the firm size, the growth, the leverage, and the firm's profitability.

In addition to validity standards, the findings of a study also need to be reliable, which refers to the consistency of a firm's measured results over a period, (Chivandire et. al., 2019). Furthermore, Mohamad, Sulaiman, Sern and Salleh (2015) are of the opinion that the reliability of an experiment can be concluded based on its consistency and stability. Therefore, diagnostic tests and remediation processes will be applied to the models to further enhance the validity and reliability of the findings of this study.

3.7. Conclusion

In this chapter, the methodological approach that will be followed in conducting the study is outlined, considering the research aims, the objectives, the propositions, the research paradigm, the research design, the analysis strategy, as well as issues of validity and reliability. Since the main aim of this study is to determine the impact of hedging on the firm value of SA mining firms, the primary variables that will be used in fulfilling the aims were highlighted, as well as the control variables that will assist in ensuring the robustness of the study. The main method that will be used is the panel data regression model, which is consistent with the previous studies that resolve similar aims and objectives. In the following chapter, the empirical results of this study will be presented and analysed.

Chapter 4: Empirical Analysis, Discussion, and Interpretation of Results

"The goal is to turn data into information, and information into insight" - Carly Fiorina (2004)

4.1. Introduction

The purpose of this chapter is to present the core findings of the research, by using the data and the model specifications outlined in the previous chapter. The research data and model specifications will be used to find conclusive evidence on the research aim, which is to determine the impact of derivative-based hedging (hereafter *hedging*) on the firm value of the SA mining firms listed on the JSE Precious Metals Index. There are three research objectives that will be used in finding conclusive evidence for the research aim. The first objective is to classify the mining firms included in this study as either hedgers or non-hedgers. The second objective is to determine if a hedging premium (or hedging discount) to firm value exists in firms that choose to hedge against price risks, compared to firms that choose not to hedge. The final objective would be to determine the significance of the relationship between hedging and the firm value of the mining firms. Three corresponding methods will be used to fulfil these three objectives. The hedging criterion will be used to fulfil the first objective, while a Wilcoxon signed-rank model and a panel data analysis model will be used to fulfil the second and third research objectives, respectively.

The chapter will consist of seven different sections, where the first section will consist of the research proposition statements that will be used to anticipate the outcomes of the research objectives. The second section will explain the process followed in classifying the mining and energy firms as either "hedgers" or "non-hedgers." In the third section, the descriptive statistics of the variables will be presented and analysed. The results from the Wilcoxon-signed rank model, which compares the variables of the hedging and non-hedging firms, will be presented in section 4. The research results of the panel model showing the relationship between hedging and firm value will be presented in section 5 and will also include the model's residual diagnostics tests. Section 6 will consist of a summary of the findings and will be followed by a conclusion of the chapter in the last section.

4.2. Research propositions

In the pursuit of finding conclusive evidence on the relationship between hedging and firm value, the outcomes of the study will be tested against three research propositions. The

proposed statements for the predetermined outcome of the results will be based on the findings in theory. According to Allayannis and Weston (2001), firms that adequately hedge their exposure to any market risks are likely to have higher firm values awarded to them by investors. This is consistent with the information asymmetries theoretical argument, which asserts that hedging reduces information asymmetries between investors and firm management. Theory further suggests that the higher firm values are likely to be realised by hedging firms which have lower information asymmetries, as revealed by Ameer (2010), Fauver and Naranjo (2010) and Qiao et al. (2020). As found in the literature review, other key benefits of hedging are reduced financial distress costs, improved debt capacity, improved optimisation and access to capital and tax benefits. However, the findings in emerging market studies by Lau (2016), Lambrechts and Toerien, (2016) and Ayturk et al. (2016) mostly suggest that hedging does not result in an enhanced firm value for non-financial firms. The following conjectural propositions are formulated based on existing literature concerning hedging and other control variables that have been documented as firm value drivers.

> Research proposition 1: There are no significant differences between the firm values of hedging firms and non-hedging firms.
>
> Research proposition 2: The relationship between hedging and firm value is positive and statistically insignificant.
>
> Research proposition 3: The relationship between firm value and the control variables is statistically significant.

The three research propositions are tentative and need to be judged as either true or false by fulfilling the research objectives. The first research objective to classify the sample of SA mining firms as either hedging or non-hedging firms will be established in the next section.

4.3. Classification of the SA mining firms

The sample of mining firms selected in this study consists of nine firms. The intention of the first objective of the study is to differentiate between the mining firms that hedge (hedgers) and the mining firms that do not hedge (non-hedgers). The classification of the firms as either hedgers or non-hedgers is differentiated by using the dummy variables to compute a

hedging percentage criterion, as described in Chapter 3. Essentially, the classification of firms as either "hedgers" or "non-hedgers" will be based on the following criteria:

If "hedge percentage" is **< 50%** in 10 years between 2010 and 2019, then *"mining firm"* = **non-hedger**

If "hedge percentage" is **≥ 50%** in 10 years between 2010 and 2019, then *"mining firm"* = **hedger**

Therefore, if a firm is classified as a hedger, the dummy variable for that firm will be 1, and if it is classified as a non-hedger, the dummy variable will be 0.

The results of the mining firm classifications are shown in Table 4.1. below:

Table 4.1: Table classifying a sample of firms in the JSE Precious Metals Index as hedgers and non-hedgers, over the 10-years between 2010 and 2019

Mining Index Firms	Hedge Percentage (%) over the 10-year period	Classification	Hedge Dummy
Anglo American Platinum	$HP^* = \frac{6}{10}$ = 60%	Hedger	1
Anglo Gold	$HP^* = \frac{5}{10}$ = 50%	Hedger	1
DRD Gold	$HP^* = \frac{1}{10}$ = 10%	Non-Hedger	0
Gold Fields	$HP^* = \frac{9}{10}$ = 90%	Hedger	1
Harmony Gold	$HP^* = \frac{3}{10}$ = 30%	Non-Hedger	0
Impala	$HP^* = \frac{8}{10}$ = 80%	Hedger	1
Northam Platinum	$HP^* = \frac{3}{10}$ = 30%	Non-Hedger	0
Pan African Resources	$HP^* = \frac{7}{10}$ = 70%	Hedger	1
Royal Bafokeng	$HP^* = \frac{1}{10}$ = 10%	Non-Hedger	0

Source: Author compilation based on notes to the financial statements

The above classification of firms shows that the mining firms classified as hedgers make up 56% of the sample, while non-hedgers account for 44% of the sample. In the following section, the descriptive statistics of the panel data consisting of all firms, hedging firms and non-hedging firm are presented and interpreted.

4.4. Descriptive Statistics of Variables

The descriptive statistics clarify the characteristics of the variables that will be included in the study. Therefore, as shown in Table 4.2 below, the measures of central tendency, variability and distribution of the different variables will be analysed in this section. Furthermore, since the classification of the hedging and non-hedging SA mining firms has been established, the descriptive statistics will be explained in terms of the three separate panels. Specifically, the descriptive statistics will be explained as all mining firms, as mining firms classified as hedgers and as mining firms classified as non-hedgers. The inclusion of the descriptive statistics of the firms at a combined level and at their different classification levels allow for the distinct characteristics of the firm classifications to also be understood.

Table 4.2: Descriptive statistics of the variables in three the panel datasets, which are "all firms", hedgers", and "non-hedgers."

Variables	Obs.	Mean	Median	Range	Standard Deviation	Skewness	Kurtosis	Jacque Bera Probability
Panel A: All Firms								
TQ	90	2.660	2.586	6.892	1.140	1.181	6.309	0.000
HEDGE_DUMMY	90	0.478	0.000	1.000	0.502	0.089	1.008	0.001
D_E	90	0.971	0.771	3.367	0.717	1.760	6.078	0.000
Growth	90	0.141	0.091	3.882	0.396	4.853	37.748	0.000
MNGT	90	0.007	0.002	0.065	0.015	2.867	10.380	0.000
Invest	90	0.086	0.080	0.339	0.044	2.248	14.289	0.000
ROA	90	0.009	0.009	0.553	0.085	-0.738	5.561	0.000
ASSETS	90	47072.910	39372.000	112387.529	36348.950	0.157	1.460	0.010
Panel B: Hedgers								
TQ	50	2.456	2.606	4.484	1.070	0.137	2.377	0.618
HEDGE_DUMMY	50	0.700	1.000	1.000	0.463	-0.873	1.762	0.008
D_E	50	1.156	0.949	3.265	0.755	1.469	5.000	0.000
Growth	50	0.100	0.083	1.150	0.201	-0.078	4.196	0.220
MNGT	50	0.002	0.000	0.021	0.004	2.781	11.607	0.000
Invest	50	0.097	0.085	0.297	0.046	3.277	17.533	0.000
ROA	50	0.019	0.017	0.553	0.099	-1.017	5.337	0.000
ASSETS	50	68547.640	80558.000	112387.529	34536.070	-1.126	2.815	0.005
Panel C: Non-Hedgers								
TQ	40	2.915	2.586	6.042	1.186	2.158	8.195	0.000
HEDGE_DUMMY	40	0.200	0.000	1.000	0.405	1.500	3.250	0.001
D_E	40	0.739	0.524	3.025	0.597	2.555	10.195	0.000
Growth	40	0.193	0.099	3.882	0.550	3.924	21.861	0.000
MNGT	40	0.014	0.004	0.065	0.020	1.664	4.270	0.000

Invest	40	0.072	0.068	0.163	0.038	0.322	3.183	0.688
ROA	40	-0.004	0.007	0.320	0.062	-0.093	4.064	0.378
ASSETS	40	20229.500	19697.710	40912.600	13649.170	0.166	1.849	0.303

Source: Author Computation using E-Views

Looking at the descriptive statistics, the firm size, which is represented by assets, seems to be unmatched with the scales of the rest of the variables, as it is much larger in comparison. The variable calls for its data series to be logged, as the application of the logarithmic scale will assist in aligning it with the measurement units of the remaining variables. The adjustments of the measurement units for the firm size will also prevent the model outcomes from being distorted (Robbins, 2012).

In terms of the distributions of the variables, at a combined level relating to panel A, the variables for all the mining firms are not normally distributed based on the consistent Jarque-Bera probability of 0.00. However, at a separate classification level, certain variables are normally distributed. For firms in classified as hedgers in panel B, the firm growth and the Tobin's Q are normally distributed as indicated by the Jarque-Bera probability of 0.22 and 0.61, respectively. The normal distribution of the variables is reinforced by the low positive skewness of 0.13 for the Tobin's Q and negative skewness of -0.07 for the growth. The distributions of the two variables also diverge from a mesokurtic distribution, which is relatively low. In contrast, the assets of the hedging firms have a platykurtic distribution, the remaining variables are leptokurtic, which is indicated by the high excess kurtosis.

A leptokurtic distribution is also evident in the variables of the mining firms classified as non-hedgers, which indicates the presence of outliers in the datasets. These variables consist of the Tobin's Q, the D/E ratio, the management shareholding, and the firm growth, which has the highest level of excess kurtosis. Furthermore, the Jarque-Bera probabilities of these variables are all 0.00, reinforcing the fact that they are not normally distributed. In relation to in panel C, the remaining variables relating to the non-hedging mining firms are normally distributed. In terms of skewness, the most skewed variables are the firm investments of the hedgers and the firm growth of the non-hedgers.

It is evident that there are inconsistencies in the distributions of the variables based on the classifications of the mining firms. The same inconsistencies are prevalent in the measures of central tendency. Furthermore, the distributions of the data series are mostly not

normally distributed and inconsistent across the mining firm classifications. Therefore, a parametric test such as the ANOVA cannot be used in the second objective of the study, which is to establish the significance of differences between the mining firms classified as hedgers and non-hedgers. It is more appropriate to base inferences on the differences between the firm classifications using a non-parametric test. In view of these data limitations, the most appropriate model to make such inferences between the two firm classifications is the Wilcoxon signed-rank test, which will be presented in the following section.

4.5. Wilcoxon Signed-Rank Test: Differences between Hedgers and Non-Hedgers

The Wilcoxon signed-rank test will be used to fulfil the second objective of the study, which is to determine if there is a significant difference in the firm value of SA mining firms that hedge, and those that do not hedge. The model is defined as a non-parametric statistical test that is used in the detection of differences between data sets. According to Liu (2018), the test is appropriate in two instances, and the first is if variables are not normally distributed. The second condition of using the Wilcoxon signed-rank test is if the variables can be differentiated based on a binary outcome. These conditions make the test appropriate for the existing variables, as it has been established from the descriptive statistics that the majority of the variables are not normally distributed.

Furthermore, the variables to be differentiated are classified as either “hedgers” or “non-hedgers” based on the described binary outcome of the dummy variables. The null hypothesis of the test is that the median difference between pairs of observations is zero, which means that there are no statistically significant differences between the variables of the two firm classifications (hedgers and non-hedgers). A summary of the estimation of the model is provided in Table 4.3 below:

Table 4.3: Output of the Wilcoxon signed-rank test showing the significance of the differences in the variables between hedging and non-hedging SA mining and energy firms.

Variable	Hedgers	Non-hedgers	Difference	Wilcoxon Test	P-value
TQ	2.606	2.586	0.020	1.076	0.282
D_E	0.949	0.524	0.425	3.496	0.001***
Growth	0.083	0.099	-0.016	0.394	0.694
MNGT	0.000	0.004	-0.003	4.573	0.000***
Invest	0.085	0.068	0.018	2.927	0.003***

ROA	0.017	0.007	0.010	1.644	0.100
Size	80558.000	19697.710	60860.290	5.436	0.000***

**** represents significance different at a 99% confidence interval.*

Source: Author computation using E-Views

Based on the outcome of the firm value proxy using the Wilcoxon signed-rank test, the firm value of the SA mining firms classified as hedgers is slightly larger than the firms classified as non-hedgers. However, this observed difference between the Tobin's Q proxy of the two firm value classifications is not statistically significant. In contrast, other significant differences between the hedging and non-hedging firms are observed in some of the variables that have been deemed as contributors to firm value. It can therefore be said that at a 99% confidence interval, SA mining firms that hedge have a D/E ratio that is 0.43 times higher, a management shareholding that is 0.34% lower and a firm size that is 60 860 units larger than their non-hedged counterparts. However, there are no statistically significant differences observed in the firm growth and the ROA of the two different firm classifications.

Seeing that the significance of the differences in the variables of the hedging and non-hedging mining firms has been established, it is important to determine the isolated effect of the firm's hedging decision on its firm value. As such, the following section will present the panel regression analysis to establish the relationship between hedging and the firm value of the SA mining, with the inclusion of control variables.

4.6. Panel Data Analysis

In this section, the results of the multivariate panel data model will be presented to determine the relationship between hedging and firm value. The output of the research results will be presented first, followed by the interpretation of the results and the residual diagnostics. The results in Table 4.4. present the estimation of the relationship between hedging and firm value, including control variables using the POLS, the FE and the RE models. The estimations are based on the econometric models concerning the Tobin's Q proxy for firm value, which is the dependent variable. Additionally, the outcomes of the Redundant Fixed Effects test and the Correlated Random Effects test are also presented in Table 4.4.

Table 4.4: Results from the panel data model displaying the relationship between hedging and the Tobin's Q of sample of firms listed on the JSE Precious Metals index.

VARIABLES	Pooled OLS		Fixed Effects		Random Effects	
	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
C	4.436	0.000***	-5.262	0.118	3.623	0.002***
HEDGE_DUMMY	0.651	0.003***	0.198	0.302	0.389	0.031**
D_E	0.212	0.189	0.512	0.002***	0.483	0.001***
GROWTH	0.113	0.653	0.011	0.956	0.063	0.740
MNGT	36.213	0.000***	25.638	0.010**	29.627	0.000***
Invest	-1.198	0.611	2.828	0.198	0.998	0.622
ROA	2.203	0.075*	4.260	0.000***	3.375	0.001***
Size	-0.244	0.003***	0.675	0.045**	-0.192	0.088*
R-squared	0.424		0.716		0.342	
Adjusted R-squared	0.376		0.658		0.287	
F-statistic (Prob)	0.000***		0.000***		0.000***	

; **; * represent significance at 90%; 95% and 99% confidence interval, respectively.*
Source: Author compilation based on E-Views estimates.

Table 4.5: Results of the Redundant Fixed Effects and the Random Effects tests used to select the most appropriate model to estimate the relationship between hedging and Tobin's Q.

Redundant Fixed Effects Test (Fixed Likelihood Ratio)	F-Statistic	d.f.	Prob.
Cross-section	9.849	-8.65	0.000***
Period	1.707	-9.65	0.105
Joint Cross-Section & Period	5.735	-17.65	0.000***
Correlated Random Effects (Hausman Test)	**Chi-Square. Statistic**	**Chi-Square. d.f.**	**Prob.**
Cross-section random	27.074	7	0.000***

**** represents significance at a 99% confidence interval.*

Source: Author compilation based on E-Views estimates.

The POLS regression which includes the explanatory and control variables explains 37.6% of the variance in the Tobin's Q proxy for firm value. In this model, the hedging proxy is significant at a 99% confidence interval, along with management shareholding and the firm size. The management shareholding and the firm size are also significant at the same 99% confidence interval. Additionally, the ROA ratio has a highly suggestive level of significance at a 90% confidence interval, while variables such as the D/E ratio, the firm growth and the firm investments are insignificant contributors to the variance in the Tobin's Q proxy for firm value.

In order to determine the prevalence of the cross-section and the period effects in the model estimates, the Redundant fixed effects test is applied to the estimation of the FE model. The null hypothesis of the test is that the cross-section and period effects are

redundant. The p-value of the cross-section F-statistic is significant at a 99% confidence interval. However, for the period fixed effects, the p-value of the F-statistic is 0.105, which indicates that the period effects are not significant. These results mean that the null hypothesis stating that the cross-section effects in the model are redundant can be rejected, as there is heterogeneity that needs to be accounted for in the individual mining and energy firms. However, for the period effects, the null hypothesis is not rejected as there is no heterogeneity present over the course of the observation period. Therefore, the FE and RE models estimating the relationship between hedging and firm value using the Tobin's Q proxy are to be estimated by only incorporating the cross-section effects.

An additional establishment of the best fitting model between the FE and the RE models is determined by using the Hausman test for correlated random effects. The test is applied to the estimation of the RE model, which explains only 28.7% of the variance in the Tobin's Q proxy for firm value. The Hausman test for the cross-section random effects shows that the p-value of the chi-square statistic is 0.00, which means that the null hypothesis stating that the RE model is appropriate can be rejected, since the FE is evidently the most appropriate estimation model. Therefore, the interpretation of the first model using the Tobin's Q proxy for firm value is interpreted using the estimation outcomes of the FE model with cross-section effects.

Based on the adjusted R-squared, the outcome of the FE model explains 65.8% of the variance in the Tobin's Q proxy for firm value. While there is a positive relationship between hedging and firm value, the model reveals that hedging is not a significant factor in affecting the firm value of the SA mining firms as the corresponding p-value is 0.302. The insignificant effect of hedging on firm value is in line with expectations, as this is the norm in emerging market studies. In contrast, control variables such as the D/E ratio and the ROA are positive and statistically significant in affecting firm value at a 99% confidence interval. The management shareholding and the firm size also indicate a positive significance in explaining the variance in the firm value proxy, at a 95% confidence interval.

The implication of these outcomes is that hedging does not explain the variance in the firm value of SA mining firms as measured by Tobin's Q. However, the Tobin's Q of the firms will increase by approximately 0.512; 4.26; 25.638 and 0.675 units in response to single unit increases in the D/E ratios, the ROA ratios, the management shareholding percentages, and

the firm sizes of the mining firms, respectively. All other control variables are insignificant in explaining firm value, as measured by the Tobin's Q proxy.

Given that the isolated effect of hedging on the firm value of SA mining firms has been established using the most appropriate estimation model, residual diagnostic tests need to be applied to the selected FE model. The intention of performing the residual diagnostic tests is to ensure that the model adequately captures the outcomes of the data. These tests will be specified in the next segment of the research findings.

4.6.1. Residual diagnostics

The residual diagnostic tests that will be run on the previously estimated FE model will include the Jarque-Bera test for normality and the Breusch-Pagan Lagrange Multiplier (LM) test for heteroscedasticity. The correlation test to examine multicollinearity between the variables of the FE model will also be included in the residual diagnostic tests. The results of the residual diagnostics test are shown in Table 4.6. below.

Table 4.6: Table of Residual Diagnostic tests on the multicollinearity, normality and the heteroscedasticity in the FE model estimating the relationship between hedging and firm value.

Estimated Model	Multicollinearity			Jarque Bera		Breusch-Pagan LaGrange Multiplier (LM)		
	Lowest Corr.	*Highest Corr.*	*Collinear Variables*	*Stat.*	*Prob.*	*Statistic*	*d.f.*	*Prob.*
Cross-sectional FE model	-0.321	0.515	-	7.006	0.030**	51.725	36	0.043**

*** represents significance at a 95% confidence interval.*
Source: Author Compilation based on E-views outcomes

There is no evidence of multicollinearity between all the variables used to determine the underlying relationship between hedging and firm value. Collinearity is determined based on the correlation matrix of the variables, using the bounds of -0.7 and +0.7 to estimate the presence of multicollinearity. Considering that the correlation estimates of the variables in the model did not transcend these bounds, it can be said that no multicollinearity is detected in the model.

The Jarque-Bera test for normality is the second residual diagnostic test applied to the models. The corresponding p-value of the test is 0.03, which means that the null hypothesis

stating that the model follows a normal distribution can be rejected. To adjust the model to a normal distribution, it will be estimated using the square root of the dependant variable, specifically the Tobin's Q. In addition to the normality test, the final residual diagnostic test for the FE model is the LM test for heteroscedasticity. The corresponding p-value of the LM test is 0.043, which means that the null hypothesis stating that there are no cross-sectional dependencies in the residuals of model can be rejected. The rejection of the null hypothesis means that the presence of heteroscedasticity has been detected. To adjust for the presence of heteroscedasticity, the results of the redundant effects from the initial model will need to be revised as it will assist in correcting for heteroscedasticity. It was previously established that the cross-section effects of the model were not redundant. Therefore, the White cross-section (period cluster) will be applied to the model to remediate it for heteroscedasticity. The post-remediation residual diagnostics tests of FE model can be found in table 4.7 below.

Table 4.7: Table of Residual Diagnostic tests on the multicollinearity, normality and the correlation in the models estimating the relationship between hedging and firm value.

Estimated model	Multicollinearity			Jarque-Bera		Breusch-Pagan (LM)		
	Lowest corr.	Highest corr.	Collinear Variables	*Statistic*	*Prob.*	*Statistic*	*d.f.*	*Prob.*
Cross-sectional FE model	-0.324	0.558	-	4.546	0.103	59.180	36	0.009***

**** represent significance at a 99% confidence interval.*
Source: Author compilation based on e-views outputs

After correcting for the presence of normality in the model, the Jarque-Bera probability is now 0.103, which exceeds the 0.05 critical value. This means that the null hypothesis of a normal distribution is not rejected, as the model estimate is now normally distributed. Lastly, concerning heteroscedasticity, the implementation of the White cross-section (period cluster) in model 1 improved the level of significance of the LM test from a 95% to a 99% confidence interval. Despite the slight improvement in the significance level of the p-value, the null hypothesis stating that there is no cross-sectional dependence in the residuals cannot be rejected. Nonetheless, the remediation of the residual diagnostic issues brings about changes in the original estimations of the model, which can be observed in Table 4.8. presented in the following sub-section.

Post-Remediation Results

In Table 4.8 below, the significant change that is observed from the original estimations of the FE model is the improvement in its explanatory power, which improved from 65.8% to 68.4%, based on the adjusted R-Squared statistic. However, the primary relationship between hedging and firm value remains positive but insignificant. With regards to the significance of the variables, a reduced level of significance is observed in the D/E ratio where its level of significance changed from a 99% to a 95% confidence interval.

Table 4.8: Results from the panel data model displaying the relationship between hedging and the Tobin's Q of sample of firms listed on the JSE Precious Metals Index

VARIABLES	SQRT (Tobin's Q)	
	Coefficient	Prob.
C	-0.553	0.343
HEDGE_DUMMY	0.068	0.222
D_E	0.103	0.030**
GROWTH	0.008	0.829
MNGT	6.643	0.036**
Invest	0.956	0.043**
ROA	1.253	0.000***
Size	0.184	0.002***
R-squared	0.738	
Adjusted R-squared	0.684	
F-statistic (Prob)	0.000***	

****and ** represent significance at a 99% and a 95% confidence interval.*
Source: Author compilation based on e-views outputs

The implication of this change is that a single unit increase in the D/E ratio will result in an increase of 0.103 in the firm value of the SA mining firms. In diametrical contrast, the significance of the firm size improved from a 95% to a 99% confidence interval in terms of explaining the variance in the Tobin's Q. The significance of the firm size implies that a single unit increase in firm size will result in an increase of 0.184 in the firm value of the SA mining firms. Other variables that were initially deemed significant, such as the management shareholding and the ROA, maintained their positive significance at the same confidence intervals (99% and 95% respectively). As such, a single unit increase in the management shareholding and the ROA would result in respective increases of 6.63 and 1.25 in the firm value of the SA mining firms. Additionally, the application of the model remediation tools changed the initially insignificant firm investments variable to be statistically significant at a 95% confidence interval. The change in the significance of the firm investments variable

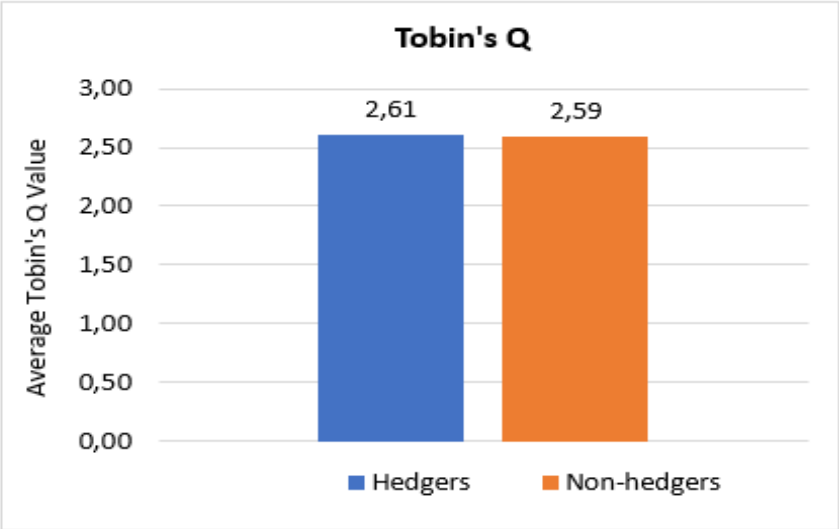
implies that if it increases by a single unit, it will result in a corresponding increase of 0.95 in the firm value of SA mining firms. By taking all these results into account, the following section will expand on all the findings acquired in this chapter.

4.6. Interpretation of Results

The first objective of classifying the sample of SA mining firms as hedgers and non-hedgers was achieved through a hedging percentage criterion. While the hedging criterion revealed that 56% of the sample of SA mining firms are classified as hedgers, the descriptive statistics also revealed that these mining firms tended to hedge against price risk 47% of the time, on average. In the second and third research objectives, the primary relationship between hedging and firm value was assessed at a univariate level and at a multivariate level, respectively.

At a univariate level, the second research objective determined if a hedging premium or hedging discount to firm value existed between the hedging and non-hedging firms. This was done by observing the differences in the firm value proxies of the hedging and non-hedging firms in a silo, using the Wilcoxon signed-rank test. The results showed that on average, the firm value of the mining firms classified as hedgers is slightly greater than the firm value of the mining firms classified as non-hedgers. However, based on the outcome of the Wilcoxon signed-rank test concerning the two firm classifications, this slight premium in the firm value of hedging firms is statistically insignificant. The visual representation of the findings is shown in Figure 4.1 below.

Figure 4.1: Estimation of median differences in the Tobin's Q between the SA mining firms classified as hedgers and non-hedgers, using the Wilcoxon signed rank non-parametric test.



Source: Author compilation

The insignificant differences observed between the Tobin's Q proxies of both the hedging and non-hedging mining firms are in line with findings by Jin and Jorion (2007). The authors did not find significant differences in the firm value of oil and gas firms that chose to hedge compared to their non-hedged counterparts. However, the findings contradict theories by Allayannis and Weston (2001), Lau (2016) and Bessler et al. (2018), who found significant differences in the firm values of hedgers and non-hedgers. Specifically, Allayannis and Weston (2001) and Bessler et al. (2018) found that firms that hedge had a hedging premium to firm value. On the other hand, Lau (2016) found that Turkish firms that hedged had a discount to firm value instead, from a univariate perspective.

The third research objective aimed to determine if the hedging premium (or discount) to firm value would still hold if it were subjected to control variables that have been found to also affect firm value in literature. As such, a multivariate panel regression was used to find evidence on the impact that hedging has on firm value, with the inclusion of the control variables. The results revealed that while hedging is positively related to the firm value of the mining firms, it is statistically insignificant in actually affecting the variance of their firm value. Therefore, the first proposition, which anticipated an insignificant relationship between hedging and firm value, is not rejected. The results concur with earlier theoretical propositions made by Miller and Modigliani (1985), that stated the conditions of the irrelevance of hedging in affecting firm value. The theory has been used as a basis to determine the relationship between hedging and firm value across the prescribed literature.

With reference to the commodity-producing industries in the developed markets, literature by Jin and Jorion (2006) has shown evidence of an insignificant and negative relationship between hedging and the firm value of USA oil and gas firms. In a similar developed market study concerning the USA and Canadian oil-and-gas producing firms, Lookman (2004) found an insignificant relationship between hedging and the firm value. The latter authors attributed the insignificance of hedging in affecting firm value to the efficiency of information in the industry, which enables investors to diversify their own exposure to price risks. This resonates with the sentiments proposed by Smith and Stulz (1985), who stated that a firm's decision to diversify away unsystematic risk for their shareholders/ investors would only be a disservice to the investors. The authors reason that the diversification process would increase internal costs of risk reduction that are already being incurred by

investors externally. The investors are therefore unlikely to compensate firms with higher firm values for undertaking additional risk management measures such as derivative-based hedging.

An additional reasoning concerning the insignificance of hedging on firm value is provided by Chivandire et al. (2019), who asserts that financial engineering initiatives are not sole creators of firm value, but rather tools which can be used to optimise core value creation initiatives in firms. Therefore, since derivative-based hedging is a financial engineering initiative, its observed insignificance in affecting the value of the SA mining firms can be ascribed to its efficacy as a financial optimisation tool, rather than primarily being a core firm value enhancing tool. This is also in line with reasoning presented by dos Santos et al. (2017), who attributed the insignificance of derivative-based hedging in affecting firm value to the ability of derivatives to manage cash flows, rather than to add value.

In contrast to the insignificance of hedging in affecting firm value, the control variable that was found to be significant in affecting the firm value is the D/E ratio. The significance of the D/E ratio is in line with theory by Graham and Smith (1999), Graham and Rogers (2002) and Hahnenstein and Röder (2006). According to these authors, the positively significant D/E ratio induces higher interest payments in a firm, which provides a wider tax-shield that reduces the tax payments of a firm. The reduced tax inadvertently translates to more earnings being retained in a firm, which reinforces higher profitability. The tax shield also offsets the potential financial distress costs that could be incurred from the higher debt in the D/E ratio.

Additionally, agency issues such as management shareholding were also significant in affecting firm value using the Tobin's Q proxy. The original proposition by Jensen and Meckling (1976) suggests that a misalignment of interests between shareholders and managers could potentially result in the reduction of the shareholders' utility, in terms of maximising shareholder value (Laplume et al., 2008). The significance of management shareholding in affecting firm value is line with theory suggesting that an alignment of interests between management and shareholders would allow management to make beneficial hedging decisions for the firm (Liu et al., 2018). Such decisions would in turn preserve or enhance firm value for both the shareholders' interests and the management interests.

The firm investments were also found to significantly affect firm value in a positive way. While the significance of the firm investments in affecting firm value is line with findings in the UK oil and gas industry, the direction was different. The findings presented by Ullah, Irfan, Kim and Ullah (2021) suggest that the combination of hedging and firm investments (capex) resulted in a reduced firm value for the UK oil and gas firms. The findings by Ullah et al. (2021) contradicts the idea that hedging combats against the underinvestment problem, as expressed by Baker and Filbeck (2018 significance). However, the results of this study confirm that SA mining firms that hedge tend to invest more in their firms, which in turn results in an improved firm value.

In addition, other findings in the univariate analysis concerning the differences in the ROAs of hedgers and non-hedgers contradict theories suggesting that hedging firms are more profitable than non-hedging firms (Ayturk et al., 2016). Instead, this study finds that there are no significant differences in the ROA of SA mining firms classified as hedgers and those classified as non-hedgers. However, the ROA was found to positively affect the firm value of the SA mining firms in the multivariate analysis. The positive significance of the ROA is similar to the findings presented by Graham and Rogers (2000), Allayannis and Weston (2001), and Carter, Roger and Simkins (2006). Contrasting findings of an insignificant relationship between the ROA and firm value are presented by Ayturk et al. (2016).

Lastly, the positive significance of the firm size in affecting Tobin's Q is in tandem with theory by Nance, Smith, and Smithson (1993), as well as Carter et al. (2006). The authors propose that larger firms are more likely to engage in derivative-based hedging. They assert that the tendency for larger firms to hedge more than smaller firms is supported by their economies of scale, which are efficient in sustaining the high costs of having a hedging program. However, the firm size findings contrast with theory by Allayannis and Weston (2001) and Adam et al. (2017), who do not find a significant relationship between firm size and firm value.

4.7. Conclusion

This chapter aimed to find conclusive evidence in relation to the impact that derivative-based hedging has on the firm value of mining firms listed on the JSE Precious Metals Index. When measuring the differences in the firm value proxies in terms of their classifications, no

significant differences are observed between the Tobin's Q of the mining firms classified as either hedgers or non-hedgers. Furthermore, the initial findings of an insignificant difference in the Tobin's Q of the hedging and non-hedging mining firms were not altered by the inclusion of control variables, using the multivariate FE estimation model. However, variables that were found to be significant in explaining the variance in the Tobin's Q are the D/E ratio, the management shareholding, and the firm size. The primary findings of an insignificant relationship between hedging and firm value for the mining and energy firms are supported by literature provided by Miller and Modigliani (1985), Lookman (2004) and Lambrechts and Toerien (2016). In the next chapter, an overall conclusion of the whole study will be presented. The conclusion will relate to the current and preceding chapters which encompass the study on derivative-based hedging and its impact on the firm value of SA mining firms.

Chapter 5: Conclusion

"The only possible conclusion that the social sciences can draw is that some do, and some don't."

~Ernest Rutherford (n.d.)

5.1. Introduction

This study examined the effect of derivative-based hedging on the value of firms listed on the JSE, particularly the constituents of the JSE Precious Metals Index. The research topic was introduced by highlighting the importance of the SA mining industry from a domestic context, where it was found that the mining industry contributes to the country's FDIs, GDP and the income of the national treasury. The importance of the SA mining industry also extends to the international market, as it is a leading producer of sustainability-promoting commodities worldwide, such as PGMs. However, the research background provided evidence suggesting that the mining and commodity producing firms are susceptible to market price risks. This sensitivity to price risk has encouraged investigation to find evidence to either support or negate the notion that price risk mitigation is a firm value-enhancing pursuit, for the SA mining firms. The specific risk mitigation process was assessed in terms of the financial engineering strategy of hedging through use of derivatives as financial instruments. Therefore, the overarching aim of the research was to establish the effect of derivative-based hedging on the firm value of SA mining firms.

The first objective used to direct the course of the study was to classify the sample of SA mining firms as either hedgers or non-hedgers. The second objective was to determine whether a premium or discount is assigned to the firm value of hedging mining firms, relative to the firm value of non-hedging mining firms. The final objective was to determine the significance and the direction of the relationship between derivative-based hedging and the firm value of the mining firms. The fulfilment of the research objectives was directed by the preceding three chapters. As such, the layout of this concluding chapter will chronologically provide summaries and conclusions of Chapters 2 to 4, which were the literature review and the research methodology, as well as the research results. The study limitations and the recommendations will be presented at the end of this concluding chapter.

5.2. Summary of the study

In Chapter 2, derivatives were defined and explained in terms of their uses, which led to the extraction of their usability in the process of hedging against market price risks. Considering the market price risk exposure that the mining firms are susceptible to, it became evident that derivatives were useful in hedging against market price risks. However, the question remained in terms of whether the process of managing risks was a firm value enhancing pursuit for companies in the SA mining industry. Different theories suggested that the purpose of the firm is to create value for shareholders (Friedman, 1970) and other stakeholders (Jensen & Meckling, 1976). However, theory on the implications of derivative-based hedging on firm value have been pursued in terms of the shareholder primacy theory, developed by Friedman (1970). The theory stipulates that the firm exists for the purpose of improving shareholder value, which means that firm value should be looked at through the lens of shareholder value enhancement.

The fundamental theory by Miller and Modigliani (1985) was then adopted to assist in understanding the effect of hedging in managing risks, and the ultimate impact that this has on the value of a firm. The theory suggested that the corporate financial policies of an organisation, such as hedging, were irrelevant to firm value under perfect market conditions, in the context of the shareholder primacy theory of firm value. As mentioned by Ammon (1998), the irrelevance of such financial engineering policies in affecting the firm value assumes that shareholders can hedge against risks by diversifying away their own exposure to risk. The basis of the argument rested on the irrelevance of certain costs explained in the Miller-Modigliani trade-off theory, which include agency costs such as bankruptcy costs, external capital markets, debt capacity issues, financial distress costs, information asymmetries, tax benefits, optimal capital structures and underinvestment problems, as developed by Smith and Stulz (1985), Froot et al. (1993), as well as Graham and Rogers (2002).

A vast amount of literature has been produced to ascertain whether the Miller-Modigliani irrelevance theory holds in affecting the shareholder primacy take on firm value. The findings have been inconclusive, as some researchers, such as Lookman (2004) and Lambrechts and Toerien (2016), found evidence supporting the theory. In contrast, other authors contested the theory by presenting findings that oppose the notion that hedging is

not a firm value-enhancing management decision. Findings by Allayannis and Weston (2001), Carter et al. (2006), as well as Bessler et al. (2018), suggested that hedging is a value-enhancing pursuit for a firm. Additionally, other authors only find hedging to be a firm value- enhancing pursuit during periods of high volatility (Aretz et al., 2008).

Most of the literature has been conducted based on various non-financial indices and industries in both emerging and developed markets. However, there has been a limitation in the exploration of the impact of derivative-based hedging on the firm values of mining and energy firms. Only two studies were found to address this topic in the oil and gas industries in developed markets, namely in the USA (Jin and Jorion, 2006) and in Canada (Lookman, 2004). A similar developed market study was conducted by Jin and Jorion (2007), based on the USA gold mining industry. However, industry-specific research relating to the impact of derivative-based hedging on firm value in emerging market industries such as mining was not found. This presented a research gap to be filled in order to enhance the body of knowledge on the implications of hedging on the firm value of mining firms in emerging markets, particularly the concerning the SA mining industry. The research methodology used to pursue the study was presented in chapter 3.

The research methodology was presented in relation to the research paradigm, the research design, the research methods, and the research data. A quantitative research methodology was followed in finding conclusive evidence on locating a single reality regarding the impact of derivative-based hedging on the firm value of the SA mining firms. The SA JSE Precious Metals Index was the sample selected to address the research problem in this emerging market mining industry. The sample included the public firms listed on the index as of 31 July 2020, with the exclusion of “Sibanye Stillwater”, which has only been listed for seven years and which is less than the 10-year observation period. The data variables of the remaining sample of the nine SA mining firms were used in a three-step process to fulfil the three research objectives and to test the research hypotheses.

The variables of the study consisted of the dependent variable, an independent variable and six control variables. The dependent variable was the Tobin’s Q, which was a proxy that was used to measure firm value. The independent variable was the proxy for hedging, which was computed by using a dummy variable based on a hedging percentage criterion. The criterion specified the parameters of classifying the mining firms as hedgers and non-hedgers, where

the hedgers were given a dummy variable of 1, and non-hedgers were given a dummy variable of 0. The final category of variables included in the study comprised of the miscellaneous accounting variables that have been found in literature to affect firm value and were therefore used as control variables. All variables were sourced from the publicly available financial statements, over a 10-year sample period starting from January 2010 and ending in December 2019. Following the selection of the research data, two models were used to address the research question, the first of which was a Wilcoxon signed-rank test. The test assessed the significance of the differences between the firm values of the two mining firm classifications (hedgers and non-hedgers), solely based on the differences in the firm value proxy.

Essentially, this test estimated whether there was a premium (or discount) in the firm value of mining firms that chose to hedge against price risk, as opposed to mining firms that chose not to hedge against price risk. The panel data analysis model was the second model used to fulfil the overarching research aim. The panel model was specified in terms of the firm value proxy against the hedging dummy variable. Furthermore, the accounting variables were included in the model as control variables that helped assess if the hedging discount or hedging premium to firm value would still stand when subjected to other factors that affect firm value. Essentially, the findings of the econometric model aimed to determine the impact of derivative-based hedging on firm value, from a multivariate perspective. The following section will provide a summary of the findings from the research models.

5.3. Research findings: Conclusion on the first research objective

The first research objective was to classify the SA mining firms included in the sample as either hedgers or non-hedgers, using the dummy variable hedging percentage criterion. The percentage of the SA mining firms classified as hedgers constituted 56% of the sample of firms, while the non-hedgers constituted 44% of the sample of firms. Furthermore, the descriptive statistics revealed that the firms classified as hedgers tended to hedge against price risk 70% of the time, while the non-hedging firms tended to hedge against price risk only 20% of the time. More differences in the characteristics of the two firm classifications were established using the Wilcoxon signed-rank test, which also helped fulfil the second research objective.

5.4. Research findings: Conclusion on the second research objective

The second objective was to determine whether a premium or discount is assigned to the firm value of the SA mining firms classified as hedgers, relative to the SA mining firms classified as non-hedgers. This was done by determining if significant differences existed between the firm values of the two firm classifications from a univariate perspective, using a Wilcoxon signed- rank test. The results obtained from the Wilcoxon signed-rank test showed that the firm value of the hedging firms was marginally larger than the firm value of the non-hedging firms, using the Tobin's Q as a proxy for firm value.

However, this slight hedging premium was found to be statistically insignificant, as there were no significant differences between the firm values of the hedging and non-hedging SA mining firms. The insignificance of the differences in the firm values between the two firm classifications is in line with previous findings on the insignificance of the effect of hedging on the firm value, given by Ayturk et al. (2016). However, it contradicts findings of a significant hedging premium to firm value in the theory presented by Lookman (2004), Bessler et al. (2018) and Zhang (2012). The findings also contradict theory suggesting a significant hedging discount to firm value, as presented by Lau (2016).

5.5. Research findings: Conclusion on the third research objective

The third research objective was to determine if the significance of the hedging premium/discount would either change, or still hold, when other factors affecting firm value were included in a multivariate analysis. The findings of the multivariate panel regression model included the control variables. The results showed that the decision for the SA mining firms to hedge against price risk is inconsequential in determining firm value. These findings contradict similar literature concerning global non-financial firms in developed markets, as observed by authors such as Allayanis and Weston (2001) and Bessler et al. (2018). However, the findings are in line with research relating to non-financial firms in emerging markets, as seen in research by Lambrechts and Toerien (2016) and Ayturk et al. (2016). In addition, the findings are also aligned with literature on the U.S. gold mining industry as observed by Jin and Jorion (2007), as well as literature on the global oil and gas exploration industries, as observed by Lookman (2004) and Jin and Jorion (2006). The overall findings of

this study suggest that the SA mining firms tend to follow general emerging market trends, as well as trends that are specific to the mining and energy industries in global markets.

It is important to note that during the boom of the Palladium Group Metals (PGM) in 2018-2019, most of the PGM mining firms only hedged against currency exposure on the back of a weakening Rand and these firms still maintained high firm values. The maintenance of high firm values with the absence of commodity price hedging is explained by Bubere and Shihab (2013). The authors state that mining firms should not hedge, in order to take advantage of the price exposure on the upward movement of the underlying commodities that they produce. Such upside potential is deemed beneficial for investors who seek to gain exposure to the commodity markets by investing in commodity-producing firms like the SA mining firms included in this study. Since the significance of hedging on the firm value of SA mining firms has been determined, the following section will expand on the additional variables that were found to affect firm value based on the outcome of the multivariate analysis.

5.6. Research Findings: Additional factors influencing firm value

The multivariate model consisted of control variables that were found to affect firm value, in the theoretical framework. Of the six control variables, five variables were found to positively affect the variance of the Tobin's Q proxy for the firm value of the SA mining firms. These variables are the D/E, the management shareholding, the firm investments, the ROA, and the firm size. The result of the Wilcoxon signed-rank test concerning the firm size found that firms that are classified as hedgers were four times larger than the firms classified as non-hedgers. This is in line with theory by Allayannis and Weston (2001), who have suggested that larger firms in developed markets tend to hedge more than smaller firms, as they have the scale to support the high costs of establishing an effective hedging program. An opposition to this notion was found in the Indian gold mining industry, where smaller firms tended to hedge more than larger firms (Adam et al., 2017).

While there were no significant differences observed between the ROAs of the hedging and non-hedging firms, the ROAs of the SA mining firms were found to be significant in affecting the variance of their Tobin's Q. The year-on-year changes in the profitability metrics such as the ROA were explained in the financial statements of the SA mining firms. The mining firms ascribed the changes in the ROAs to commodity price changes, tax regime changes, strikes

by miners, impairments of mining assets and mine closures. While the findings on the significance of the ROA in affecting firm value contradict theory by Ayturk et al. (2016), they do instead correspond with findings by authors like Graham and Rogers (2000), Allayannis and Weston (2001), Carter et al. (2006).

In addition, the D/E was found to affect the firm value of the mining firms. Furthermore, significant differences were observed between the D/E ratios of the hedging and non-hedging firms, where hedging firms had gearing levels that were almost two times more than the non-hedging firms. According to Haushalter (2000), as well as Bhagwan and Lukose (2017), a reason for the differences in the D/E ratios is that the hedging firms may need to hedge against higher probabilities of financial distress costs which are induced by the high gearing levels. The hedging against price risk would stabilise cash flows, which would in turn reduce the volatility in firm value. At the same time, theory also suggests that hedging may also induce high debt levels, which would provide a tax shield for the firms' profits when interest payments are deducted from operating profit (Graham & Rogers, 2002). This would essentially result in improved profitability and firm value.

Significant differences were also found in the firm investments of the mining firms, where the hedging firms had a higher capex-to-assets ratio, compared to the non-hedging firms. Furthermore, the firm investments were found to significantly affect firm value in a positive way. The findings are in line with the idea that hedging combats against the underinvestment problem, as expressed by Baker and Filbeck (2018), as the results of this study confirm that the hedging firms tend to invest more, which in turn results in an improved firm value. A factor that did not affect firm value is the sales growth. There were also no significant differences between the sales growth of the two mining firm classifications in this study.

On the opposite side of the significance spectrum, the management shareholding of hedging firms was found to be significantly different to that of the non-hedging firms. The management of the firms classified as non-hedgers tended to have more shares in the SA mining firms compared to their hedged counterparts. Furthermore, the management shareholding was found to be positively significant in affecting the firm value. These findings insinuate that when managers' interests are aligned with the shareholders' interests through shareholding, they tend to make decisions that are more firm value enhancing. The

insignificance of hedging in affecting firm value when all factors are considered reinforces this claim, as the firms with higher management shareholding made decisions to not undertake pursuits that are not firm value enhancing, such as hedging.

5.7. Overall Findings

The study has been undertaken with the aim of finding conclusive evidence on the implications of derivative-based hedging on the firm value of the SA mining industry. The findings of the univariate analysis suggest that while the firm value of hedging firms was higher than the non-hedging firms, the hedging premium was not statistically significant as there were no differences between the Tobin's Q of the hedging and non-hedging mining firms. Furthermore, this result did not change when the effect of hedging was subjected to control variables that contribute to firm value, as hedging was still insignificant in affecting firm value in the multivariate analysis. Therefore, it can be concluded that when all factors are considered, derivative-based hedging is not a significant factor in determining the firm value of SA mining firms, despite its positive relation to the firms' value. Therefore, conclusive evidence on the research aim has been found and the research gap in the mining industry of emerging markets, particularly the South African mining industry, has been filled.

5.8. Recommendations to stakeholders

Considering the findings on the insignificance of derivative-based hedging on the firm value of SA mining firms, recommendations on the implications of the findings for mining firm managers and investors will be provided. It is important for risk managers to understand that financial engineering initiatives such as hedging against price risk through derivative usage are not silo creators of firm value. Hedging should rather be deemed as a tool which can be used to optimise core value creating initiatives in firms. As such, derivatives should be considered as augmentation tools in the process of managing cash flows, as well as instruments with which debt covenants can be met.

The evidence in the study suggests that merely growing sales is not enough to affect firm value, and that it is rather more effective to ensure that the sales growth reaches the bottom line to positively affect profitability. The findings suggest that the managers of high value firms have a greater risk appetite and can absorb more debt to fund capital expenditure, to purchase assets that would maximise profitability metrics such as the ROA.

This would inadvertently translate to an improvement in firm value using the Tobin's Q proxy. In addition, potential investors should note that information asymmetries concerning the presence of derivative-based hedging in the financial statements are indicative of management ability to add value, as suggested by theory. Based on the findings, it would be better for investors to invest in mining firms where managers' interests are aligned with shareholder interests, whereby managers take on restrictive derivative-based hedging policies. This is because the additional hedging costs do not affect firm value when all factors that affect firm value are considered.

5.9. Recommendations for future research

Future studies on the same topic could be conducted to include listed mining firms across the African continent at large. Similar research could also incorporate the optimal hedge ratio to estimate its effectiveness in preserving the firm value of the mining firms. Another suggestion for future research would be to determine the effectiveness of derivative-based hedging on the firm value of mining firms, based on the commodity cycle of the firm's production output.

5.10. Limitations of the study

This study mainly focussed on the South African mining firms that have headquarters in the country, which lead to the selection of the sample of firms listed on the JSE Precious Metals Index. The mining firm Sibanye Stillwater was excluded from the sample since it has only been listed for 7 years, which is lower than the 10-year observation period.

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Annexure A: Evolution of derivatives contracts

The history of derivatives is far-reaching. According to Swan (2000), the early forms of derivatives date back to antiquity and evidence of their existence can be seen in the code of the Babylonian king – Hammurabi - in the period between 1750 – 1792 BC. Under the 48th law of the code, the king stipulated a contractual agreement between himself and his farmers who had mortgages on his property. The farmers were to pay him interest using the grain that they reaped at the end of the harvest. He further provided a no-payment condition where farmers were not obligated to pay him anything in the event that there was no harvest. Such a contract exhibits features of a derivative contract, as the "interest" to be paid derives its value from the outcome of the underlying asset – the grain. There are many other milestones that derivatives have reached before becoming the sophisticated instruments that we see being traded on exchanges across the globe today. A graphical depiction of their milestones can be seen in the two diagrams below.

History of derivatives: Ancient Times

1750 – 1792 BC

- The Babylonian King Hammurabi establishes a code of 282 laws that governed civil and commercial issues. The 48th law stipulates contractual agreements between farmers and land-owners that emulate the features of derivative-type contracts.

1400 BC

- Commercial contracts were developed in Ancient Mesopotamia to help enhance trading of commodities in the region. These were written on clay tablets in cunieform script and were further used to minimise counterparty risk between buyers and sellers. Another derivative type of contract was established in the form of a forward contract - where the underlying commodity was purchased at a price for delivery at a later date. These contracts were also transferrable to other parties.

625-500 BC

- The fundamentals of call-options can be ascribed to a contractual agreement between the ancient Greek philosopher, Thales of Miletus and olive press owners. Thales foresaw a large olive harvest and subsequently purchased the right, but not the obligation to hire all the olive presses of the region at a price for that season. This enabled him to lease out the presses at a substantial premium when demand surged as the harvest was as prolific as he had anticipated. This exhibits features of an options contract that was purchased at a premium in the event that the market steered towards the upside - whch occured and resulted in Thales gaining a fortune.

101-200 AD

- Derivatives were adopted and incorporated into Roman law by Gnaeus Pompeius Magnus, who was the political leader of the late Roman Republic. Laws were established to secure food supplies of the future. According to Swan (2000), two types of forward derivatives existed, where the first was a promise for the future delvery of goods, while the second was deemed a purchase of expectancy. The difference between the two lies in the validity of the contract if the seller defaulted, where the latter was still valid while the former was considered void.

476-1450 AD

- During the middle ages, various types of derivatives were also formed:
- The "***commanda***" was used by Italians as a partnership agreement betwen buyers and venturers of the land and sea to purchase goods for them to be delivered at a future date.
- The "***monti shares***" were used in Italy and employed as transferrable promissory notes from the government to repay future debts - which were said to have been fungible.
- The "***bill of exchange***" was established as a promise to repay an amount of money in a different location and currency at a future date. It mainly provided as a medium of exchange in long-distance trade and generated both a credit and a change operation.
- Centralized markets emerged and were organised in the "***periodical fair***" supervised by Churches. These were eventually replaced by ***permanent trading sites in several ports and land routes.***

History of derivatives: Modern Times

1400-1500's

- The first official trade exchange was establised in Antwerp, Belgium, where global traders gathered for business. The exchange mainly used "bill of exchange" options contracts, which many merchants moved to instead of trading actual commodities as the secondary market grew. This removed the delivery obligation from the initiators of the contracts, which increased traders' leveraging and speculative power, fueled by "contract for difference" type of derivates.
- Global trade moved to Amsterdam in the late century due to the "Spanish Fury" attacks.

1602-1610

- In the early 17th century,companies in Amsterdam raised capital by issuing transferrable shares to establish the first exchange called "***The Dutch East India company".*** However, the shares could only be transferred once they had been settled. The first unsuccessful ***"short-selling"*** attack by an Antwerp syndicate was witnessed during the establishment of the exchange .

17th Century Japan

- The Dojima rice futures market (DRE) was legalized in Osaka, Japan, in 1715, where all the country's rice was stored and traded through auctions. "***Rice bills", "Empty bills", "prepayment bills"*** were given to buyers, which guaranteed them future delivery of the commodity at the current price. The exchange was controlled by the Shogunate.
- In 1730***,*** the ***DRE*** was recognised as an official exchange where traders had to register and pay an annual fee to obtain a trading license. By the 1750's, 60 rice clearinghouses were established for the delivery of the commodity between the counterparties.
- Futures trading became profilic where the rice bills exceeded actual capacity by up to more than three times. On several occasions, the Shogunate had to set floors and caps to maintain normality.
- By 1773, the Shogunate began guaranteeing all the rice bills by changing the financing bills into today's "government guaranteed bonds", due to the increased credit caused by futures trades.

17th Century England

- England began dominating maritime trade in Europe after receiving trading advice from Amsterdam financiers. Subsequently, "***bills of exhange"*** started being recognised in English law as transferrable and negotiable instruments of trade.
- During this time, the first derivatives bubble known as the "South Sea bubble" occurred, where option holders of the South Sea company shares defaulted on their premiums. This option was called a **"refusal",** where the trader was obligated to initially pay between 10%-20% of the share price, and the remainder in installments, thus giving them the option to own the share.
- As a consequence to the bubble, Sir John Barnard's Act to ban options and short-selling was passed.

1848 - 1922

- The **Chicago Board of Trade (CBOT)** was created by a group of merchants in 1848 to provide a central location to conduct high volume derivatives trading between producers, merchants and consumers of the abundant commodities in the Midwestern states. Initially, trade occurred on a same-day basis through the Chicago Mercatile Exchange,however, forward trading was later introduced in 1865.
- Further improvemnets to futures trading were made, in that certain **contracts were regulated and standardised, clearinghouses were instituted** and a **margining system** was also introduced to trades.

20th & 21st century

- In 1970, the CBOT and the CME revolutionised derivatives trading by creating non-agricultural derivatives such as **financial derivatives and interest rate derivatives.** Many derivatives exchanges have been adopted and instituted across the globe.
- Other emerging markets established derivative trading exchanges much later: **Brazil – 1985, South Africa-1988, Russia-1992, India – 2000 and China-2006.**
- Exchanges in the USA still dominate the derivates trading market in terms of contract volumes. They are followed by the National Stock Exchange of India, B3 of Brazil and the Moscow Exchange of Russia.

Annexure B: Disparities between the futures and forward derivatives

Features	Futures	Forwards
Access to contracts	Traded on a centralised exchange, under defined rules	Traded in the "over the counter" market, where contracts are directly between counterparties via brokers
Type of contract	Contracts are standardised	Contracts are customised
Counterparty	Counterparty identification is irrelevant	Counterparty identification is relevant and the
Regulation	The market is formally regulated by exchanges	Regulation of the market is limited
Margin	Contract is subject to a margin requirement	No margin is required; however, collateral can be negotiated
Price	The value of the contract is *marked to market* based on standardised pricing mechanisms	Value is determined by the counterparty pricing agreements
Credit/Default risk	Risk is borne by a clearinghouse	Risk is borne by the counterparty
Liquidity	Liquid market on the exchange	Not as liquid – limited
Size	Contracts are small and fixed	Contract sizes are variable
Termination/Settlement	Contract is usually closed out before maturity. Settled by entering into another opposite contract with the same expiry date to offset it.	Settled through delivery, where the buyer receives the underlying asset, and the seller receives cash in return.
Delivery Date	Delivery dates are specific	There is a range of delivery dates available
Transparency	Exchanges provide the continually updated information about prices and trading	Public information with contract specific detail is limited
Market Participants	A wide range of participants exist across the globe	Almost exclusively a wholesale market

Annexure C: Hybrids of the basic four derivatives contracts

Options	Swaps	Forwards
• By expiration • By underlying security • Employee stock options • Cash settled options • Exotic options	• Interest rate • Currency • Commodity • Credit default • Zero coupon • Total return • Volatility swap • Bond swap • Basis/ spread swap	• Forward rate agreements