The effect of idiosyncratic and macroeconomic risk on cash holdings

by

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Declaration

I, Marvelous Kadzima, do hereby declare that the work in this thesis, is my own, except where acknowledged and that this thesis or any part of it, has not been previously submitted for the award of a degree at any university

Signed ……
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Abstract

The thesis explores the dynamics and determinants of corporate cash holding (or corporate liquidity) in South Africa in three related studies. The first study empirically investigates the sensitivity of corporate cash holdings to changes in idiosyncratic and macroeconomic risk. The analysis is carried out for a panel of South African non-financial firms from 1980 to 2019. Employing the two-step system Generalised Methods of Moments (GMM), results show that South African firms become conservative with their cash when faced with high idiosyncratic risk and reduce cash levels in periods of high macroeconomic uncertainty. In addition, the evidence shows that the impact of both macroeconomic and idiosyncratic risk on corporate cash holdings is more pronounced in financially constrained firms. Overall, the study provides evidence of the role of risk in corporate decisions and gives insight into the firm characteristics that drive the increase in corporate cash holdings.

The second study investigates the role of social media in reducing idiosyncratic risk and in enhancing firm liquidity. Specifically, the study explores the individual impacts of Facebook indicators on stock returns, idiosyncratic risk, and stock liquidity. In doing this, the study employs firm-specific Facebook data sourced from Crowd Tangle merged with stock data and financial data of JSE listed firms from 2010 to 2020. Using linear regression and controlling for industry and time fixed effects, results show positive social media sentiments are associated with higher liquidity and lower idiosyncratic risk. However, the volume of social media content is associated with lower liquidity and higher idiosyncratic risk, suggesting that the risk exposure associated with information dissemination offset the benefits of reducing information asymmetry, at least for the sample firms. Further analyses show evidence of the heterogeneous impacts of social media across different types of firms. Overall, the study provides evidence for the role of firm social media activities and public sentiments on stock market performance and highlights social media's predictive and explanatory power in finance.

The final study explores the extent to which chief executive officer (CEO) and directors' characteristics impact the probability that a firm adopts social media. Employing logistic regressions on non-financial firms listed on the JSE for 2010 to 2020, the study finds that older directors and executives reduce firms' likelihood of adopting social media. Whereas female directors are positively associated with the probability that firms adopt social media. Further analysis shows that financial resources and business risk may not always make a difference in the influence of director characteristics. While female directors are likely to consider the factors when making social media decisions, the impact of age is not influenced. The study adds to

and expand existing literature on board structure and organisational outcomes and offers a novel approach to evaluating the role of directors in firm social media decisions.

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Dedication

To my mother, Jane Kadzima and to every young person who will come across this project.

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List of acronyms

CEO	Chief Executive Officer
FE	Fixed Effects
GMM	Generalised Methods of Moments
JSE	Johannesburg Stock Exchange
OLS	Ordinary Least Squares
PPI	Producer Price Index
UK	United Kingdom
US	United States of America

Chapter 1. Introduction

This thesis includes three empirical studies that document the dynamics of corporate cash holdings and risk using data for South African non-financial firms listed on the Johannesburg Stock Exchange (JSE). These studies are important because they explain the vast cash resources firms are holding and further investigate the identified determinants of cash holdings. In doing so, the studies seek to answer the following fundamental questions. How does risk affect corporate cash holdings? Can firms use social media to predict risk and liquidity? What determines firms' social media decisions? The three studies are important for the following reasons. First, the studies help explain firms' cash hoarding behaviour of firms, which is important as it affects the efficient allocation of resources (Xu and Li, 2018).

Second, by exploring the role of social media in predicting idiosyncratic risk, the study presents an alternative way of managing cash holdings. One of the problems firms face in accessing external capital is information asymmetry. In the presence of asymmetric information, capital and debt markets become inaccessible and expensive to firms, increasing reliance on internal capital. The advent of social media allows firms to inform and seek information on their investments, thereby reducing the information gap between the investors and the firm. The need to reduce information asymmetry is important, more so in the South African context[1].

Existing literature that explores the difference in firms cash holding decisions attribute the variability of these decisions to differences in firm characteristics and the operating environment, but all centred around access to finance. Whether or not firms can access finance when required determines corporate cash holdings and consequently allocation of financial resources. Access to finance depends on a wide range of factors such as financial market development, information asymmetry, firm own characteristics and the macroeconomic environment (Beck and Demirguc-Kunt, 2006; Drobetz, Grüninger and Hirschvogl, 2010). These financing constraints reflect on firms' investment and growth, making both more sensitive to internal finance and explain the need to hold cash.

Although there is considerable research in cash holdings dynamics in major emerging markets such as China (see, for instance, Liu, Luo and Tian, 2015; Xu et al., 2016; Guariglia and Yang, 2018), much of the literature is concentrated on developed economies particularly the US and

[1] Literature suggest that asymmetric information is prevalent in less developed economies because of the slow advancements in financial technology (Capasso, 2006; Colombage, 2009).

the UK, while South Africa and other emerging and developing countries remain unexplored. There are also many institutional differences across China, South Africa, and the rest of the developing markets, making studies on China less applicable to the South African context. Moreover, the South African context provides a dynamic context for understanding corporate decisions in a developing country, a robust emerging market, and an African setting.

The thesis begins by exploring the direct impact of idiosyncratic and macroeconomic risks on corporate holdings. Motivated by the global increase in corporate cash holdings and a reported increase in firm risk, the global financial crisis and the concentration of studies in developed markets, this study serves three purposes. First, the study explores the direct and impact of idiosyncratic and macroeconomic risk on corporate cash holdings in South Africa, hence giving an insight into the role of risk in corporate decisions. The focus on macroeconomic risk also offers an insight into the role of the macroeconomic environment in corporate finance decisions. Second, the study explores the heterogeneous impacts of risk on cash holdings across firms, thereby giving an insight into which firm characteristics drive the rise in corporate cash holdings. Last, the study seeks to evaluate the validity of the precautionary motive in explaining corporate cash holdings of South African firms.

Using a robust two-step system Generalised Methods of Moments (system GMM) estimator, on a panel dataset of 596 South African firms, the study shows that firms increase cash holdings in periods of higher idiosyncratic risk and reduce their cash holdings when facing higher macroeconomic uncertainty. The findings suggest that firms draw from their cash reserves in periods of macroeconomic uncertainty. High macroeconomic risks create an uncertain lending environment; lenders impose more strict debt covenants, increase interest rates, reduce loan amounts and shorten maturities (Sorge, Zhang and Koufopoulos, 2017; Machokoto, Areneke and Ibrahim, 2020). This scenario is relevant in South African firms whose external financing is mainly bank debt (Gwatidzo and Ojah, 2014). Further, the heterogeneous impact of risk across firms is conducted for financially constrained and unconstrained firms. If cash holdings are used as an alternative source of financing, then it is likely that constrained and unconstrained firms respond differently to changes in risk. Results show that the effect of both idiosyncratic and macroeconomic risk on corporate cash holdings is significant and more pronounced in firms facing financial constraints.

Having established the effect of risk on corporate cash holdings in the first empirical study, the following study investigates determinants of idiosyncratic risk and stock liquidity with a

particular focus on social media. Can social media drive idiosyncratic risk? The second empirical study evaluates various Facebook indicators' direct and individual impact on idiosyncratic risk, abnormal returns, and stock liquidity. The study is motivated by the documented ability of social media to reduce information asymmetry (Nguyen et al., 2015; Lin, Li and Wang, 2017). The presence of information asymmetry distorts corporate finance; firms adjust their decisions based on the information available to them. Studies have shown social media's ability to predict firm stock market performance (Gu and Kurov, 2020; Al Guindy, 2021). This has enabled firms to make informed decisions about their investments and observe the impact of information they post on social media. Specifically, this empirical study explores the role of social media in firms by specifically investigating the direct and individual effects of firms' Facebook posts and the public reactions to firms posts on idiosyncratic risk, stock liquidity and abnormal returns. The study of social media in South Africa is still in its infancy stages. This study contributes to the literature by providing evidence on the role of social media in South African firms.

Facebook data employed in this analysis is obtained from Crowd Tangle, and it consists of firm posts on Facebook and public reactions on firms Facebook posts. The analysis is carried on a sample of 142 listed firms. The findings show that positive public sentiments and public reactions are associated with higher abnormal returns and stock liquidity and lower idiosyncratic risk. Public reaction indicators, likes, shares and comments also have a positive association with abnormal returns and stock liquidity and a negative impact on idiosyncratic risk. These findings suggest that firms can reduce idiosyncratic risk and improve stock market performance by generating social media posts that attract positive sentiments and feedback from the public. However, the results show a negative impact of the volume of social media posts on abnormal returns and a positive impact on idiosyncratic risk and stock liquidity. This finding suggests that if a firm increases the volume of information it discloses on social media, it may expose itself to reputation risk and scrutiny, increasing the volatility of its idiosyncratic returns. This may discourage investors and lead to lower share prices and consequently lower returns. It is the quality of information that determine the reaction of investors and attitude towards the firm. The increase in exposure explains the positive association between stock liquidity and the volume of Facebook posts. It increases the firm's popularity and consequently the rate at which its shares are bought.

After documenting the value of social media in reducing idiosyncratic risk and consequently the need to hold cash, the following study investigates firms' social media decisions. The

decision to adopt social media is a strategic decision that requires the approval of the board. Chapter 4 studies the extent to which the characteristics of directors determine the likelihood of firms to adopt social media. Prior empirical evidence suggests that firms can derive value from social media (see, for instance, Leonardi and Treem, 2012; Gil-Garcia, Helbig and Ojo, 2014; Bhimani, Mention and Barlatier, 2019). However, there is limited evidence on the determinants of firms' social media decisions and activities.

The study employs a panel logistic model with Facebook as a dependent variable indicating social media adoption. The main independent variables indicate the gender and age of directors and chief executive officers (CEOs). Estimates of the panel logistic regression models show evidence of a negative impact of directors and CEOs age on the likelihood of adopting social media. Firms with, on average older directors, are less likely to consider social media to manage information asymmetry, reduce idiosyncratic risk, and ensure efficient allocation of resources. The positive impact of female directors on the likelihood of adopting social media suggests that firms with a higher proportion of female directors are more innovative. The effect of CEO gender and CEO age is less pronounced and less significant than the impact of directors' age and proportion of female directors, implying that the characteristics of board members have more influence on corporate outcomes than the CEO alone.

The study further investigates the impact of directors and CEO characteristics on social media activities. This analysis focuses on firms that have adopted social media at one point during the sample period. Specifically, the analysis examines the impact of directors age and gender on the volume of firms posts and the public sentiments to give an intensive margin of the board's role on social media. Results show that a firm with older directors and older CEOs is associated with fewer Facebook posts and less positive social media sentiments. On the other hand, the proportion of female directors is associated with more Facebook posts and positive sentiments. Overall, the findings suggest that age and gender are important determinants of social media outcomes. However, the role of the CEO is less significant than the role of the board. While literature suggests that firms consider the availability of financial resources and firm risk before pursuing long term projects such as social media adoption, the evidence suggests otherwise. Female directors may consider firm risk and availability of internal financing, but these contingent factors do not significantly moderate the effect of age.

This thesis consists of five chapters. The rest of the thesis is organised as follows. Chapters 2 presents the first empirical study titled, 'The effect of idiosyncratic and macroeconomic risk

on cash holdings'. Chapter 3 presents the second empirical study titled 'Social media, idiosyncratic risk and stock liquidity. Chapter 4 presents the final empirical study titled 'The board and firm social media decisions'. Lastly, Chapter 5 summarises and concludes the thesis.

Chapter 2. The effect of idiosyncratic and macroeconomic risk on cash holdings

2.1 Introduction and motivation

Despite the vast literature on corporate cash holdings, the dynamics of cash holdings in emerging countries, particularly in Africa, remains unexplored. The global increase in corporate cash holdings over the past decades coincide with significant changes in macroeconomic and business conditions, for instance, financial crises, advancements in financial markets and technology. Why has there been a persistent increase in corporate cash holdings? While theory suggests that firms hold cash for precautionary and transaction motives (Keynes, 1937), the advancements in information technology reduce information asymmetry[2] hence making it possible for firms to access financial markets easily and to hedge associated risks. This should reduce the need to hold cash. The increase in cash holdings occurring against this background is paradoxical.

Prior studies investigating the effect of idiosyncratic risk on cash holdings are concentrated in developed economies (predominantly the UK and the US). Despite this concentration, these studies report mixed results (e.g., Bates, Kahle and Stulz, 2009; Cruz, 2016; Sánchez and Yurdagul, 2013). Few multi-country studies which provide evidence on the impact of macroeconomic risk on cash holdings include South Africa. However, there is no study yet that look at the direct effect of risk on cash holdings in an emerging market context, especially in Africa. Notwithstanding the contributions from these studies, this study will provide evidence on how macroeconomic and idiosyncratic risk affect firm cash holdings of South African firms.

The results for developed economies cannot be generalised for developing countries due to the differences in market characteristics. Information asymmetry, for example, the degree of which depends on the type of technology used for market information dissemination (Colombage, 2009)[3]. Hence, firms in less developed economies may face higher asymmetric costs, and that modifies their financial policies differently. Firms will choose internal financing to external financing to avoid those information asymmetries and adverse selection costs in financial markets. Due to the perfect correlation between the value of new equity issuances and existing equity, selling new equity will result in the depreciation of the entire value of the firm (Edmans et al., 2012). Hence, managers accumulate cash to ensure financial flexibility and limit exposure to external financing costs. Retained earnings allow managers to limit security

[2] Information asymmetry makes it difficult for firms to access financial markets.
[3] According to Capasso (2006), "economic growth and capital accumulation improve new communication technologies and diffuse multiple information sources".

issuances, retain shareholder control and prevent the firm from selling under-priced securities (Myers and Majluf, 1984). Given the costs of accessing financial markets, internal financing is the least cost financing strategy in less developed markets.

The sensitivity of firm cash holdings to risk in emerging markets is likely to differ from developed market contexts due to the differences in significance and levels of risk. According to Bartram, Brown and Stulz (2009), firms undertake riskier investments when operating under improved and stable economic conditions. This makes hedging risks much more critical in less developed economies; however, hedging through financial markets is less accessible due to the limited development of financial markets in developing countries. In the presence of imperfect market conditions, firms use cash as a source of financing.

South Africa provides an interesting setting for studying financial and liquidity management policies for two reasons. First, South Africa has less developed governance and institutional settings compared to the widely studied developed countries (Worldwide Governance Indicators, 2020). Poor governance manifests in weak monitoring instruments and an increase in agency conflicts; managers can easily hoard cash for their private interests (Dittmar et al., 2003). The effect of risk on cash holdings is contingent upon institutional factors and the additional risk they expose on a firm (Li et al., 2014).

Second, South Africa has implemented several structural changes, which resulted in the significant development of its stock market (Adelegan and Radzewicz-Bak, 2009). This should improve access to external markets and diffuse the need to hold cash. Yet despite this, South African firms hold significantly high levels of cash holdings. Hoarding cash entails delaying or cutting back investments, and it reflects the existence of financial frictions in the market. Hence, understanding the dynamics of cash holdings, in particular, the increase of cash, is of interest to managers, policymakers, and academics. High levels of cash have adverse effects on economic growth, more so within the South African context that is characterised by low per capita growth.

Empirical studies report that both idiosyncratic and macroeconomic risk does not affect firm cash holdings in isolation but in conjunction with other firm characteristics. Hence the impact risk on cash holdings is expected to differ across firms with different characteristics. For example, Baum et al. (2008), report that the impact of both idiosyncratic and macroeconomic risk is more pronounced in smaller and high growth firms. Previous studies also show that cash holdings are greater in firms that are financially constraint. For instance, Chen and Yang (2019)

show that the value of cash is higher in financially constrained firms. Similarly, Faulkender and Wang (2006) and Denis and Sibilkov (2009) report cash holdings are more valuable in financially constrained firms. This study additionally investigates whether the sensitivity of cash holdings to risk differs between constrained and unconstrained firms.

The analysis begins by estimating the individual effects of idiosyncratic and macroeconomic risk on corporate cash holdings of South African listed firms. After establishing the impact of both risks on cash holdings next, the study examines the cross-sectional variation in subsamples based on several conditioning proxies which are linked to the financial flexibility/constraints of a firm (Xie et al., 2017; Orlova and Sun, 2018). To establish the effect of risk on cash holdings subject to financial constraints, the empirical investigation employs several measures of financial constraints to capture the differential effects of risk while controlling for other firm variables.

The findings in this study are summarised as follows. Using a robust two-step system Generalised Methods of Moments (GMM) estimator, the study shows that the increase in idiosyncratic risk has a positive and significant impact on corporate cash holdings. These findings concur with most literature on cash holdings in developed countries, which report the increase in corporate cash holdings in response to rising risk levels (see, for instance, Bates, Kahle and Stulz, 2009; Acharya, Davydenko and Strebulaev, 2012). In the case of macroeconomic risk, the results show that the impact of risk on cash holdings is negative and statistically insignificant. These findings are robust across different estimation techniques and different combinations of risk measures. The signs for the coefficients of other firm-specific determinants of cash holdings is consistent with findings in the existing literature.

Last, the study investigates whether the effect of risk on cash holdings is consistent in firms with different characteristics. The evidence gathered for South African firms shows that both idiosyncratic and macroeconomic risks have significant effects on the cash holdings of financially constrained firms. Overall, the results show that the impact of risk is pronounced in financially constrained firms. The impact of idiosyncratic risk, although significant in both financially constrained and unconstrained firms it has higher significance in financially constrained firms. The sensitivity of cash holdings to changes in macroeconomic risk is negative and significant in firms facing financial constraints. This supports the findings by Almeida et al. (2004) and Denis and Sibilkov (2009) that cash holdings are more valuable in financially constrained firms.

The rest of this study is as follows. Section 2.2 presents the literature review and the research hypotheses. Section 2.3 describes the dataset, explains the construction of key variables and descriptive statistics. Section 2.4 discusses the methodology, while section 2.5 presents the empirical results. Section 2.6 summarises and concludes the study.

2.2 Literature and hypotheses development

This study focuses on the precautionary motives of corporate cash holdings and contributes to two strands of literature. The first strand of literature focus on the effect of risk on cash holdings premised on the precautionary motive for holding cash. This study exploits variation in risk levels and cash holdings across firms to investigate the relationship. The precautionary motive put forward by Keynes (1936) suggests that firms hold cash as a buffer against emerging risks. The amount of cash firms hold is determined by the degree of confidence they have in the market and overall business environment. The precautionary motive arises when firms anticipate undesirable changes in the economic and business environment, firms and individuals save money to cater for unforeseen contingencies (risk). For example, in economic crises, liquidity dries up in financial markets, and credit systems collapse; firms can accumulate cash to meet these unexpected contingencies. Cash shortfalls prevent firms from taking up profitable investments when opportunities emerge, for example, acquisitions. This concurs with the transaction motive.

The precautionary motive has been used to explain corporate finance relationships, in particular, cash holdings and credit risk, capital structure decisions and risk, and policy uncertainty and corporate decisions (Acharya et al., 2012; Han and Qiu, 2007; Zeng et al., 2019). Han and Qiu (2007) developed a model of corporate precautionary cash holdings and show that when firms cannot hedge investment on multiple periods directly in the market, they rely on internal cash reserves for future financing. These cash reserves are accumulated from cash flows. Hence, when firms cannot fully diversify future cash flow risks, they use cash holdings to hedge against the refinancing risk. Further, Acharya et al. (2012) show that the precautionary motive causes riskier firms to maintain large cash balances. The study supports the Keynes (1936) proposition that the level of income determines precautionary cash balances, and distressed firms are more likely to adopt conservative cash policies.

The precautionary motive maintained its relevance in cash dynamics over the years and has become applicable in both domestic and foreign firms. Some scholars, however, argue that the precautionary motive cannot explain the abnormal cash levels because during the subprime crisis period firms drew down their cash balances (Alves, 2018). Although, it may be argued

that it was time for firms to utilise precautionary savings made in anticipation of the crisis. Alves (2018) suggests that the precautionary motive is weakening as an explanatory theory for cash holdings contrary to the agency motive, which seem to have provided a better explanation of cash dynamics during and after the crisis. Lei et al. (2018) provide an analysis of credit risk spillovers and cash holdings and show that firms hold more cash when they anticipate an increase in credit risk contagion and this increases the value of cash. Further, the study shows that firms with more significant credit risk contagion face higher spreads and more restrictive non-price terms when accessing bank loans, the transactional demand for cash increases.

There is a difference between the dollar amount of cash holdings and the value of cash holdings. One explanation to the cash holdings puzzle is the assumption that the value of cash holdings has increased such that firms find it more beneficial to maintain high cash ratios. Im et al. (2017) analyse the role of uncertainty on the value of cash holdings for firms traded on the major US stock exchanges for the period 1980 to 2015. The study shows that a dollar amount of cash is more valuable to a firm facing high risk than it is to a firm with low risk. Therefore, there is a positive relationship between uncertainty and the value of cash holdings. This effect is enhanced by financing frictions caused by the agency costs of debt. Thus, a firm facing high uncertainty reduces investments and retains cash. Cash holdings are more valuable in financially constrained firms (Denis and Sibilkov, 2009).

Baum et al. (2008) suggest that firms act homogeneously in the face of macroeconomic uncertainty; they all maintain high cash ratios. However, in more stable conditions, firms behave idiosyncratically and maintain varied cash levels. Ceteris paribus, firms with higher cash balances have a lower probability of credit default. However, this is not always the case. Firms adopt conservative cash policies under distress as they find it difficult to adjust to their target cash level in the presence of market frictions in the short run. According to Acharya et al. (2012), US firms increase their cash levels in anticipation of liquidity challenges or when there is a high probability of long-term debt default. Hence, optimal cash policies should be balanced with investment policies; firms should offset the benefits and costs of cash holdings. Large cash holdings imply low investment. A firm should hold enough cash to pay off debt for the current and next period while adopting investment projects that allow for optimal firm growth.

Lei et al. (2018) provide an analysis of credit risk spillovers and cash holdings using credit risk contagion and product market rivalry as measures of credit risk spillovers. The results show

that firms hold more cash when they anticipate an increase in credit risk contagion, and this increases the value of cash. Moreover, firms with more significant credit risk contagion face higher spreads and more restrictive non-price terms when accessing bank loans, the transactional demand for cash increases. However, the study reports a negative impact of product market rivalry on corporate cash holdings, contrary to Kim and Bettis (2014) findings which show that firms hoard cash to maintain a competitive advantage.

Risk is a significant factor in corporate financing decisions. According to Krainer (2014), firms conduct asset adjustments in response to income and operating risks. Managers study the stockholders' attitude to risk and conform investment policies accordingly. When dealing with risk-averse stockholders, managers engage in conservative cash policies. In this era of advanced financial technology, firms can hedge risks using various financial instruments. However, when a fund cannot be hedged on multiple investment periods, firms may resort to cash holdings. According to Huang and Mazouz (2018), adequate cash holdings attract traders, even when market liquidity dries up. Cash reduces liquidity risk and the cost of equity capital.

Baum et al. (2006) developed a partial equilibrium model of the precautionary demand for liquid assets. The results show that firms adjust their cash ratios in response to changes in idiosyncratic and risk. Further, Bates et al. (2009) record an increase in both cash flow risk and cash holdings over the period 1980 to 2000, which suggest a positive relationship between the two variables. Cruz (2016) also attribute the increase in cash holdings of US firms to idiosyncratic risk, and Baum et al. (2004) report a positive relationship between liquidity ratios and macroeconomic and idiosyncratic uncertainty. Firms facing greater macroeconomic uncertainty hold more cash to counter the effects of adverse economic conditions (Chen and Manso, 2017; Rose and Spiegel, 2009). Macroeconomic factors, directly and indirectly, influence the cash holding levels of firms. The indirect effects of macroeconomic uncertainty include limited investment opportunities or poor investment projects with negative net value. Firms choose to hold cash as they stand to lose if they invest in such projects. Following these predictions and propositions of the precautionary motive, cash holdings should increase with idiosyncratic and macroeconomic risk.

Several studies show that macroeconomic risk cause firms to hold more cash. In periods of recession, cash holdings act as a buffer against adverse economic situations (Sánchez and Yurdagul, 2013). Firms usually do not find the stock market as an appealing source of growth during periods of uncertainty, so they create a buffer to finance growth opportunities as well

as cater to capital needs (Myers and Majluf, 1984). Opler et al. (1999) observed an increase in cash holdings of US companies after a crisis. They come up with the term 'abnormal cash holdings' to explain the excess cash holdings of firms that accumulate from before the crisis to after the crisis. Their study shows that firms facing higher cash flow risk maintain higher cash ratios. These studies emphasise the role of macroeconomic factors in the evolution of cash holdings.

Macroeconomic uncertainty also influences the risk-taking behaviour of firms given certain constraints. Cash provides operation and strategic flexibility. Gupta and Krishnamurti (2018) show that in rising oil prices, firms reduce their risk-taking behaviour when the macroeconomic outlook is unfavourable. So the effect of macroeconomic uncertainty on corporate decisions is subject to institutional factors like corporate governance. In poor governance conditions, the effects of a recession are more prominent as firms may engage in unconventional means to survive. The value of cash is overestimated or underestimated. Consistent with the precautionary motive and reports from existing literature, we expect corporate cash holdings to increase with macroeconomic uncertainty. The predictions for the effect of idiosyncratic and macroeconomic risk in this study are summarised in hypotheses one and two below.

Hypothesis 1: Firms increase their cash holdings in response to an increase in idiosyncratic risk.

Hypothesis 2: Firms increase their cash holdings in response to an increase in macroeconomic risk.

The second strand of literature focus on the dynamics of cash holdings in financially constrained firms. According to the pecking order theory, firms follow a financing hierarchy to which they prefer internal to external financing due to the existence of information asymmetry and adverse selection costs in financial markets. As a result, firms facing financial constraints due to information asymmetry accumulate cash holdings (Donaldson, 1961; Myers, 1984; Myers and Majluf, 1984). The presence of market frictions is likely to cause observable variations in cash holdings across firms in different industries and or firms of different sizes and leverage. Liquidity constrained firms may have access to investment opportunities but are unable to fund them. Firms increase their holdings of liquid assets in response to the increase in external financing costs. Firms facing financial constraints are more likely to be affected by changes in the macroeconomic environment; hence do have a high demand for precautionary savings (Almeida, Campello and Weisbach, 2004). Similarly, Hubbard, Kashyap and Whited

(1993) suggest that exogenous financial frictions are more binding for financially constrained firms.

Literature generally agrees that the sensitivity of cash holdings to changes in firm-specific factors is different between financially constrained and unconstrained firms. Financially constrained firms are more sensitive to changes in firm-specific and macroeconomic determinants of cash holdings (see, for instance, Hubbard, Kashyap and Whited, 1993; Almeida, Campello and Weisbach, 2004; Han and Qiu, 2007). Fazzari, Hubbard and Petersen (1988) also suggest that the sensitivity of investments to cash increases with the degree of financial constraints when external financing is more costly than funding internally. However, Kaplan and Zingales (1997) argue that the relationship between financial constraints and investment cash flow sensitivity do not have a theoretical basis. Instead, they show that the least financially constrained firms have the highest investment sensitivity to cash flows. The present study contributes to the literature by directly investigating the impact of firm-specific and macroeconomic risk on cash holdings in financially constrained firms. The above discussion is summarised below as hypothesis three.

Hypothesis 3: The sensitivity of cash holdings to risk is more pronounced in financially constrained firms.

Overall, prior research provides mixed evidence on the relationship between risk and cash holdings with limited evidence on emerging countries. Therefore, this study examines the direct effects of both firms specific and macroeconomic risk on corporate cash holdings in South Africa.

2.3 Data and variables

This section describes the data, sample selection criteria and variables used in this study.

2.3.1 Data and sample selection

The data of all firm-specific variables is drawn from Worldscope through Datastream. The Worldscope database provides financial and profile data on public companies. The data is collected from financial statements, and it takes into account a variety of accounting conventions. Hence, the data can facilitate comparison between companies and across industries and countries. The base year for the database is 1980 (Thomson Reuters, 2003). The Worldscope database is chosen over other sources because of its wide coverage of listed firms (Ulbricht and Weiner, 2005). The data on macroeconomic indicators used to generate

macroeconomic risk measures is extracted from the International Monetary Fund (IMF) database; the International Financial Statistics (IFS).

This chapter focuses on listed firms in South Africa. Several filters are applied to the data following standard in cash holdings literature. First, the initial sample which excludes financial and utility firms consist of 32,964 firm-year observations over the period 1980 to 2019. Utility and financial firms are governed by special regulations that affect their capital, and cash structure decisions, excluding them, allows for direct comparison with prior studies on cash holdings. Bates, Kahle and Stulz (2009) and (Xu and Li (2018) applied the same approach. Second, negative values for all variables except for cash flows are set as missing, and all observations with missing key variables (cash and cash equivalents, sales and total assets) are dropped from the sample. Third, in order to control for mergers and acquisitions, firms with abnormal changes (over 100%) in sales or total assets; firms with a 100% growth in total assets are excluded from the sample consistent with Bloom, Bond and Van Reenen (2007).

Fourth, since the system GMM utilised in the analyses in this chapter require the use of lagged variables, firms with less than five years of observations are excluded from the sample (Roodman, 2009). Finally, all variables are winsorised at the upper ninety-nine percentile and lower one percentile of the distribution in each year to address the effects of outliers and conserve sample size (see, Baum et al., 2008; Boubaker et al., 2015). The final sample includes delisted and suspended firms to reduce survivorship bias. The final sample, 7,413 firm-year observations (600 firms), has an unbalanced panel structure where each firm contributes at least five years of observations.

2.3.2 Measuring idiosyncratic risk

Previous studies apply various statistical methods; the state-space model, autoregressive models, ARCH/GARCH models (Baum et al., 2006) and stochastic volatility models to generate proxies for risk. While these measures are appropriate, they may introduce bias in the proxies of risk for relatively small firms. The context of this study is South Africa, an emerging market context characterised by both large and small firms. Hence in this study, time-variant risk proxy generating methods are employed since they are also suitable for small firms.

The autoregressive process AR(1) is used to generate the firm-specific risk for each firm. The autoregressive method considers the components resulting from the movement of the underlying variable other than the change in the variable (Rashid, 2012). The autoregressive

model for firm sales (natural logarithm of sales) is estimated over the period 1980 to 2019, as follows:

$$S_{i,t} = \kappa_i + \phi S_{i,t-1} + \epsilon_{i,t} \quad (2.1)$$

where i and t indicate the firm and year, respectively. S is the natural logarithm of net sales, κ is the constant, ϕ is the autoregressive parameter and ϵ is the error term, with mean zero and finite variance. Annualised recursive variances for each firm are computed from the forecasted residuals from the estimated model. The proxy for idiosyncratic risk is the square root of the estimated recursive variance (cumulative sales volatility).

The second measure of idiosyncratic risk is calculated from the following model of firm sales normalised by total assets using firm and year fixed effects.

$$S_{it} = f_i + f_t + \epsilon_{i,t} \quad (2.2)$$

where i and t denote firm and year, respectively. ϵ_{it} is the error term. The proxy for idiosyncratic risk is the absolute value for residuals, $|\epsilon_{i,t}|$ (sales volatility) (Morgan, Rime and Strahan, 2004; Caglayan and Rashid, 2014).

2.3.3 Measuring macroeconomic risk

Literature suggests various approaches to computing a proxy for macroeconomic risk. For example, Baum et al. (2004) computed the conditional variance of the real GDP to measure macroeconomic stability, Baum et al. (2008) and Driver et al. (2005) employ a GARCH model to provide a proxy for macroeconomic uncertainty. Other literature, for instance, Graham and Harvey (2001) and Schmukler et al. (1999), compute the moving standard deviation of macroeconomic series. On the contrary, Ghosal and Loungani (2000) employ moving standard deviation of the energy prices.

In this chapter, two proxies are used to measure macroeconomic risk, inflation risk and financial risk computed from the conditional variance of monthly Producer Price Index (PPI) and Financial Market Prices, respectively. The conditional variances are measurable and can be related to the measured behaviour of cash holdings (Baum et al., 2006). Data for monthly PPI and Financial Market Prices is extracted from the International Financial Statistics. Following Baum et al. (2006) and Driver et al. (2005), conditional variances are derived from the ARCH/GARCH model of the monthly series. The main proxy for macroeconomic risk is derived from the following specification.

$$\Delta PPI_t = \omega + \eta(L)\Delta PPI_{j,t} + \delta(L)\epsilon_{j,t} + \epsilon_{j,t} \quad (2.3)$$

$$\sigma_{j,t}^2 = \alpha + \beta(L)\epsilon_{j,t}^2 \quad (2.4)$$

where, j and t denote country and time respectively, ω is a constant term, η is an autoregressive parameter, and δ is a moving average parameter, L is the lag operator. σ_t^2 is the estimated conditional variance based on lagged values, α is a constant and $\epsilon|\Delta PPI_{j,t-1} \sim N(0, \sigma_{j,t-1}^2)$ is the error term. The conditional variances are averaged across four quarters to obtain annual frequencies denoted as inflation risk (a proxy for macroeconomic risk). The second measure of macroeconomic risk is derived from the generalised ARCH/GARCH model of the Financial Market Prices. Appendix 2B presents the time series plots for the macroeconomic risk variables (inflation risk and financial risk), respectively. The study considers both PPI and Financial Market Prices as appropriate proxies for macroeconomic risk because firms consider both production and financing when making corporate finance decisions.

2.3.4 Variables and measures

Dependent variable

The dependent variable, cash, is defined as the ratio of cash and short-term investments to total assets. Literature provides varied approaches to measuring corporate cash holdings. Some studies employ the ratio of cash to total assets see, for instance, Palazzo (2012); Faff, Gunasekarage and Shams (2019) and Zeng, Zhong and He (2019). Chen et al. (2015) and Harford, Klasa and` Maxwell (2014) measure cash holdings as the ratio of cash and short-term investments to book assets (total book value of assets). Chen et al. (2015) also employed cash to net assets and cash to sales as alternative variables for robustness checks. Hill et al. (2014) measure cash holdings as cash and cash equivalents divided by net assets. Other literature measure cash as the ratio of cash and marketable securities to net assets (Kim, Mauer and Sherman, 1998; Opler et al., 1999; Ferreira and Vilela, 2004; Bates, Kahle and Stulz, 2009; Bates, Chang and Chi, 2018). In this study, cash to total assets is the primary measure of cash holdings. Cash to net assets measure is used as an alternative proxy for cash.

$$Cash/TA_{it} = \frac{Cash\ and\ Short\ Term\ Investments_{it}}{Total\ Assets_{it}}$$

$$Cash/NA_{it} = \frac{Cash\ and\ Short\ Term\ Investments_{it}}{Total\ Assets_{it} - Cash\ and\ Short\ Term\ Investments_{it}}$$

Control variables

Firm cash holding decisions are determined by several firm characteristics. The study includes these control variables to minimise omitted variable bias. Based on previous literature, the

study controls for leverage, cash flow, dividends, size, and growth opportunities. Literature suggest that highly leveraged firms draw down their cash reserves to meet debt obligations and to finance investments and new projects without increasing the debt burden (Lamont, 1997; Molina, 2005). On the contrary, firms with low leverage do not have obligations to pay with cash, so their cash reserves are preserved, unlike leveraged firms that have to draw down the cash regularly for debt repayments (Strebulaev and Yang, 2013).

A firm with stable cash flows is able to cover transaction costs and raise cash when required. Several studies report a negative impact of cash flows on cash holdings. Firms with higher cash flows have lower precautionary demand for cash (see Kim, Mauer and Sherman, 1998; Riddick and Whited, 2009; Bao, Chan and Zhang, 2012). Contrariwise, some studies align with the pecking order proposition that firms do not have an optimal cash level; hence, firms with higher and stable cash flows maintain substantial cash levels (Myers and Majluf, 1984; Almeida, Campello and Weisbach, 2004). Several studies report a negative association between dividends and cash holdings. They suggest that dividend payments subsequently reduce cash holdings (Opler et al., 1999; Shah, 2011; Mihai and Radu, 2015). Concerning growth opportunities, John et al. (2011) suggest that firms with limited or no investment opportunities have no reason to hold cash as there will be no prospects for future transactions. Further, Acharya et al. (2012), show that firms with higher growth options conserve cash to avoid credit default. Long term growth options explain variations in cash levels. The value of equity is high in firms with high growth options. So with high credit spreads firms would resort to internal fiancing which is cash.

There are mixed views on the effect of size on corporate cash holdings. On the one hand, literature suggest that bigger and more established firms may not be interested in continuing investment projects. They have more stable cash flows and lower precautionary demand for cash. Small firms on the other hand, are growth focused; thus, they are always looking out for investment opportunities. As a result, they hold substantial cash reserves for future transactions as difficulties in raising cash may lead to them missing the investment opportunities (Atanassov, 2013; Harford and Uysal, 2014). A contrasting view suggests that larger firms may experience agency conflicts that will (indirectly) force managers to hold more cash (Xie et al., 2017). All variables are defined in Appendix 2A.

Financial constraints indexes

There is considerable debate on the best method to measure financial constraints as each measure is subject to certain empirical assumptions that may not be valid, theoretically. Literature identify various proxies for financial constraints. For instance, Han and Qiu (2007) employed firm size, dividend pay-out ratio, bond ratings and commercial paper ratings to classify firms into constrained and unconstrained groups. Smaller firms (in the 1st quartile), non-dividend-paying firms, and firms with no bond or commercial paper ratings are classified as constrained. Similarly, Almeida, Campello and Weisbach (2004) use pay-out policy, asset size, KZ index and bond and commercial paper ratings to identify firms facing financial constraints. The KZ index is an index measure derived from Kaplan and Zingales (1997), which measures the value maximisation choices of managers based on future expected financial constraints. The results show that constrained firms have a positive cash sensitivity to cash flow, signifying the importance of cash flows in financially constrained firms. Following Li (2011) and Molina (2005), firms are classified according to their size, dividend pay-out, leverage and two indexes that measure financial constraints, the KZ index and WW index.

The KZ index by Kaplan and Zingales (1997) measures the firm's reliance on external financing; hence it is higher for firms that are financially constrained. The KZ index is a function of cash flows scaled by total capital, market to book ratio, debt to total capital, dividends to total capital, and cash holdings to capital (Lamont, Polk and Saaá-Requejo, 2001). The index is derived from the following formula.

$$\begin{aligned} KZIndex = {} & -1.001909 \times \frac{Income - Interest - Taxes}{PPE} \\ & + 0.2826389 \times MarkettoBook - 39.3678 \times \frac{Dividends}{PPE} \\ & + 3.139193 \times \frac{LTDebt + STDebt}{LTDebt + STDebt + TA - TL} \\ & - 1.314759 \times \frac{Cash}{PPE} \end{aligned} \tag{2.5}$$

where, Income is the operating income, Interest is interest on debt, Taxes is the income taxes paid, Cash is the cash and short term investments, and PPE is the property plant and equipment. TA is the total assets, TL is the total liabilities, LTDebt is the long term debt, and STDebt is the short term debt.

The WW index by Whited and Wu (2006) is a measure of financial constraints constructed from the structural investment model. Contrary to the KZ index, the WW index measures the

firm's exposure to external finance constraints. WW index is a function of cash flows, debt, size, firm sales growth, dividends and industry sales growth. The index is computed according to the following formula.

$$\begin{aligned} WWIndex = & -0.091 \times Cash\ Flow - 0.062 \times Dividend\ Indicator \\ & + 0.021 \times LTDebtTA - 0.044 \times Size \\ & + 0.102 \times IndSalesGrowth - 0.035 \times Sales\ Growth \end{aligned} \quad (2.6)$$

where, $LTDebtTA$ is the long term debt scaled by total assets and $IndSalesGrowth$ is the average industry sales growth, $Divindend\ Indicator$ is a dummy equal to 1 if a firm pays dividends and 0, otherwise.

2.3.5 Summary statistics

Table 2.1 provides descriptive statistics for the full sample on the variables used. It reports observations (N), mean, standard deviation (Stdev), 25th percentile, median, 75th percentile. The means of the full sample show the corporate cash reserve of South African listed firms for the period 1980 to 2019 is about 10% of total assets. The amount is sizeable and similar to that reported by Tran (2019) for listed firms in Vietnam and by Baum et al. (2008) for US firms. However, it is lower than the 14% reported by Chen and Yang (2019) for Chinese firms. Appendix 2C shows the cross-industry distribution of cash holdings and risk levels, respectively. Cash holdings are concentrated in technology and telecommunications companies, while real estate companies maintain low cash holdings. The large cash holdings in the technology industry can be explained by the fast-paced environment the firms operate in and the constant need to invest in research and development.

Table 2.1 Summary statistics

	N	Mean	Stdev	Min	P25	P50	P75	Max
Cash	7597	0.1004	0.0864	0.0000	0.0366	0.0786	0.1406	0.5194
Firm Risk 1	7597	0.0981	0.0971	0.0000	0.0291	0.0692	0.1345	0.8104
Inflation Risk	7597	0.0089	0.0079	0.0025	0.0032	0.0063	0.0083	0.0286
Leverage	7597	0.2038	0.1496	0.0002	0.0917	0.1791	0.2857	0.8739
Cash Flow	7597	0.0503	0.1455	-2.7787	0.0107	0.0588	0.1119	0.5770
Dividends	7597	0.0181	0.0655	0.0000	0.0000	0.0000	0.0084	0.9709
Size	7597	1.5411	0.1822	0.9600	1.4207	1.5532	1.6762	1.9950
Growth	7597	0.1498	0.0760	0.0456	0.1001	0.1274	0.1801	0.6214

The table presents the number of observations (N), mean, standard deviation, median, 25th and 75th percentile for the variables used. The sample consists of South African non-financial firms over the period 1980 to 2019. All variables used are defined in Appendix 2A and are winsorised at the lower 1st and upper 99th percentile. The descriptive statistics are for the estimated [e(sample)] sample generated from regressing cash holdings with firm-specific variables and macroeconomic risk.

Appendix 2D shows the time series plots of mean cash and risk measures for the sample. The figure shows that, on average, the cash holdings of South African firms have increased over time since the 1980s. There is, however, an observable decline just before the year 2010. This coincides with the period around the global financial crisis and confirmed findings by Alves (2018), that firms drew down cash during the financial crisis. The gradual decline afterwards can also be attributed to the development of financial markets over the years. The figure also indicates an average increase in firm specific risk over the period with an observable but gradual decline since the late 2000s, which can be attributed to the improvements in financial technology and reduction in information asymmetry. Macroeconomic risk peaked in the period during and immediately after the global financial crisis as expected. The decline in firm specific risk after the crisis is gradual compared to macroeconomic risk, suggesting that firms take a longer time to adjust and recover from the aftermath of a global crisis. And sometimes, the burden of economic recovery is placed on firms through various fiscal and monetary policies. Appendix 2E shows the evolution of other firm characteristics. Leverage, cash flow and size increased during the period under study while growth fluctuated, and dividends decreased.

Table 2.2 Correlations

	1	2	3	4	5	6	7	8
1. Cash	1							
2. Firm Risk1	0.0604	1						
3. Inflation Risk	0.0475	0.0928	1					
4. Leverage	-0.3008	0.0011	0.0270	1				
5. Cash Flow	0.1006	-0.0531	0.0939	-0.0798	1			
6. Dividends	-0.0117	0.0021	-0.0662	-0.1252	-0.1106	1		
7. Size	-0.1042	-0.0577	-0.0155	0.1537	0.0925	-0.0648	1	
8. Growth	0.1274	-0.0704	0.0186	-0.0886	0.2776	0.0806	0.1371	1

This table presents the correlations between the variables used. All variables used are defined in Appendix 2A and are winsorised at the lower 1st and upper 99th percentile. The sample consists of listed firms in South Africa (excluding financial and utility firms).

Table 2.2 present a correlation matrix of the variables used. None of the independent variables are highly correlated; hence multicollinearity may not be a problem. Both macroeconomic and firm-specific risk variables are positively correlated to cash holdings. The positive correlation between the risk variables and cash holdings is consistent with the proposition that firms hold cash when faced with high uncertainty. The sign of the coefficient of risk measures is the same, suggesting that both idiosyncratic and macroeconomic risk increase cash holdings. However, the correlation is relatively more pronounced for idiosyncratic risk (magnitude of the correlation coefficient). It is also important to note that there is a negative correlation between

leverage and cash holdings which support the notion that firms faced with financing constraints hold more cash than firms with easy access to credit/external financing.

2.4 Empirical framework

This section presents the methodology and estimation techniques used in this chapter.

2.4.1 The impact of risk on cash – baseline model

To examine the relationship between risk and cash holdings, we estimate panel data models for listed firms in South Africa. Panel data models allow for the modelling of cross-sectional dynamics of cash holdings over time. The baseline model incorporates measures for idiosyncratic and macroeconomic risk in the standard cash model to allow for the analysis of the linkages between risk and cash holdings. Consistent with Hill et al. (2014) and Bartram, Brown and Stulz, (2009), the model contains lagged dependent variable to control for the residual effects not captured in past cash levels and persistence in cash holdings. The model is expressed as follows.

$$\begin{aligned} Cash_{it} = {} & \beta_0 + \beta_1 Cash_{i,t-1} + \beta_2 FirmRisk_{i,t} + \beta_3 MacroRisk_t \\ & + \beta_4 Leverage_{i,t} + \beta_5 CashFlow_{i,t} + \beta_6 Size_{i,t} + \beta_7 Dividends_{i,t} \\ & + \beta_8 Growth_{i,t} + f_i + \varepsilon_{i,t} \end{aligned} \quad (2.7)$$

where, i and t denote firm and year, respectively, f_i denotes the firm-specific fixed effects and $\varepsilon_{i,t}$ is the error term. β_2 and β_3 capture the effects of idiosyncratic and macroeconomic risks on cash holdings, respectively; whether they attain a positive or negative coefficient and whether they are significant.

2.4.2 The impact of risk on cash holdings – subsample analysis

The subsample analysis in this chapter allows for the investigation of the impacts of risk in financially constrained versus unconstrained firms. To further investigate the impact of risk on cash holdings, the baseline equation is extended to incorporate measures of financial constraints and distinguish between financially constrained and unconstrained firms. Previous studies partition the sample into different sizes to classify firms. For instance, Tran (2019) used the median and partitioned the sample into two equal sizes to distinguish between larger and smaller firms and high growth and low growth firms. Similar studies in cash holdings use the 25th and 75th percentile to differentiate between large and small firms or high growth and low growth firms see, for instance, Baum et al. (2008). In this study, tertiles are used to distinguish between firm classes. Firms whose mean size and dividends over the period lies in the lower tercile (lower 33%) are classified as financially constrained firms (Han and Qiu, 2007). For

leverage, KZ index and WW index, firms that lie in the upper tercile (upper 33%) are financially constrained (Li, 2011).

For the subsample analysis, a dummy variable for financial constraints is introduced to the baseline equation. The dummy variable approach is preferred to sample partitioning in this context because it minimises the loss of observations. Given the small sample size partitioning the sample would result in a much smaller sample size which would render our instruments invalid. The model is specified below.

$$\begin{aligned} Cash_{it} = {} & \beta_0 + \beta_1 Cash_{i,t-1} + \beta_2 FirmRisk_{i,t} + \beta_3 MacroRisk_t + \beta_4 FCD_i \\ & + \beta_5 FCD \times FirmRisk_i + \beta_6 FCD \times MacroRisk_{i,t} \\ & + \beta_7 Leverage_{i,t} + \beta_8 CashFlow_{i,t} + \beta_9 Size_{i,t} \\ & + \beta_{10} Dividends_{i,t} + \beta_{11} Growth_{i,t} + f_i + \varepsilon_{i,t} \end{aligned} \tag{2.8}$$

where, FCD_i is a dummy variable equal to 1 if a firm is financially constrained and 0 for unconstrained firms. The coefficients of interest are β_5 and β_6 which show the response of cash holdings of financially constrained firms to changes in idiosyncratic and macroeconomic risk, respectively. β_2 and β_3 shows the sensitivity of cash holdings in unconstrained firms to changes in idiosyncratic and macroeconomic risk, respectively.

2.4.3 Estimation procedure

Due to endogeneity problems, employing ordinary least squares (OLS) on the model discussed above, the instrumental variable approach is more appropriate. Including lagged dependent variable renders OLS estimates biased and inconsistent. Equations (2.7) and (2.8) are estimated using a robust two-step system GMM dynamic panel data estimator developed by Blundell and Bond (1998). With system GMM first differenced and lagged variables can be used as instruments to control endogeneity problems (Blundell and Bond, 2000). To avoid instrument proliferation, instruments are restricted to the second and fifth lags (Mehrhoff, 2009; Roodman, 2009).

The system GMM technique removes fixed effects as the model can be estimated in first differences. It also allows for the use of different instruments with different lag structures. The validity of the instruments is tested using the $J\ test$. The Hansen-Sargan test ($J\ test$) checks whether models are correctly specified and instruments used are valid, the $m2$ checks for second-order serial correlation in the differenced residuals (Arellano and Bover, 1995; Blundell and Bond, 1998). Although first-order serial correlation in the idiosyncratic disturbances is expected in dynamic panel data models, residuals should not show second-order serial

correlation of the variables. The $m2$ follows a normal distribution with a null hypothesis of no second-order serial correlation of differenced residuals. $J\ statistic$ follows a chi square distribution. The degrees of freedom for the distribution equals the difference between the number of instruments and the number of parameters.

2.5 Empirical findings

This section presents the results of the analyses in this study.

2.5.1 The impact of risk on cash holdings

This chapter begins the empirical analysis by estimating the joint impact of idiosyncratic and macroeconomic risk on cash holdings using six different methodologies. This allows to check model fitness and determine the most appropriate estimation method. Table 2.3 presents the results. Column (1) provides Ordinary Least Squares (OLS) estimates which suggest the existence of a positive and significant relationship between idiosyncratic risk and cash holdings and a negative and not significant relationship between macroeconomic risk and cash holdings. Column (2) provides Fixed Effect (FE) estimates for the baseline equation. Similar to the OLS estimates, the results suggest a positive and significant relationship between idiosyncratic risk and cash holdings and a negative and not significant impact of macroeconomic risk on cash holdings. Columns (3) through to (6) show GMM and system GMM estimates for the effects of risk on cash holdings.

The estimates of the lagged dependent variable $L.Cash$ are positive and significant, suggesting the persistence of cash holdings. Firms with high cash holdings are likely to hoard cash in future. The OLS and FE estimates for the autoregressive term $L.Cash$ are 76% and 53%, respectively. The rest of the estimates fall within the range 53%-76% indicating the appropriateness of the model (Dang, Kim and Shin, 2015). The large difference between OLS and FE coefficient estimates is due to the downward bias by OLS and upward bias by the FE. The lagged cash ratio can indicate the expected return on firm's investment. Firms are likely to decrease their cash ratios in response to increase in the expected opportunity cost of cash (Baum et al., 2008).

As shown in Table 2.3, the results are almost similar across the six methodologies, with minor variation in the magnitude of the coefficients[4]. The coefficient for idiosyncratic risk is positive and significant across all methodologies, and the coefficient for macroeconomic risk is negative

[4] Appendix 2F plots the coefficients and 95% confidence intervals for the estimations based on OLS, Fixed Effects, difference GMM 1, difference GMM 2, system GMM 1 and system GMM 2.

and not significant. Taking into account the similarity and the advantages of GMM over OLS and FE, this chapter employs the system GMM for the rest of the analysis. The panel data used in this chapter contains gaps, and system GMM allows the use of orthogonal deviations to maximise sample size (Roodman, 2009). Results for other firm-specific variables show that size has a positive and significant impact on firm cash holdings. Bigger and established firms are likely to accumulate cash since they have more stable cash flows and operate less aggressively than smaller and young firms (Atanassov, 2013).

Table *2*.3 The effect of idiosyncratic and macroeconomic risk on cash holdings

	(1)	(2)	(3)	(4)	(5)	(6)
Cash	OLS	FE	DGMM-1	DGMM-2	SGMM-1	SGMM-2
L.Cash	0.763***	0.533***	0.570***	0.570***	0.669***	0.669***
	(0.011)	(0.018)	(0.031)	(0.031)	(0.021)	(0.021)
Firm Risk 1	0.030***	0.015**	0.045**	0.045**	0.038**	0.038**
	(0.007)	(0.007)	(0.018)	(0.018)	(0.015)	(0.015)
Leverage	-0.037***	-0.054***	-0.088***	-0.088***	-0.076***	-0.076***
	(0.005)	(0.007)	(0.014)	(0.014)	(0.011)	(0.011)
Cash Flow	0.033***	0.061***	0.064***	0.064***	0.030**	0.030**
	(0.007)	(0.011)	(0.022)	(0.022)	(0.014)	(0.014)
Dividends	-0.003	-0.010	-0.011	-0.011	-0.015	-0.015
	(0.010)	(0.013)	(0.023)	(0.023)	(0.013)	(0.013)
Size	0.016***	0.002	0.018	0.018	0.029***	0.029***
	(0.001)	(0.013)	(0.023)	(0.023)	(0.002)	(0.002)
Growth	-0.009	-0.043***	-0.036	-0.036	-0.021	-0.021
	(0.010)	(0.016)	(0.029)	(0.029)	(0.019)	(0.019)
Inflation Risk	-0.049	-0.069	-0.120	-0.120	-0.080	-0.080
	(0.086)	(0.089)	(0.094)	(0.094)	(0.104)	(0.104)
Observations	7,329	7,329	6,733	6,733	7,329	7,329
Firms	596	596	595	595	596	596
m2			0.216	0.214	0.514	0.513
p-value			0.829	0.831	0.607	0.608
J statistic			465.7	465.7	580.2	580.2
p-value			0.342	0.342	1.000	1.000

This table presents estimates for the impact of both idiosyncratic and macroeconomic risk on cash holdings using different methodologies. Column (1) reports the OLS estimates of the effects of risk on cash holdings. Column (2) presents the FE estimates for the baseline equation. Columns (3) and (4) presents the estimates of the effects of risk on cash holdings using the GMM1 and GMM2, respectively. Columns (5) and (6) estimates the joint impact of risk on cash holdings using the system GMM1 and system GMM2, respectively. The standard errors are given in parenthesis. * denotes significance at the 10% level, ** indicates significance at 5% level, and *** indicates significance at 1% level.

There is also the possibility that large firms experience owner-manager agency conflict that will force managers to maintain ample cash reserves (Xie et al., 2017). As expected, the

coefficient for leverage is negative and consistent with predictions from literature see, for instance, Ferreira and Vilela (2004). Firms with access to eternal financing do not hoard cash. Contrary to prediction in literature, the results show that dividends, cash flow and growth of firm do not have a significant impact on the cash holdings decisions of firms in South Africa.

2.5.2 The impact of risk on cash holdings – alternative risk measures

Table 2.4 reports estimates for the two-step system GMM estimator for the effect of risk on corporate cash holdings using alternative risk measures. The different proxies are expected to capture the different aspects of risk in firms' operational environments. Basing on the correlations of the estimated sample presented in Table 2.2, a positive impact of both risks on cash holdings is expected. Column (1) show results for the impact of idiosyncratic and macroeconomic risk measured by cumulative sales volatility and conditional variances of financial market prices, respectively. Results show that firm specific risk has a significant positive impact on cash holdings, whereas the impact of financial risk is negative and not significant. Column (2) reports estimates for the two-step system GMM using cumulative sales volatility and conditional variances of PPI as proxies for idiosyncratic and macroeconomic risk, respectively. The results also suggest a positive impact of cumulative sales volatility and a non-significant negative impact of inflation risk.

Columns (3) reports estimates of the joint impact of sales volatility and conditional variances of financial market prices on cash holdings. The impact of sales volatility on cash is positive and significant, whereas the impact of financial risk is negative and not significant. Estimates of the joint impact of sales volatility and inflation risk on cash holdings in column (4) show a significant positive impact of sales volatility and a negative and significant impact of inflation risk on cash holdings.

There are two key findings in Table 2.4. First, idiosyncratic risk exerts a positive and significant effect on cash holdings. Specifically, the findings show that for each model presented, the coefficient of idiosyncratic risk is positive and significant. The positive impact of risk on cash holdings is consistent with the precautionary motive, which suggests that firms hold cash as a buffer against adverse cash flow shocks. The findings also agree with empirical findings by Acharya, Davydenko and Strebulaev(2012) and Lei et al. (2018), who also show that idiosyncratic risk has a significant positive impact on cash holdings. Second, macroeconomic risk has a negative and not significant effect on cash holdings. This finding contradicts findings by Bartram, Brown and Stulz (2009), who suggest that the impact of macroeconomic risk is

more pronounced in developing economies. These findings are robust with different combinations of risk measures. The diagnostic tests show the $m2$ and $J\ statistic$ in panel B, which suggest that there are no concerns with the validity of the instruments and second-order autocorrelation

Table *2*.4 Robust two-step system GMM estimates for the effects of risk on cash holdings - alternative risk measures

Cash	(1)	(2)	(3)	(4)
Firm Risk 1	0.040***	0.042***		
	(0.014)	(0.014)		
Financial Risk	-0.006		-0.017	
	(0.088)		(0.082)	
Inflation Risk		-0.072		-0.157*
		(0.101)		(0.091)
Firm Risk 2			0.052***	0.055***
			(0.018)	(0.017)
Controls	Yes	Yes	Yes	Yes
Observations	7,412	7,412	7,412	7,412
Firms	600	600	600	600
m2	0.544	0.549	0.467	0.449
P-value	0.586	0.583	0.640	0.653
J statistic	586.2	586.0	578.6	578.8
P-value	1.000	1.000	0.993	0.993

This table reports estimates of the robust two-step system GMM model for the impacts of idiosyncratic and macroeconomic risk on cash holdings. The dependent variable cash holdings is measured as cash and short-term investments scaled by total assets. Column (1) reports estimates the joint impact of cumulative sales volatility and inflation risk (PPI). Column (2) reports estimates the impact of firm sales volatility and volatility in financial market prices on firm cash holdings. Column (3) estimates the joint impact of volatility in firm sales and inflation risk on firm cash holdings. Model 4 estimates the joint effects of cumulative sales volatility and volatility in financial market prices on corporate cash holdings. The instruments for the differenced equations are second to fifth lags of the independent variables. The diagnostic tests presented are, the AR(2), test of second-order autocorrelation in the first differenced residuals and the J-statistic. The standard errors are given in parenthesis. * denotes significance at the 10% level, ** indicates significance at 5% level, and *** indicates significance at 1% level.

2.5.3 The impact of risk on cash holdings – alternative dependent variable

Table 2.5 reports estimates for the two-step system GMM estimator for the effect of risk on corporate cash holdings using alternative measures for cash holdings and risk. The dependent variable cash holdings is measured as the ratio of cash and short-term investment to net assets. Columns (1) to (4) report the joint impact of different forms of idiosyncratic and macroeconomic risk on cash holdings. Overall, the results confirm the baseline findings that cash holdings increase in response to an increase in idiosyncratic risk and decrease in response

to an increase in macroeconomic risk. These findings are robust with different combinations of risk measures and alternative cash holdings measures.

Table *2*.5 Robust two-step system GMM estimates for the effects of risk on cash holdings – alternative cash holdings measure

Cash	(1)	(2)	(3)	(4)
Firm Risk 1	0.068***	0.070***		
	(0.023)	(0.024)		
Financial Risk	-0.066		-0.069	
	(0.140)		(0.126)	
Inflation Risk		-0.121		-0.258*
		(0.169)		(0.150)
Firm Risk 2			0.087***	0.091***
			(0.028)	(0.028)
Controls	Yes	Yes	Yes	Yes
Observations	7,412	7,412	7,412	7,412
Firms	600	600	600	600
m2	-0.817	-0.816	-0.837	-0.848
p-value	0.414	0.415	0.403	0.397
J statistic	582.5	581.8	577.2	578.9
p-value	1.000	1.000	0.994	0.993

This table reports estimates of the robust two-step system GMM model for the effects of idiosyncratic and macroeconomic risk on corporate cash holdings. The dependent variable cash holdings is measured as cash and short-term investments scaled by net assets. Column (1) reports estimates of the joint impact of cumulative sales volatility and inflation risk (PPI). Column (2) reports estimates of the impacts of volatility in firm sales and volatility in financial market prices on firm cash holdings. Column (3) reports estimates the joint impact of volatility in firm sales and inflation risk on firm cash holdings. Model 4 estimates the joint impact of cumulative sales volatility and volatility in financial market prices on corporate cash holdings. The instruments for the differenced equations are second to fifth lags of the independent variables. The diagnostic tests presented are, the AR(2), test of second-order autocorrelation in the first differenced residuals and the J-statistic. The standard errors are given in parenthesis. * denotes significance at the 10% level, ** indicates significance at 5% level, and *** indicates significance at 1% level.

2.5.4 Heterogeneous impact of risk on cash holdings

Having established the effect of risk on cash holdings, for the full sample, next subsample analysis is conducted to evaluate the cross-sectional variation of the sensitivity of cash holdings to risk. A dummy variable is introduced that identifies financially constrained firms according to their size, dividend pay-outs, leverage and the two index measures, KZ and WW index. Table 2.6 presents the findings. The variable of interest is the interaction between the financial constraints dummy FCD and the risk measures, $FirmRisk$ and $MacroRisk$.

Five models are estimated using the five different indicators for financial constraints identified. The first column reports results for small firms. The estimates show that the effect of

idiosyncratic risk on cash holdings is insignificant in smaller firms. However, small firms exhibit greater sensitivity to changes in macroeconomic risk.

Table *2*.6 Heterogeneous impacts of risk on cash holdings

Cash	(1) Size	(2) Dividends	(3) Leverage	(4) KZ index	(5) WW index
Firm Risk 1	0.035**	0.024	0.033**	0.014	0.023
	(0.017)	(0.020)	(0.016)	(0.019)	(0.019)
FCD	0.000	-0.004	0.006	-0.011***	-0.003
	(0.005)	(0.004)	(0.004)	(0.004)	(0.005)
FCD *x* Firm Risk 1	0.049	0.065	0.069**	0.113***	0.100**
	(0.038)	(0.040)	(0.032)	(0.036)	(0.047)
Inflation Risk	-0.003**	0.000	0.001	-0.004***	-0.001
	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)
FCD *x* Inflation Risk	0.006**	-0.001	-0.006***	0.009***	0.001
	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)
Controls	Yes	Yes	Yes	Yes	Yes
Observations	7,412	7,412	7,412	7,412	7,412
Firms	601	601	601	601	601
m2	0.671	0.594	0.742	0.401	0.733
p-value	0.502	0.552	0.458	0.688	0.464
J statistic	573.4	560.3	579.2	567.5	570
p-value	0.986	0.995	0.978	0.991	0.989

This table reports estimates of the robust two-step system GMM model for the impact of idiosyncratic and macroeconomic risk on corporate cash holdings. FCD is an indicator variable equal to 1 for financially constrained firms and 0 otherwise. The dependent variable cash holdings is measured as cash and short-term investments scaled by total assets. Columns (1) and (2) report estimates of equation (3) with FCD equal to 1 for firms with mean size and dividends in the lower tercile. Columns (3) to (5) estimates the equation (3) with FCD equal to 1 for firms whose mean falls in the upper tercile of leverage, KZ index and WW index. The instruments for the differenced equations are second to fifth lags of the independent variables. Panel B reports the diagnostic tests, the AR(2), a test of second-order autocorrelation in the first differenced residuals, and the J-statistic). The standard errors are given in parenthesis. * denotes significance at the 10% level, ** indicates significance at 5% level, and *** indicates significance at 1% level

Column (2) shows that non-dividend-paying firms' cash holdings have greater sensitivity to both sales volatility and volatility in the inflation index. Non-dividend-paying firms are likely to be financially constrained; hence changes in risk are likely to modify their demand for cash. Columns (4) and (5) show that cash holdings of firms with high KZ index and WW index have greater sensitivity to changes in risk. In all five cases, the impact of both idiosyncratic and macroeconomic risk is more pronounced in firms facing financial constraints.

2.6 Conclusion and recommendations

Many studies in finance investigate corporate cash holdings, particularly in developed economies, with a considerable number investigating the effect of risk on cash holdings.

However, there is a limited number of studies investigating cash holdings in developing and emerging countries, which are characterised by less developed financial markets, high bank debt in firms, all of which suggests the importance of internal financing. Given this context, how do firms respond to changes in risk levels? To address this question, this chapter investigates the relationship between macroeconomic and idiosyncratic risk on corporate cash holdings using a panel of South African non-financial firms drawn from Worldscope through Datastream.

Using the two-step GMM results show that firms become conservative with their cash holdings when they are faced with high idiosyncratic risk. Macroeconomic risk, however, does not show a significant impact on the cash holdings. Further investigations show that macroeconomic risk has a negative and significant effect on cash holdings in high leveraged firms and a positive and significant impact in smaller firms. Specifically, subsample analysis shows that the impact of idiosyncratic risk on cash holdings is more pronounced/significant in financially constrained firms. Overall, this chapter contributes to the literature that studies the determinants of corporate cash holdings by providing evidence on the direct link between idiosyncratic and macroeconomic risk. Contrary to Alves (2018), the results show that the precautionary motive has explanatory power for cash holdings of firms in South Africa.

Chapter 3. Social media, idiosyncratic risk and stock liquidity

3.1 Introduction and motivation

Social media has changed the way in which information is produced and disseminated. Firms have adopted social medial as a form of communication with investors and clients. Subsequently, studies have sought to investigate the economic value of the large volumes of real-time data generated on social media. A vast body of empirical literature that explore the predictive and explanatory power of social media in finance is mainly focused on the U.S. and emerging Asia, see, for instance, Bollen, Mao and Zeng (2011); Heimer and Simon (2012); Chen et al. (2014); Dang, Huynh and Nguyen (2020). Little attention has been paid to Sub-Saharan Africa despite the recent active adoption and the rapid growth in the use of the internet and social media in Africa (Nyirenda-Jere and Biru, 2015; Owusu-Agyei et al., 2020).

This study attempts to characterise the relationship between social media and daily stock market activity using firm-specific Facebook content of 142 South African firms over the period 2010 to 2020. To the best of our knowledge, this study is the first to provide evidence on the impact of Facebook indicators on stock market activity in South Africa. Specifically, the study examines the individual impact of various Facebook indicators on stock return, idiosyncratic risk and stock liquidity. Results show that on average positive public sentiments are associated with higher stock market performance as indicated by the positive association with liquidity and abnormal returns and negative association with idiosyncratic risk. Public reactions to firm posts - likes, shares and comments increase stock liquidity and abnormal returns and reduce firm risk. The performance of a Facebook post is positively associated with a firm's stock market performance. The findings for the volume of posts are inconsistent with the literature, which suggests that volume of social media content reduces information asymmetry and is associated with higher stock performance (see, for instance, Liu et al., 2010; Al Guindy, 2021). Posts have a negative impact on abnormal returns and a positive association with idiosyncratic risk, suggesting that the risk exposure associated with information dissemination outweigh the benefits of reducing information asymmetry, at least for the case of South African firms.

This study contributes to the literature by documenting new empirical evidence on the role of social media on the stock market performance of South African firms. The study closely relates to Chung et al. (2020), who investigate the financial returns of firm initiated Facebook posts of 63 South Korean firms over three years but differs in terms of our focus on South Africa and our inclusion of public sentiments and public reactions. These departures are important as they

address the concentration of studies in developed economies and provide evidence from a unique emerging market. Aside from the scant literature, the focus on South Africa is motivated by the popularity of social media that came with the recent active adoption of the internet[5].

The study also draws interesting comparisons for small *versus* large firms and low risk *versus* high risk to find the differential impacts of social media. These additional analyses are important as they give an insight into the channels through which social media affects stock market performance and which firms are most likely to benefit from social media strategies. Results show significant differences between small and large firms as well as low risk and high risk firms. Social media strategies are more significant to small and high risk firms, and public reactions to the firm's activities are more important than the firm's activities on social media. This highlight the importance of internet availability in emerging market economies and is of interest to policymakers as it may have indirect welfare implications.

The rest of this study is organised as follows. Section 3.2 presents the literature review and hypothesis development. Section 3.3 describes the data, variables and methodology used. Section 3.4 presents and discusses the empirical findings. Section 3.5 summarises and concludes the chapter.

3.2 Literature and hypotheses development

This section reviews prior research on the business value of social media and highlights the contribution of this study. The role of news and media in financial markets was first suggested after early economists reported wild movements in stock prices that cannot be explained by fundamentals (Keynes, 1936). Mixed inferences on the role of social media can be drawn from financial market theories. On the one hand, some theories attribute movements in stock prices to changes in fundamentals. The neo-classical theory, for example, suggests that movements in stock prices are about some aspect of fundamentals and that markets are efficient. Hence firms respond to the high prices by issuing more shares and reducing debt financing (Lamont and Stein, 2006).

The behavioural market view gives a similar analysis of the market. It suggests that managers take advantage of higher stock prices and issue equity which is more sensitive to aggregate price movements than individual stock price movements (Campello and Graham, 2013). Both views suggest stock prices are due to opportunistic timing and are primarily determined by

[5] The South African Social Media Report, reports an 13% increase in the number of active subscribers between January 2020 and January 2021 (Ornico and World Wide Wox, 2021).

equity issuances. In support of the theories, Vuolteenaho (2002) shows that variations in individual stock returns are widely driven by cash flow news, a smaller component explained by time-varying expected returns is mostly permanent, leaving a limited role for sentiments as relative prices are almost efficient.

On the other hand, the efficient market hypothesis suggests that new information other than past and current information on prices can drive stock market prices. Although this new information, for example, news, may not fully predict the stock market, social media can provide very early indicators to predict changes in economic and commercial indicators, including the stock market. Hence, social media is more effective than news in predicting stock prices (Bollen, Mao and Zeng, 2011). Similar to the efficient market hypothesis is the Samuelson dictum, which suggests that stock markets are micro efficient and macro inefficient (Samuelson, 1998). As a result, time-series aggregates of stock indexes are sometimes below or above the values of fundamental. Since the operations and activities of individual firms are diverse, the implication is that there is market information that informs stock returns on a micro-level. Based on these theories, social media content can capture the other factors to make the simple efficient market model work (Jung and Shiller, 2005). Several studies concur with the efficient market theories. For example, Frijns, Gilbert and Tourani-Rad (2015); and Frijns, Indriawan and Tourani-Rad (2015) show that the flow of information can influence stock prices, stock returns and trading patterns. Further studies by (Dergiades, Milas and Panagiotidis (2015) and Bampinas, Panagiotidis and Rouska (2019) show that information contained in social media and web search intensity has a significant impact on financial and commodity markets.

Earlier studies on media and stock prices report that news and stories cannot explain large market returns unless accompanied by quantitative macroeconomic events (Cutler, Poterba and Summers, 1988). However, more recent studies confirm the predictive and explanatory power of social media in finance. Our study contributes to several strands of literature. The first strand of literature focus on the impact of social media sentiments on stock market activity. De Long et al. (1990) developed a model of investor sentiments, which shows that lower investor sentiments are associated with lower stock prices. Unpredictable sentiments, on the other hand, create risk in the asset price. This risk deters investors from betting against them, resulting in unusually low and unusually high fees associated with high volumes.

Similarly, Tetlock (2007) explores the relationship between U.S. firms' media content and stock market activity. He finds that negative sentiments push down stock prices and result in higher trading volume. His findings that media pessimism predicts a decrease in returns are consistent with the investor sentiments' model but fails to predict risk. Zhang, Fuehres and Gloor (2011) also report a negative correlation between emotional tweets and the Dow index. They show that when people express hope, fear, and worry, the Dow Index goes down the following day. Bollen, Mao and Zeng (2011) also predict closing values on the Dow index using sentiments derived from daily tweets of Google Profile of Mood States. The results show a significant reduction in prediction error, indicating that Twitter sentiments can, to some extent, predict the stock market.

Further, Gilbert and Karahalios (2010) empirically test the relationship between the stock market and mood from an online community. They identified a Granger-causal relationship between the algorithmic estimate of the mood of people and the stock market; a one standard deviation increase in anxiety index reduces stock returns by 0.4%. Lower stock returns, in turn, result in a negative public mood, leading to critical and pessimistic information. The above discussion suggests that social media sentiments can predict the stock market activity, and positive sentiments are associated with higher returns and lower risk. The present study examines the individual impact of firm-level Facebook sentiments on stock returns and idiosyncratic risk. The study investigates the following hypotheses drawn from the above discussion.

*Hypothesis 1(a)**:** There is a positive association between public sentiments on Facebook and abnormal returns.*

Hypothesis 1(b): There is a negative association between public sentiments on Facebook and idiosyncratic risk.

The second strand of literature investigates social media's power in reducing information asymmetry and consequently improving firms' stock market performance. Firms do not choose whether they are subjected to greater or lower information asymmetries. However, some industries are subject to more severe information asymmetries than others. For such firms, social media data can complement traditional sales data in helping understand markets (Liu et al., 2010). Two recent studies draw interesting conclusions on the ability of social media to inform markets. Gu and Kurov (2020) study how firm-specific Twitter sentiments influence the stock market. They find that firm-level Twitter sentiments contain information that can

predict the stock market, and this predictive power is stronger in firms with less analyst coverage. Gu and Kurov (2020) further show that the predictive power of Twitter on stock returns is stronger for firms in a weaker information environment. These findings imply that social media can play an essential role in reducing information asymmetry.

Similarly, Al Guindy (2021) examines the impact of Twitter use adoption by firms listed on the NYSE, AMEX and NASDAQ. He finds that firms that use Twitter have lower cost of equity capital and firms that suffer information asymmetry benefit from tweeting financial information. Al Guindy (2021) findings suggest that social media plays a dissemination and disclosure role in reducing information asymmetry and firm-specific content that includes stock relevant information is beneficial to firms in weaker information environments.

Earlier studies provide mixed conclusions on the impact of social media content on firm stock market performance, and these studies focus on Twitter. For instance, Zhang, Fuehres and Gloor (2012), using a set of retweets originating from the U.S., show that changes in the volume of retweets of messages containing selected economic keywords are related to changes in asset value. Similarly, Azar and Lo (2016), using a dataset of tweets referencing the Federal Reserve, show that tweets predict returns on the Federal Open Market Committee (FOMC) announcement days. They argue that even though social media participants engage in conversations about markets, whether they are informed or not, the information contained in tweets has limited ability to predict future stock prices. Antweiler and Frank (2004) examine the impact of internet stock message boards on stock market movements. Their analysis shows that increase in the volume of posting can help predict returns volatility and trading volume. Contrary to Al Guindy (2021), Antweiler and Frank (2004) show that an increase in message volume indicates negative returns. The amount and type of information a firm supplies to its clients and the public is associated with the risk; it generates information exposure.

Further study by Sprenger et al. (2014) investigates the association of tweets and trades of publicly listed U.S. firms. They show that tweets with above average investment advice are mostly shared. These findings have two implications on the role of social media in reducing information asymmetry. First, social media allows investors to access information from each other, which compound information dissemination and reduce information asymmetries. Second, social media participants are more interested in investment relevant information on firm Facebook pages. Without social media, financial market participants will have to rely on intermediaries for value relevant information of stocks. This study takes a tangent from the

literature that focuses on Twitter messages and focus on the volume of Facebook messages on stock returns, idiosyncratic risk and stock liquidity. Hence, the researcher investigates the following hypotheses drawn from the above discussion.

Hypothesis 2(a): There is a positive association between the volume of firm posts on Facebook and abnormal returns.

Hypothesis 2(b): There is a negative association between the volume of firm posts on Facebook and idiosyncratic risk.

The third strand of literature investigates how client and public engagement with the firm on social media can potentially impact firm stock market performance, equity value and other financial indicators. Recent studies on social media have included the role of firm and client engagement on social media on firm value focusing on client engagements and feedback. For instance, Goh, Heng and Lin, (2013) analyse a single firm Facebook page to identify the impact of firm generated posts on consumer purchase expenditure. They define directed and undirected information to distinguish between posts based on consumer remarks and content not addressed to a specific consumer. The results show that undirected communication is more effective for both informative and persuasive purposes. A similar study by Lee, Hosanagar and Nair (2018) investigates the impact of firm social media content on customer engagement. They compare the effects of informative *versus* brand personality-related content on customer engagement metrics such as likes and comments. While this study also explores the impact of firm generated social media content, it differs from the two studies in two ways. First, the study investigates the impact of firm social media posts on a firms' stock performance. Second, the study explores the impact of public engagement metrics on a firms' stock performance. Fewer studies focus on the impact of a firms' social media posts on its performance. Whereas all these studies have investigated the impact of social media on stock returns, social media content in Facebook concerning financial markets is largely unexplored. Previous studies based on Twitter sentiments cannot be generalised because in as much as firms' Twitter contents are usually similar to the content on their Facebook pages, Twitter is not as effective and active as their Facebook pages (Öztamur and Karakadılar, 2014).

Hypothesis 3(a): There is a positive association between the number of reactions to a firm's Facebook posts and abnormal returns.

Hypothesis 3(b): There is a negative association between the number of reactions to a firm's Facebook posts and idiosyncratic risk.

The study is extended to investigate the impact of social media on stock liquidity. While several studies examine social media impacts on stock returns, little or no attention has been given to the effects of social media on stock liquidity. The researcher proposes that social media sentiments can potentially impact short sales. The intuition is that a sequence of good cash flow news overvalues the stock market leading to lower trading volume in the short run. Eventually, the higher prices will lead to optimistic beliefs and positive sentiments and, consequently, increased share purchases (Barberis et al., 2015). Higher liquidity allows for more informed trading through enhanced informational efficiency of stock prices.

In most cases, managers are well informed of the fundamentals of their firms. Still, they have little information on other price-determining factors such as the competitor strategies and public sentiments, of which investors may be more informed. Hence, managers should listen to social media information as much as they listen to financial markets (Subrahmanyam and Titman 2001). A similar study by Brogaard, Li and Xia (2017) suggest that positive sentiments are associated with higher liquidity. The negative relationship between risk and liquidity could result from the value effects; social media increase firm value. Further, Hu and Tripathi (2015) show that negative sentiments disclosed on investor forums lead to more capital being short sold. Social media allows for direct interaction among users and firms, making the information more valuable than news. Following this discussion, the study investigates the following hypotheses.

Hypothesis 4(a): *There is a positive association between public sentiments on Facebook and stock liquidity.*

Hypothesis 4(b): *There is a positive association between the volume of firm posts on Facebook and stock liquidity.*

Hypothesis 4(c): *There is a positive association between the number of reactions to a firm's Facebook posts and stock liquidity.*

3.3 Data variables and methodology

This section describes the data, variables and methodology used in this study.

3.3.1 Sample selection and data collection

The context of this study, firms listed on the Johannesburg Stock Exchange (JSE) is selected for two reasons. First, the JSE, being the largest exchange in Africa, will allow the researcher to draw some insights into the role of social media on stock market operations in an emerging economy and Africa. Second, the number of listed firms with active Facebook pages is sizable

enough to allow for meaningful conclusions of the overall market. The initial sample consists of JSE listed companies with active Facebook pages. Some firms especially holding companies, operate several Facebook pages for the different brands; following Chung et al. (2020), data from the multiple Facebook pages of a company is aggregated to create daily indicators for each firm.

Next, the study excludes media companies from the sample because their social media content is mainly news. They generate extremely large volumes of content that would create outliers in our measures of post volumes. Also, the public sentiments on their Facebook pages are not necessarily about the company but the news' subject. To control for outliers and ensure results are not driven by fewer firms, all variables are winsorised in the lower one percent and upper ninety nine percent. The final sample is an unbalanced panel dataset of 142 firms spanning from 1 January 2010 to 15 October 2020. Although the number of firms is small compared to the South African stock market, investigating firms active on social media still gives significant insights into the role of social media in the South African stock market.

3.3.2 Variables and measures

This subsection describes the data sources, variables, and variable construction.

Facebook variables

The Facebook variables were obtained from Crowd Tangle. Crowd Tangle provides comprehensive historical, social media data publicly available on Facebook, Instagram, and Reddit. The data accessed from Crowd Tangle comprise of Facebook posts and reactions to the posts. It also identifies the type of post, giving the researcher opportunity to compare the impacts of several posts on firm stock performance. The following firm-level daily Facebook indicators are computed using posts and reactions on the firm's social media posts. The total number of posts made by a firm measure *Posts*. The study uses the number of posts to indicate firms' information supply and social media visibility which can also translate to exposure (Ramirez and Huang, 2015). The study includes the type of posts measured by the total number of a firm's enhanced posts in a day: *Photo*, *Video*, and *Link*. Public *Sentiments* on a firm's posts are measured by the difference between total daily positive reactions (Likes, Love, Wow and Care) and negative reactions (Angry and Sad) to a firm's posts.

The study also includes indicators to measure public reactions to a firm's Facebook posts. *Likes*, to indicate positive reactions to Facebook posts measured as the total number of likes on firm posts in a day. *Shares* indicate information sharing measured by the number of times a

firm's posts are shared in a day. *Comments,* to indicate the volume of feedback on a firm's posts. Although there is no distinction between positive and negative feedback, the volume of opinions revealed on social media may predict stock market performance (De et al., 2014). Finally, the study includes the measure of overperformance, which indicates the level at which a post overperformed relative to similar posts from the same page in similar time frames. Crowd Tangle uses the average interactions for 100 previous and similar posts as the benchmark. The interactions include comments, shares and likes (Crowd Tangle Codebook). Logarithmic transformation is applied on all variables (except *Scores*) to allow for comparison with financial variables.

Financial variables

Data for financial variables is collected from Datastream and Yahoo Finance. The study uses three different dependent variables to analyse the impact of social media on firm stock market activities and performance. The first dependent variable, abnormal returns, measure the firm's performance beyond expected returns and the second dependent variable idiosyncratic risk measure the vulnerability of firm value on the stock market (Dewan and Ren, 2007; Luo, 2009). Both variables are generated from the extended Fama-French model.

$$R_{it} - Rf_t = \beta_{0i} + \beta_{1i}(Rm_t - Rf_t) + \beta_{2i}SMB_t + \beta_{3i}HML_t + \beta_{4i}WML_t + e_{it} \quad (3.1)$$

where R_{it} is the returns for firm i on time t, Rf_t is the risk-free rate, Rm_t is the average market returns, SMB_t measures the size effects, HML_t measures the value effects, WML_t is the Carhart's momentum effects and e_{it} is the residuals of the model. Stock price data was obtained from Yahoo Finance at https://finance.yahoo.com/. Data for Fama-French and Carhart's momentum factors is collected from Kenneth R French data library available at https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html Abnormal returns are proxied by the model's residuals, and idiosyncratic risk is the standard deviation of the residuals from the model.

The third measure of stock market performance, stock liquidity, signifies informational efficiency (Smith, 2008). The study employs effective spread as a proxy for stock liquidity. Lower effective spread indicates that the stock is liquid (Brogaard, Li and Xia, 2017). The effective spread is calculated as follows.

$$Effective\ spread = \frac{price - \frac{bidprice + askprice}{2}}{\frac{bidprice + askprice}{2}} \quad (3.2)$$

Several control variables that can determine firm stock market performance are included in the models. The study includes the logarithm of total assets to control for firm size, the market to book value to control for firm growth opportunities, the trading volume to control for high volume returns (Gervais, Kaniel and Mingelgrin, 2001; Tetlock, 2007; Gu and Kurov, 2020). The models also control for market return and excess return. Data for market return is obtained from Kenneth R French data library, which provides information for current research returns at https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html. All variables are defined in Appendix 3A.

3.3.3 Summary statistics

Table 3.1 presents the summary statistics, including the mean, standard deviation, minimum, median and maximum for the entire sample.

Table 3.1 Summary statistics

Variables	N	Mean	Stdev	Min	P25	P50	P75	Max
Volume of Posts	88477	0.1075	0.0449	0.0693	0.0693	0.1099	0.1386	0.2565
Sentiments	88449	0.4194	0.2105	0.0000	0.2639	0.3951	0.5714	0.9189
Likes	88477	0.4168	0.2097	0.0000	0.2565	0.3932	0.5677	0.9170
Shares	88477	0.1871	0.1562	0.0000	0.0693	0.1609	0.2890	0.6215
Comments	88477	0.2317	0.1964	0.0000	0.0000	0.2079	0.3807	0.7000
Photo	88477	0.0650	0.0578	0.0000	0.0000	0.0693	0.1099	0.2197
Video	88477	0.0216	0.0394	0.0000	0.0000	0.0000	0.0693	0.1609
Link	88477	0.0204	0.0366	0.0000	0.0000	0.0000	0.0693	0.1386
Score	88477	-0.0016	0.0050	-0.0345	-0.0013	-0.0003	0.0001	0.0055
Abnormal return	83866	0.0074	0.5109	-1.2717	-0.2574	-0.0036	0.2013	1.4691
Idiosyncratic risk	85707	0.4402	0.2750	0.0711	0.2367	0.3547	0.5263	1.4098
Liquidity	80187	0.4642	0.0723	0.1848	0.4384	0.4690	0.5024	0.6560
Market Capitalisation	69697	16.6145	1.7911	10.7116	15.7158	16.8843	17.8215	19.5638
Trading volume	78477	12.9264	2.2312	6.0210	12.0095	13.2183	14.4189	17.2316
Price	85707	8.1591	1.6192	3.6376	7.3603	8.4279	9.4572	11.0635
Size	72633	16.8389	2.1147	11.2423	15.2959	16.8258	17.9423	21.4295
Excess return	83866	0.0454	0.6156	-1.8158	-0.2451	0.0024	0.3198	1.8540
Market return	84215	0.0063	0.0497	-0.1697	-0.0234	0.0047	0.0359	0.1215
Market to book	72862	3.7683	2.9380	0.2600	1.4900	2.9200	5.7500	13.2300

This table presents the number of observations (N), mean, standard deviation, median, 25th and 75th percentile for the variables used. The sample consists of 142 South African firms listed on the Johannesburg Stock Exchange. All variables used are defined in Table 1 and are winsorised at the lower 1st and upper 99th percentile.

An average firm in the sample has abnormal returns of 0.7%. The abnormal returns are skewed to the right, the median is -0.4%, while the maximum is 146%, and the standard deviation is

large at 51%. The mean and standard deviation for idiosyncratic risk is 44% and 27.5%, respectively. The mean for effective spread is 46%, much higher than the mean illiquidity of 17.2% reported by Ng et al. (2016) for South Africa from 2003 to 2009. The means for Facebook variables looks relatively standard and have considerable variation.

Table 3.2 Correlations

	Variables	1	2	3	4	5	6	7	8	9	10
1	Volume of Posts	1									
2	Sentiments	0.415	1								
3	Likes	0.415	0.999	1							
4	Shares	0.382	0.749	0.746	1						
5	Comments	0.433	0.723	0.725	0.623	1					
6	Photo	0.606	0.466	0.465	0.443	0.299	1				
7	Video	0.430	0.248	0.245	0.315	0.326	0.081	1			
8	Link	0.246	-0.105	-0.104	-0.086	-0.086	-0.218	-0.070	1		
9	Score	-0.273	0.262	0.261	0.231	0.169	0.006	-0.004	-0.308	1	
10	Abnormal return	-0.113	0.028	0.029	0.029	0.015	-0.038	-0.039	-0.065	0.066	1
11	Idiosyncratic risk	0.126	-0.038	-0.039	-0.066	-0.105	0.103	0.000	0.142	-0.162	-0.175
12	Effective spread	0.069	-0.007	-0.007	-0.023	0.004	-0.023	0.032	0.068	-0.087	0.037
13	Market Capitalisation	0.127	0.182	0.182	0.125	0.227	0.007	0.095	0.035	-0.028	-0.016
14	Trading volume	0.072	0.100	0.102	0.046	0.177	0.000	0.111	-0.045	0.047	-0.050
15	Price	0.099	0.281	0.282	0.177	0.375	-0.043	0.117	-0.025	0.008	0.113
16	Size	0.118	0.186	0.186	0.147	0.221	0.017	0.097	-0.002	0.038	-0.038
17	Excess return	0.023	-0.023	-0.023	-0.019	-0.040	0.030	-0.032	0.038	-0.031	0.101
18	Market return	-0.019	0.026	0.026	0.022	0.040	-0.025	0.032	-0.039	0.029	0.005
19	Market to book	0.166	0.273	0.272	0.177	0.228	0.114	0.026	0.040	-0.091	0.095

This table presents the correlations between the variables used. All variables used are defined in Appendix 3A. and are winsorised at the lower 1st and upper 99th percentile. The sample consists of 142 South African firms listed on the JSE.

Correlations (continued)

	Variables	10	11	12	13	14	15	16	17	18	19
10	Abnormal return	1									
11	Idiosyncratic risk	-0.175	1								
12	Effective spread	0.037	0.107	1							
13	Market Capitalisation	-0.016	-0.146	0.000	1						
14	Trading volume	-0.050	-0.222	-0.186	0.261	1					
15	Price	0.113	-0.139	0.438	0.467	0.142	1				
16	Size	-0.038	-0.136	-0.027	0.735	0.402	0.445	1			
17	Excess return	0.101	0.117	0.036	-0.001	-0.112	-0.010	-0.092	1		
18	Market return	0.005	-0.115	0.023	0.000	0.099	0.044	0.087	-0.985	1	
19	Market to book	0.095	0.020	-0.030	0.204	0.045	0.183	0.056	0.113	-0.097	1

This table presents the correlations between the variables used. All variables used are defined in Appendix 3A and are winsorised at the lower 1st and upper 99th percentile. The sample consists of 142 South African firms listed on the JSE.

Table 3.2 provide correlations among key variables. None of the financial variables are strongly correlated except the dependent variables, idiosyncratic risk and abnormal returns. Facebook variables show strong correlations amongst themselves. To avoid multicollinearity, this study

deviates from the literature (see, for instance, Chung et al., 2020) and investigates the impact of the various Facebook indicators in separate specifications.

3.3.4 Econometric specification

This section presents the econometric specifications and methodology used in this study. The study begins the analysis by investigating the relationship between social media and abnormal returns. We estimate the model for abnormal returns. The model incorporates Facebook indicators to study the linkages between social media and abnormal returns. The regression specification is:

$$\begin{aligned} Abnormal\ returns_{i,t} &= \beta_0 + \beta_1 Facebook_{i,t} + \beta_2 MarketReturn_{i.t} \\ &+ MarkettoBook_{i,t} + Volatility_{i,t} + Size_{i,t} + Volume_{i,t} + \varphi_i \\ &+ \vartheta_t + \varepsilon_{i,t} \end{aligned} \quad (3.3)$$

where i denotes individual firms and t denotes time (day), respectively. $Abnormal\ returns$ is the measure of a firm's stock performance - abnormal returns. The coefficient of interest β_1 measures the impact of the Facebook variable on abnormal returns. Regression controls include market return, market to book value, size and volume.

Next, we investigate the extent to which firms' activities and public interactions on their Facebook page determine idiosyncratic risk. Equation (2.3) is re-estimated with $Idiosyncratic\ risk$ as the dependent variable. This estimation aims to investigate whether a firm's social media activities can predict the vulnerability of firm equity value.

The study employs a different econometric specification to investigate the impact of social medial on stock liquidity. The researcher investigates two conflicting hypotheses. First, that social media is associated with reputation risk, which may reduce stock liquidity. At the same time, social media reduces information asymmetry resulting in higher stock liquidity. The purpose of this analysis is to investigate whether, in the case of South African listed firms, the benefits from the reduction in information asymmetry outweigh the risk of exposure. To examine the impact of social media exposure on stock liquidity, the following liquidity model is augmented to include Facebook variables.

$$StockLiquidity_{i.t} = \alpha + \beta_1 Facebook_{i,t} + \beta_2 FirmRisk_{i,t} + \beta_3 Volume_{i,t} + \beta_4 ExcessReturn_{it} + \beta_5 Size_{i,t} + \beta_6 MkttoBook_{it} + \varphi_i + \vartheta_t + \varepsilon_{i.t} \quad (3.4)$$

where i denotes individual firms, t denotes time and $\varepsilon_{i.t}$ denotes the idiosyncratic error term. Regression controls include idiosyncratic risk, trading volume, excess returns, size and market to book. The coefficient of interest is β_1 which measures the impact of firm's Facebook activities on stock liquidity. Following Al Guindy (2021), the models are estimated using Ordinary Least Squares with industry and time fixed effects. We include industry/sector fixed effects to account for unobserved heterogeneity across industries. Luo, Zhang and Duan (2013) show that some sectors prioritise information dissemination more than others, and firms in such sectors generate more content and are more likely to have more public engagement. For example, the computer hardware and software companies that constantly introduce new products with shorter life cycles intensively leverage on social media to promote products online.

3.4 Empirical results

This section describes the statistical results of testing the hypothesis that social media exposure enhances firm stock market performance. Using linear regression and controlling for industry and time effects, we estimate equations (3.3) and (3.4). The parameters of interest are the coefficients of the various Facebook variables.

3.4.1 Predicting abnormal returns and idiosyncratic risk using Facebook

Table 3.3 presents estimation results for the linear regression model depicted in equation (3.3) that relates abnormal returns to Facebook indicators and control variables. The results show that the volume of firm posts on social media has a significant negative association with abnormal returns. The coefficient of -0.788 implies that future abnormal returns are 0.78% lower if posts increase by 1%. These results are consistent with findings by Antweiler and Frank (2004), who report that positive shock to the volume of messages reduces stock returns. Measures of public interactions – sentiments, likes, shares and comments have a positive and significant association with abnormal returns ($\beta = 0.117$, $\beta = 0.118$, $\beta = 0.071$, $\beta = 0.098$, respectively).

The findings suggest that firms benefit more from public reactions to their Facebook posts than the volume of the posts. A possible reason is that the public reacts to the firm's Facebook content relevant to them and ignores posts that do not interest it. Firms' social media strategy should be centred around disseminating information that captures public interest. More importantly, results suggest that sentiments are more important than shares and comments in determining stock returns. The Facebook score is positively related to abnormal returns.

Table 3.4 shows a strong positive relationship between posts and idiosyncratic risk $(0.762, p < 0.01)$, implying that an increase in Facebook posts increases firm risk. Facebook sentiments show a significant negative association with firm risk (-0.044, p<0.01), indicating that a positive change in public sentiments reduces idiosyncratic risk.

Table 3.3 Impact of social media on abnormal returns

Abnormal returns	Posts (1)	Sentiments (2)	Likes (3)	Shares (4)	Comments (5)	Score (6)
Facebook	-0.809***	0.107***	0.108***	0.075***	0.107***	0.005***
	(0.046)	(0.011)	(0.011)	(0.013)	(0.013)	(0.000)
Market return	0.130***	0.132***	0.132***	0.139***	0.132***	0.136***
	(0.045)	(0.045)	(0.045)	(0.045)	(0.045)	(0.045)
Volume	-0.016***	-0.016***	-0.016***	-0.016***	-0.016***	-0.016***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Size	-0.015***	-0.020***	-0.020***	-0.019***	-0.020***	-0.018***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Market to book	0.025***	0.022***	0.022***	0.023***	0.022***	0.024***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	60,778	60,760	60,778	60,778	60,778	60,778
R-squared	0.075	0.072	0.072	0.071	0.072	0.074

This table reports estimates of the regression of Facebook indicators on *Abnormal returns*. Columns 1- 6 show regression estimates for *Posts, Sentiments, Likes, Shares, Comments* and *Scores*, respectively. The OLS regressions include industry and day fixed effects. The standard errors are given in parenthesis. * denotes significance at the 10% level, ** indicates significance at 5% level and *** indicates significance at 1% level. Variables used are defined in Appendix 3A.

Measures of public interactions likes, shares, and comments have a negative and significant association with firm risk; $\beta = -0.042$, $\beta = -0.079$, and $\beta = -0.048$, respectively. Our results are consistent with literature that predicts that social media increase stock returns and reduces firm-specific risk (see Luo, Zhang and Duan, 2013). However, frequent communication on social media reduces abnormal returns and increases the vulnerability of firm equity value.

Table 3.4 Impact of social media on idiosyncratic risk

Idiosyncratic risk	Posts	Sentiments	Likes	Shares	Comments	Score
	(1)	(2)	(3)	(4)	(5)	(6)
Facebook	0.777***	-0.046***	-0.045***	-0.076***	-0.051***	-0.007***
	(0.025)	(0.006)	(0.006)	(0.007)	(0.007)	(0.000)
Market return	-0.366***	-0.373***	-0.373***	-0.374***	-0.373***	-0.369***
	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.020)
Volume	-0.008***	-0.008***	-0.008***	-0.008***	-0.008***	-0.007***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Size	-0.033***	-0.029***	-0.029***	-0.030***	-0.029***	-0.031***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Market to book	-0.007***	-0.006***	-0.006***	-0.006***	-0.006***	-0.007***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	61,063	61,045	61,063	61,063	61,063	61,063
R-squared	0.216	0.203	0.203	0.204	0.203	0.219

This table reports estimates of the regression of Facebook indicators on *Idiosyncratic risk*. Columns 1- 6 show regression estimates for *Posts, Sentiments, Likes, Shares, Comments* and *Scores*, respectively. The OLS regressions include industry and day fixed effects. The standard errors are given in parenthesis. * denotes significance at the 10% level, ** indicates significance at 5% level, and *** indicates significance at 1% level. Variables used are defined in Appendix 3A.

3.4.2 Predicting stock liquidity using Facebook

To investigate whether a firm's activities on Facebook and the attention it receives can impact stock liquidity, we estimate equation (4) for six different Facebook indicators. Estimation results presented in Table 3.6 indicate that social media activities and attention improve stock liquidity. Specifically, the results show that posts have a significant and positive association with stock liquidity ($\beta = -0.043$), indicating that an increase in posts increases stock liquidity. Public reaction measures; sentiments, likes, shares and comments have a significant positive association with liquidity. This implies that the higher the sentiments, the more liquid a stock is, and positive reactions are associated with higher liquidity. The performance of a firm's post on Facebook measured by the score has little influence on firm stock liquidity ($\beta = -0.001$). These findings suggest that social media improves stock liquidity and supports the negative relationship between stock liquidity and risk.[6] The results in Table 3.5 are consistent across different specifications, confirming the value of social media on stock liquidity. Overall, the

[6] The analysis in this study show that social media reduce idiosyncratic risk.

results suggest that stock prices contain social media sentiments; hence, managers can exploit social media to guide their decision-making and investments.

Table 3.5 Impact of social media on liquidity

Spread	Posts	Sentiments	Likes	Shares	Comments	Score
	(1)	(2)	(3)	(4)	(5)	(6)
Facebook	-0.043***	-0.021***	-0.021***	-0.026***	-0.039***	-0.001***
	(0.006)	(0.001)	(0.001)	(0.002)	(0.002)	(0.000)
Idiosyncratic risk	0.025***	0.023***	0.023***	0.023***	0.023***	0.022***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Volume	-0.010***	-0.010***	-0.010***	-0.010***	-0.010***	-0.010***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Excess return	0.051***	0.050***	0.050***	0.050***	0.050***	0.050***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Size	0.009***	0.009***	0.009***	0.009***	0.009***	0.009***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Market to book	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	59,570	59,552	59,570	59,570	59,570	59,570
R-squared	0.301	0.303	0.303	0.303	0.308	0.302

This table reports estimates of the regression of Facebook indicators on *Liquidity*. Columns 1- 6 show regression estimates for *Posts*, *Sentiments*, *Likes*, *Shares*, *Comments* and *Scores*, respectively. The OLS regressions include industry and year fixed effects. The standard errors are given in parenthesis. * denotes significance at the 10% level, ** indicates significance at 5% level, and *** indicates significance at 1% level. Variables used are defined in Appendix 3A.

3.4.3 The impact of Facebook post types

This section presents further analyses that scrutinise the main findings regarding the role of Facebook on the stock market performance of South African firms. Earlier evidence on public sentiments on the stock market suggests that stock markets prices react to published information (even when the information is irrelevant). Their reaction to information is determined by how the information is presented (Hirshleifer and Shumway, 2003). The analysis in Table 3.3 and Table 3.4 includes the various Facebook metrics, the signs of the coefficients are consistent across public reactions on Facebook. However, the impact of Facebook posts on firms' stock market performance is inconsistent. This study further explores whether some types of posts are more valuable than others. This also allows us to investigate whether a particular post type drives the surprisingly negative coefficients of posts to abnormal returns (and the positive impact on risk). We re-estimate equation (3.3) for both abnormal returns and firm risk, with Facebook variables represented by the various post types. Table 3.6 presents the results. Column 1-3, show results for abnormal returns, while column (4) to (6)

presents estimation results for firm risk. The results indicate that all post types are significant and positively associated with firm risk and significantly negatively impact abnormal returns, implying that no particular post type drives the results.

Table 3.6 Impact of post types on abnormal returns and idiosyncratic risk

	Abnormal returns			Idiosyncratic risk		
Idiosyncratic risk	Photo	Video	Link	Photo	Video	Link
	(1)	(2)	(3)	(4)	(5)	(6)
Facebook	-0.139***	-0.220***	-0.606***	0.235***	0.253***	0.821***
	(0.034)	(0.047)	(0.055)	(0.018)	(0.024)	(0.028)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	60,697	60,697	60,697	60,992	60,992	60,992
R-squared	0.071	0.071	0.072	0.204	0.203	0.214

This table reports estimates of the regression of Facebook indicators on *Abnormal returns* (columns 1-3) and idiosyncratic risk (columns 4-6). Columns. Columns (1) and (4) show regression estimates for *Photo* type of post, columns (2) and (5) show regression estimates for *Video* type of post, and columns (3) and (6) show regression estimates for *Link* type of post. The OLS regressions include industry and year fixed effects. The standard errors are given in parenthesis. * denotes significance at the 10% level, ** indicates significance at 5% level, and *** indicates significance at 1% level. Variables used are defined in Appendix 3A.

3.4.3 Heterogeneous impacts by size and risk

This section explores the heterogeneous impacts of social media on firm stock performance by dividing the sample by size and risk measures. Panel A of Table 3.7 presents the statistical test of the difference in coefficients of posts, sentiments and scores across small and large firms. Separating between large and small firms is essential because while larger firms are likely to make high levels of investment in social media, smaller firms are likely to be more interactive. Small firms are in a weaker information environment; their active participation on social media may play an essential informational role in reducing asymmetries (Aslan et al., 2011). Specifically, we estimate posts volume, sentiments, and the Facebook score. The score summarises public reactions to the Facebook post by measuring the overperformance of a post relative to a benchmark (which is the summary of the previous one hundred similar posts). The median size splits the sample. Panel A shows regression results for equation (3.4) for abnormal returns of small and large firms. The first two columns report the impact of number of posts. The average impact of posts on abnormal returns of small firms is about 2.5 times that for large firms and statistically different with a $p = 0.000$. The second two columns show the average impact of sentiments in small and large firms. Small firms are significantly more responsive to

changes in sentiments than large firms. The last two columns also show that small firms respond more to change in the overperformance score than large firms. These results are consistent with Gu and Kurov (2020), who find that Twitter sentiments predict returns of small firms more strongly than large firms.

Table 3.7 Heterogenous impacts by size

Panel A						
	Posts		Sentiments		Scores	
Abnormal returns	Small	Large	Small	Large	Small	Large
Facebook	-1.268***	-0.498***	0.151***	0.058***	0.006***	0.004***
	(0.069)	(0.058)	(0.016)	(0.014)	(0.001)	(0.001)
Equality test	*p=0.000*		*p=0.000*		*p=0.002*	
Observations	30,529	29,171	30,525	29,158	30,529	29,171
R-squared	0.382	0.347	0.381	0.349	0.383	0.346
Panel B						
	Posts		Sentiments		Scores	
Idiosyncratic risk	Small	Large	Small	Large	Small	Large
Facebook	1.391***	0.184***	-0.095***	0.027***	-0.009***	-0.002***
	(0.038)	(0.026)	(0.009)	(0.006)	(0.000)	(0.000)
Equality test	*p=0.000*		*p=0.000*		*p=0.002*	
Observations	31,458	29,513	31,455	29,497	31,458	29,513
R-squared	0.169	0.382	0.137	0.381	0.165	0.382
Panel C						
	Posts		Sentiments		Scores	
Liquidity	Small	Large	Small	Large	Small	Large
Facebook	-0.113***	0.044***	-0.016***	-0.018***	-0.001***	-0.000***
	(0.009)	(0.006)	(0.002)	(0.002)	(0.000)	(0.000)
Equality test	*p=0.000*		*p=0.662*		*p=0.000*	
Observations	30,529	29,171	30,525	29,158	30,529	29,171
R-squared	0.382	0.347	0.381	0.349	0.383	0.346

This table reports estimates of the regression of Facebook indicators on abnormal returns (Panel A), idiosyncratic risk (Panel B) and liquidity (Panel C). We split the sample into deciles based on the mean values of size, with the mean taken over the sample period. Small firms fall into the bottom five deciles and large firms fall into the top 5 deciles. Panel A shows regression estimates of *Posts, Sentiments* and *Scores* on abnormal returns. Columns (1) and (2) report the impact of *Posts* on small and large firms, respectively. Columns (3) and (4) report the impact of *Sentiments* on small and large firms, respectively. Columns (5) and (6) report the impact of *Scores* on small and large firms, respectively. Panel B shows regression estimates of *Posts, Sentiments* and *Scores* on idiosyncratic risk. Columns (1) and (2) report the impact of *Posts* on small and large firms, respectively. Columns (3) and (4) report the impact of *Sentiments* on small and large firms, respectively. Columns (5) and (6) report the impact of *Scores* on small and large firms, respectively. Panel C shows regression estimates of *Posts, Sentiments* and *Scores* on liquidity. Columns (1) and (2) report the impact of *Posts* on small and large firms, respectively. Columns (3) and (4) report the impact of *Sentiments* on small and large firms, respectively. Columns (5) and (6) report the impact of *Scores* on small and large firms, respectively. The OLS regressions include industry and year fixed effects. The standard errors are given in parenthesis. * denotes significance at the 10% level, ** indicates significance at 5% level, and *** indicates significance at 1% level. Variables used are defined in Appendix 3A.

Panel B shows regression results for equation 4 for the idiosyncratic risk of small and large firms. The first two columns report the impact of the number of posts. The average impact of posts on the idiosyncratic risk of small firms is significantly larger than that for large firms and statistically different with a $p = 0.000$. The second two columns show the average impact of sentiments in small and large firms. The negative coefficient of sentiments on idiosyncratic risk in the full sample is driven by small firms. The last two columns also show that small firms respond more to changes in the over-performance score than large firms.

Panel C reports the heterogeneous effects of social media on the stock liquidity of small *versus* large firms. The first two columns report the impact of posts on firm risk. The positive coefficient for posts is driven by small firms whose sensitivity is about 2.5 times that of large firms and statistically different with $p = 0.000$. There is no statistical difference between the impact of public sentiments on the liquidity of small firms versus large firms. The effect of the overperformance score on liquidity is minimal, with small firms being more sensitive than large firms. The coefficients are statistically different at $p - 0.000$. Overall, the results in Table 3.7 show that stock market indicators of small firms are more responsive to changes in the volume of Facebook posts, public sentiments, and Facebook score. Hence small firms can manipulate social media to gain competitiveness on the stock market and as a growth-enhancing strategy.

Table 3.8 presents the statistical test of differences in sensitivities of low risk and high risk firms to social media. Panel A shows the differential impact of selected Facebook indicators on abnormal returns. The effect of volume of posts on abnormal returns is more substantial for high-risk firms than their low-risk counterparts suggesting that the increase in the content compound a firm's exposure and reduces its stock market performance[7]. The sensitivities of high-risk and low-risk firms to the volume of Facebook posts are statistically different with $p = 0.000$. Public sentiments' impact on abnormal returns is positive for low-risk and high-risk firms, and there is no statistical difference in the sensitivities. The average elasticity of abnormal returns of high risk firms to the overperformance score is statistically different from, and eight times that of, low-risk firms. The overperformance score has no significant impact on the abnormal returns of low-risk firms.

Panel B shows results for stock liquidity. The first two columns show that increasing posts improves the stock liquidity of high risk firms more than it reduces the liquidity of low-risk firms. The elasticities are statistically different, with a p-value of 0.000. The average elasticity

[7] Earlier findings show positive association of posts and idiosyncratic risk.

to public sentiments for high risk firms is about four times that for low-risk firms and is statically significantly different with a p-value of 0.000. The last two columns present separate estimates for low risk and high risk firms' response to the performance of their Facebook posts. High-risk firms are significantly more responsive. The results in Table 9 show that, on average, high risk firms can benefit more from social media strategies than low-risk firms. Consistent with our previous findings in Table 3.5, which show that social media activities reduce firm-specific risk.

Table 3.8 Heterogeneous impacts by risk levels

Panel A						
	Posts		Sentiments		Scores	
Abnormal returns	Low risk	High risk	Low risk	High risk	Low risk	High risk
	(1)	(2)	(3)	(4)	(5)	(6)
Facebook	0.031	-1.145***	0.058***	0.086***	0.001	0.008***
	(0.044)	(0.070)	(0.009)	(0.020)	(0.000)	(0.001)
Equality test	*p=0.000*		*p=0.184*		*p=0.000*	
Observations	30,501	29,199	30,496	29,187	30,501	29,199
R-squared	0.642	0.334	0.642	0.342	0.642	0.337
Panel B						
	Posts		Sentiments		Scores	
Liquidity	Low risk	High risk	Low risk	High risk	Low risk	High risk
Facebook	0.013**	-0.056***	-0.001	-0.043***	-0.000**	-0.001***
	(0.006)	(0.008)	(0.001)	(0.002)	(0.000)	(0.000)
Equality test	*p=0.000*		*p=0.000*		*p=0.000*	
Observations	30,501	29,199	30,496	29,187	30,501	29,199
R-squared	0.642	0.334	0.642	0.342	0.642	0.337

This table reports estimates of the regression of Facebook indicators on abnormal returns (Panel A) and liquidity (Panel B). We split the sample into deciles based on the mean values of idiosyncratic risk, with the mean taken over the sample period. Low risk firms fall into the bottom five deciles and high risk firms fall into the top 5 deciles. Panel A shows regression estimates of *Posts, Sentiments* and *Scores* on abnormal returns. Columns (1) and (2) report the impact of *Posts* on low risk and high risk firms, respectively. Columns (3) and (4) report the impact of *Sentiments* on low risk and high risk firms, respectively. Columns (5) and (6) report the impact of *Scores* on low risk and high risk firms, respectively. Panel B shows regression estimates of *Posts, Sentiments* and *Scores* on liquidity. Columns (1) and (2) report the impact of *Posts* on low risk and high risk firms, respectively. Columns (3) and (4) report the impact of *Sentiments* on low risk and high risk firms, respectively. Columns (5) and (6) report the impact of *Scores* on low risk and high risk firms, respectively. The OLS regressions include industry and year fixed effects. The standard errors are given in parenthesis. * denotes significance at the 10% level, ** indicates significance at 5% level and *** indicates significance at 1% level. Variables used are defined in Appendix 3A.

3.5 Summary and conclusion

Social media has become one of the popular communication channels for investors and firms. Extant studies document the impact of social media in corporate finance. This study contributes to the literature by investigating the dynamics of the relationship between Facebook metrics

and firm stock market indicators. The study utilises firm-specific Facebook data accessed from Crowd Tangle merged with financial and stock data from Datastream and Yahoo Finance. Specifically, this study explores the impact of six Facebook indicators: posts, sentiments, likes, shares, comments, and the scores on firm abnormal returns, idiosyncratic risk, and stock liquidity.

Findings show that Facebook posts measured by the total number of firms' daily posts negatively impact stock performance as measured by abnormal returns and idiosyncratic risk. However, there is a positive association between the volume of posts and stock liquidity. The frequency of communication on social media increases a firm's exposure to the public. Although this may result in reputation and information risk[8], it increases the firm's popularity and consequently the rate at which its shares are bought. Facebook sentiments, public reactions (likes, shares and feedback) and performance scores are associated with higher abnormal returns, low risk and high liquidity. Further analyses show that these results are driven mainly by small firms and high risk firms, which exhibited greater elasticities to Facebook indicators.

This study has two implications. First, the study highlights the importance of public sentiments and engagement with the firm, contributing directly to firm performance. Potential investors may use public sentiments on Facebook to make investment decisions reflected in the firm's liquidity and abnormal returns and volatility. Second, our findings suggest that firms prone to information risk are more likely to benefit from the use of social media. The role of social media in reducing information asymmetry is particularly important for small firms. Information asymmetry limits access to external finance, increases reliance on internal financing, and limits firms' growth. South Africa is characterised by young and small firms; hence social media may play a critical role in the growth of these firms and, consequently, economic growth.

This study has several limitations. First, the social media content in our sample may vary depending on the posts. While most posts are likely to contain firm related information, some posts relate to specific events. The public reaction generated from such posts are not firm related and may be attributed to the public interest in the particular event and not the firm. This analysis does not control for such events. Future research could control for trending events such as political events, outbreaks/pandemics or even festival celebrations[9]. Second, the

[8] Firms can control the type of information they post on Facebook to manage reputation and information risk.
[9] For example a 'Happy holidays' message from any firm could attract many likes and comments.

research design does not comprehensively assess causality. Natural experiments in future research could address that.

Third, processing social media information to make it comparable to financial information is time-consuming and complex; more efficient procedures would allow for data processing and analysis in real time. Finally, the generalisability of results could be extended to industry-level analyses. While this excludes media companies, there are still companies that tend to generate more media content than others due to the structure of their operations. Luo, Zhang and Duan (2013) give an example of computer hardware and software firms that constantly introduce new products with shorter life cycles. There are also industries whose operations do not prioritise information dissemination. Future research could explore the influence of social media in specific industries.

Chapter 4. The board and firm social media decisions

4.1 Introduction and motivation

The apparent benefits of social media are grounded in knowledge and information sharing. Social media adoption enables cost savings, mitigate risk and generate financial returns. According to Bhimani, Mention and Barlatier (2019), effective use of social media achieves various benefits for the firm through enabling conversations between companies and their clients, business networking or connectivity and giving a platform for free expression. Indeed social media is becoming increasingly important for firms, allowing internal departments to engage with external ecosystems to integrate and develop knowledge (Ritala and Hurmelinna-Laukkanen, 2013) and increasing firm visibility (Leonardi and Treem, 2012). In addition, social media has been shaping organisational activities, increasing firm competitive strategy and enable the collection of data for policymaking (Leonardi and Treem, 2012; Gil-Garcia, Helbig and Ojo, 2014). It also plays a crucial role in firm growth through supporting innovation projects, particularly new product innovations (see Tajeddini, Trueman and Larsen, 2006; Rosenbusch, Brinckmann and Bausch, 2011; Marion, Barczak and Hultink, 2014; Roberts, Piller and Lüttgens, 2016).

Social media adoption by firms is a strategic decision that requires the approval of the executives and the board. Like all technology-related platforms, social media evolves quickly and is highly interactive; hence firms require digital resources to guide social media practices. Firms also need to be careful and strategic when approaching social media to ensure maximum value appropriation with minimal risks. The creation and extraction of value are central to strategic management. Top managers are responsible for building an intrapreneurial culture that empowers stakeholders and encourages social media tools. Hence, the decision to adopt social media depends on the board of directors and is contingent on the availability of resources and firm characteristics.

Literature in corporate finance and corporate governance, which attribute the type and quality of corporate decisions and firm performance to various board characteristics, report mixed results. For example, Donkers, Melenberg and Van Soest (2001) and Urquhart and Zhang (2021) attribute higher firm performance to higher educational achievements of directors and CEOs. However, Falato, Li and Milbourn (2015) argue that forms of education do not have a homogeneous impact on firm performance. Instead, firms pay a premium for executives with higher education qualifications. Concerning board size, Cheng (2008) suggests that larger boards are associated with low variability of corporate performance because of the time it takes

to reach consensus among a large group of directors. Therefore, decisions from larger boards are less extreme. In contrast, De Andres and Vallelado (2008) suggests that more board members allow for effective manager supervision and reduce agency conflicts. Gender and age of directors also play a critical role in corporate performance as they indicate the various masculinity and emotional traits (Jia, Lent and Zeng, 2014), confidence or overconfidence (Chen et al., 2019) and experience (Li and Patel, 2019) that determine the quality of board decisions.

Despite the well-documented benefits of social media, many firms worldwide are yet to integrate social media into their business operations. In the case of South Africa, only less than 50% of public firms have active social media accounts. Accordingly, this study empirically investigates the link between the board of directors and firm social media adoption. Extant studies report a significant impact of directors characteristics on firms likelihood of adopting external corporate practices (see Stiles, 2001; Ruigrok, Peck and Keller, 2006; Shropshire, 2010). Specifically, the present study explores the impact of the age and the gender of directors and Chief Executive Officers (CEOs) on the likelihood of South African firms adopting social media. The South African context provides an interesting setting to examine the determinants of social media adoption. First, the market is characterised by small and medium-sized firms that could benefit from social media (Aslan et al., 2011). Second, South Africa and other emerging markets firms face challenges in competing in dynamic markets. They are limited by institutional voids, making them incapable of competing with counterparts from developed economies. Creating knowledge will be a key source of competitive advantage for such firms (Story, Boso and Cadogan, 2015).

This study is dually motivated by the benefits of social media documented in the previous chapter on firm liquidity and the limited focus from the literature on the role of directors in South African firms. Studies of the impact of board characteristics on corporate decisions in South Africa mainly focus on compensation (Lemma, Mlilo and Gwatidzo, 2020), firm value (Gyapong, Monem and Hu, 2016), corporate governance practices (Mangena and Chamisa, 2008) and profitability (Mordant and Muller, 2003). This study differs from the above-cited studies through its focus on social media adoption by firms, and second the moderating role of financial resources and risk. The research adds new perspectives to literature since, from the best of my knowledge, there is no previous evidence of the role of board characteristics on social media decisions.

The study investigates the relationship between directors' age and gender, CEO age and gender on the probability of adopting social media. The study is based on a sample of 175 JSE listed firms from 2010 to 2020. Further, the study investigates the interaction role of cash holdings and firm risk on the defined relationship. Evidence documented in this study supports the impact of director characteristics on firms' social media decisions. Logistic regression is used to estimate the social media adoption model to determine the individual impacts of board age, board gender, CEO age and CEO gender. The results show that average board age and CEO age have a negative and significant effect on the likelihood of firms adopting social media. At the same time, the proportion of female directors has a significant and positive impact on the likelihood of adopting social media. However, CEO gender does not show a statistically significant impact in logistic regressions for the sample firms. Further, the study investigates the impact of directors' and CEOs characteristics on firm social media activities. Using the Heckman selection model, results show that the average age of directors is associated with fewer social media posts and less positive sentiments. Whereas, the proportion of female directors is associated with more social media posts and more positive sentiments. CEO characteristics do not exhibit a significant impact on firm social activities.

Finally, the study investigates whether the relationship between director characteristics and firm social media decisions is contingent on financial resources and business risk. Literature on the role of directors in corporate finance suggests that a contingency approach to the role of directors provide a valuable perspective to increase understanding and reconcile inconclusive results (Garengo and Bititci, 2007; Zona, Zattoni and Minichilli, 2013; Sánchez, Guerrero-Villegas and González, 2017). The results show no significant influence of cash holdings and firm risk on the link between directors' age and CEO characteristics and the likelihood to adopt social media. However, both risk and cash holdings significantly moderate the relationship between the proportion of female directors and the probability that a firm adopts social media. Overall, this study suggests that firms need to appoint board structures that align with their organisational goals.

The study makes several contributions to literature and practice. First, the discussion in the literature section unearths the value of social media in the innovation process and further links social media to the age and gender of directors. Further, the discussion provides an analysis of the channels through which firms may enhance innovation using social media and the process through which firms can capture value from social media. The discussion and the findings

define the role of company directors beyond financing decisions. Second, the study adds to and expand existing literature on board characteristics and organisational outcomes. Few studies evaluate the role of directors on the social media activity of firms. This research is the first to evaluate the role of the board of directors in the social media adoption process. It also provides a guideline of appropriate board structure for innovation-oriented firms that seek to implement and achieve maximum benefit from social media use. Further, the study explores the role of finance and firm risk in social media decisions, giving insight into the effect of board characteristics from a contingency perspective. The role of finance in these decisions remain unexplored. The results of this study show practical usefulness for investors and policymakers.

The rest of this study is organised as follows. Section 4.2 presents the literature review and hypothesis development. Section 4.3 describes the data, variables and methodology used. Section 4.4 presents and discuss the empirical findings. Finally, section 4.5 summarises and concludes the study.

4.2 Related literature and hypothesis development

This section reviews prior research on the corporate value of social media, directors' role, and the moderating role of cash holdings and risk. The section also highlights the contribution of this study.

4.2.1 Theoretical framework

Social media allows firms to interact with clients, which are considered a fundamental source of knowledge information required for innovation and growth. This study borrows from several theories which give a foundation of the value of social media in firms and the role of boards of directors. First, the stakeholder theory suggests that firms can derive value from social media during the innovation process. The innovation process is an interactive relationship between firms and clients, and other stakeholders (Laursen and Salter, 2006; Sofka and Grimpe, 2010). Hence, firms utilise social media to distribute corporate information and advertising and test the innovations by including consumers in the innovation stages, such as surveys and customer feedback. In doing that, firms benefit from unique sources of knowledge. The human agency concept of the stakeholder theory brings in the role of managers and executives in the process. Managers who, in this case, represent the human agency of the firm have a responsibility not only to shareholders but also to consumers and other stakeholders. Hence social media allows the interaction of this human agency of the firm and consumers. According to Martini, Massa and Testa (2013), social media is the material agency that allows for the interaction between

the human agency of the firm and the consumers. In the context of this theory, the current study investigates the extent to which the human agency determine the existence and or adoption of material agency. Specifically, the study focuses on whether directors consider the importance of social media.

Adopting social media is an innovation activity that requires the buy-in of executives and the board. Literature links the role of boards in corporate finance to the agency theory. The agency theory suggests that self-serving executives reduce investments in innovation activities at the expense of shareholder value (Jensen and Smith, 2000). Because innovation projects are high risk, long term, and have uncertain returns, they are vulnerable to managerial opportunism or disinterest. Managers are also less interested in long term outcomes as these may be realised beyond their tenure. Social media is a different form of investment where firms have to consider the trade-off between the costs *versus* the benefits of adopting social media. While the costs of social media are apparent to the firm, the returns are uncertain. Firms have to decide between costs of acquiring technology and social media expertise, the increased reputation risk resulting from more exposed communication and disclosure reaching a wide range of people with the perceived benefits of reducing information asymmetry. The agency theory also suggests that managers are risk averse while shareholders are risk neutral. Shareholders can manage risk by diversifying their investments across firms, whereas for managers, career and reputation will be at stake. Without effective monitoring by the board, firms are likely to restrict investments to levels below what shareholders would prefer. The board's effectiveness in monitoring and mitigating these agency problems depends on the quality of directors sitting on the board (Jensen and Smith, 2000).

4.2.2 The corporate value of social media

This study aims to determine the effect of directors' characteristics on the likelihood that a firm adopts social media. This section takes a detour from the role of directors and discusses the benefits of social media to firms. For directors to support firms' decision to adopt social media, they have to understand the values and benefits firms can extract from social media. There are several channels through which social media brings value to the firm. This study focuses on the importance of social media in information dissemination and collection. Social media synthesise with the idea of open innovation where information networks allow for effective innovation; the inflow and outflow of information accelerate innovation activities and expand markets for new products (Hitchen et al., 2017). These information networks are more

important in smaller and medium-sized firms in launching into the market. Building on this idea, Parida, Westerberg and Frishammar (2012) test the impact of firm ICT and network capability and financial slack on small firms' innovation using survey data from Swedish technology-based firms. They report a marginal influence of firm ICT capability and financial slack on innovation. ICT capabilities enable firms to access external resources and information.

The connection between social media and firm growth stems from the positive relationship between information /knowledge flows and innovativeness (Lasagni, 2012; West and Bogers, 2014; de Zubielqui, Fryges and Jones, 2019). Social media broadcast all events in real time; every event assumes relevance, no matter how minor it might be. Firms can broadcast marketing initiatives, new product features and professional figures on social media and explain and contextualise the facts. Hence social media contributes to giving some sense of the firms' choices and involving consumers. The propensity of social media towards communication also makes it an ideal source of information[10] that can be used to ensure the success of innovation activities. The increase in innovation results in increased performance, particularly for firms with low levels of innovation (Martini, Massa and Testa, 2013; Muninger, Hammedi and Mahr, 2019)

Social networks characterise innovation. Firms' ability to network determine the extent to which they can establish unique knowledge through interacting and collaborating with stakeholders. The networking capabilities are based on the company's resources available, such as its ICT infrastructure. Various capabilities are required for the firm to extract the value of social media in the innovation process. Gathering information from social media is a complex and costly process. So most firms use technologies to support customer interaction through social media (Kazadi, Lievens and Mahr, 2016). These capabilities also determine how firms acquire and apply knowledge and, consequently, innovation outcomes. Experience is also a key factor as it facilitates optimal learning behaviour and organisational routines important in supporting the development and dissemination of ideas (Nguyen et al., 2015).

Commerce activities that are focused on information sharing and competitive advantage can occur on social media. Through social media, firms can seek information from diverse groups of people (Peña, 2012). Several studies suggest that social media allows commerce activities

[10] Information from social media can be collected through surveys or reading through the feedback of clients on the firm's social media pages or trending hashtags involving the firm. Please see (Muninger, Hammedi and Mahr, 2019) for more information on the importance of feedback in the innovation process.

because it enables information sharing and allows companies to build a competitive advantage and demonstrate strategic capability (Nguyen et al., 2015; Lin, Li and Wang, 2017). Social media reduces information asymmetry by allowing information and knowledge to flow from within and outside the organisation and networking between businesses and their clients (Simula, Töllinen and Karjaluoto, 2013; Marion, Barczak and Hultink, 2014).

Roberts and Piller (2016) surveyed the use of social media for innovation by major brands across the world. The survey data showed that 82% of the surveyed firms employed social media at one stage in their innovation process, but only 14.7% of the firms had used social media in at least half of their projects. This is surprising given the well documented value of social media in enhancing the innovation process. Besides being aware of the benefits of social media, firms may be more aware of the costs of adopting social media than they are aware of the means to extract value. Hence, they are hesitant to adopt social media. Muninger, Hammedi and Mahr (2019) introduced a three-stage maturity model that allows firms to test their social media use and provide a set of capabilities required to achieve the tasks. The model suggests that there are three types of firms. The first group of firms are 'explorers' who are aware of the potential benefit of social media but are not confident enough to extract it. Hence, they do not channel substantial investment to social media since they do not have confidence in the returns. They termed the second group of firms 'gold diggers'. These are firms that understand the value of social media and work towards leveraging it by gradually increasing resource allocation towards social media, they continuously evaluate and adjust their approach to social media. The third group of firms, 'trailblazers', exhibit a high level of maturity in their social media approach. They approach social media at the strategic level. These are older, resourceful firms with greater competencies and flexible processes. Managers can use the maturity model for self-assessments which will help them to prioritise investments.

Both firm level and product level innovativeness rely on social media. There are several internal and external objectives that firms seek to achieve through social media. Social media is valuable for technical organisation and process innovation (Bhimani, Mention and Barlatier, 2019). When firms cannot find expertise outside their firms, they rely on internal resources. This is the case with most high-tech companies. However, less advanced companies (technological) rely on both internal and external media throughout the innovation process. Social media tools can drive the innovation process by providing an intermediary platform and enabling the firms to gain access to new clients and knowledge (DeNardis and Hackl, 2015).

4.2.3 Role of Directors

The board of directors is the supreme body of an organisation's governance system. It is responsible for resolving agency issues between managers and shareholders (Fama and Jensen, 1983). In addition, board of directors oversee the actions of managers, monitor and guide corporate strategy and risk policy (OECD, 2004). The relationship between board characteristics and corporate finance decisions has been widely discussed in the literature (see, for instance, (Ullah and Kamal, 2017; Ghosh and Ansari, 2018; Atif, Liu and Huang, 2019). However, the extant studies provide mixed evidence on the impact of age and gender on various organisational outcomes.

One of the most critical roles of the board relevant for this study is risk oversight. Directors ensure the balance between shareholder concerns and management incentives by integrating governance issues that determine the quality of decisions that benefit the company's investment and growth. Effective corporate governance supports effective risk management and ensures flexibility in responding to contingencies and in taking advantage of opportunities. In addition, the organisation sets oversight for company directors to manage risks, reduces losses and maintain shareholder value (Armeanu et al., 2017). The effectiveness of the board in carrying out the risk oversight function depends on the quality of directors sitting on the board. Berger, Kick and Schaeck (2014) suggest that female directors are associated with poor decisions and higher business risk. The association is attributed to lower skills compared to male directors. Contrariwise, Croson and Gneezy (2009) suggest that male directors have a higher risk tolerance as they consider risky projects as challenges to be pursued. Literature suggests that a firm's risk tolerance depends on the age of the directors and CEO of the firm. However, there is no consensus as to whether older directors are more or less risk tolerant. While some studies suggest that older directors and older CEOs are more conservative in risk taking (see, for instance, Barker III and Mueller, 2002; Serfling, 2014), there is a contrasting group of literature that report a positive impact of age on risk taking behaviour (see; Holmström, 1999; Bucciol and Miniaci, 2011).

Ferrero-Ferrero, Fernández-Izquierdo and Muñoz-Torres (2012) compare the association between board characteristics, capital structure and corporate risk taking in different macroeconomic contexts. They show that the presence of macroeconomic shocks alter the association between board characteristics and corporate performance. Further, the authors find no support for a positive impact of good corporate governance practices on corporate

performance during the global financial crisis suggesting that an uncertain and risky economic environment can attenuate the positive effects of certain board characteristics on organisational outcomes. The effectiveness of the board is contingent upon the operating environment and the ability of firms to reduce the levels of corporate risk when macroeconomic risk is very high. Corporate governance mechanisms can be used to mitigate excessive firm risk taking and preserve shareholder wealth during periods of macroeconomic uncertainty.

Directors' characteristics have received attention as an indicator of the quality of corporate governance for firms. A significant body of literature considers governance measures that consider different provisions into an index (Gompers, Ishii and Metrick, 2003; Bebchuk, Cohen and Ferrell, 2009). This approach was criticised by Bhagat and Bolton (2008). They suggest that including different provisions in an index for overall good governance without applying an appropriate weighting system for the variables may result in distorted measures. Considering this, the present study considers a 'single mechanism' approach to measuring the impact of directors. Hence, this study employs individual characteristics of the board of directors.

The business claim is that firms need to adopt social media to provide their clients with a platform to interact and participate in firm activities. Social media adoption requires endorsement by top management. Their role is to ensure that the firms have enough operational and strategic social media teams required to handle everyday social media activities. These daily interactions on social media platforms generate large volumes of data useful for innovation, investment activities and firm growth. Executives are also responsible for acquiring digital infrastructure, budget allocation and hire skilled social media staff. However, there are behavioural and organisational barriers that prevent firms from adopting social media. Some of the challenges identified by literature include financial resources, technology, and security concerns. This study focuses on the impact of the CEO and directors' age and gender on the likelihood of firms adopting social media and the interactional role of cash holdings and risk on the association.

4.2.4 Hypotheses development

The organisational learning theory suggests that older executives are more competent in handling business as they benefit from years of life and work experience. Their age reflects the experience, motivation, and cognition that affect decision-making (Xu, Zhang and Chen, 2018). Therefore, the theory predicts a positive impact of age on corporate performance. Several studies align with this theory. For example, Cheng, Chan and Leung (2010), using a

sample of Chinese listed firms, report a positive relationship between chairman's age and corporate performance. Similarly, Holmström (1999) suggests that older board managers are less risk averse as they have well-built careers and are not worried about mistakes. In contrast, younger directors who do not have a reputation are more concerned with career development and want to avoid any activities that taint their reputation and diminish career opportunities. Hence, younger board members are expected to be more risk averse.

Contrary to the organisational learning theory, several empirical studies report a negative impact of age and corporate performance. For example, Hambrick and Mason (1984) show that younger executives are interested in progression, whereas older executives are more focused on career stability. This implies that older directors are more careful in their decision making and less likely to adopt risky initiatives. In a similar study, Tsui and O'reilly III (1989) investigate the effects of executives demographics on the performance ratings of executives. They find that older directors are not only rated less than younger executives but are also less liked by their subordinates.

Further, Barker III and Mueller (2002) investigate the impact of CEO characteristics on firm research and development spending. The study shows that younger CEOs are more likely to engage in risky projects and have higher research and development spending. The conservative nature of older CEOs in research and development spending may be attributed to what Chown (1960) termed 'reduced ability to grasp new ideas'. The above discussion suggests that older directors are less likely to be interested in social media adoption given the uncertain returns and the high costs involved (Bucciol and Miniaci, 2011). Serfling (2014) further report a negative relationship between the age of the CEO and the riskiness of corporate policies implying that the risk tolerance of CEOs declines with age. Hence, the following hypotheses are formulated.

Hypothesis 1: Average board age is negatively related to the likelihood of adopting social media.

Hypothesis 2: CEO age is negatively related to the likelihood of adopting social media.

Literature in corporate finance suggests that directors' quality of decisions depends on the extent to which they take risks; that is, the decisions are a product of the risk taking ability of the directors). The effect of female directors on the likelihood of firms adopting social media can be explained from two strands of literature. The first group of studies that focus on risk

taking behaviour have been consistent on the risk avoidance nature of female executives and directors. Extant studies demonstrate the systematic differences in risk taking and competitiveness across gender. Most studies report that females are less likely to self-select into competitive environments and risk environments (Byrnes, Miller and Schafer, 1999; Beckmann and Menkhoff, 2008; Weber and Zulehner, 2010). Risk averse managers are less likely to pursue new unverified investments, especially when the returns are unknown and the projects are long term. Men are reportedly overconfident than women; hence tend to invest too much (Bengtsson, Persson and Willenhag, 2005). On the other hand, female directors have lower confidence than their male counterparts and tend to avoid risk. As a result, their investments perform better (realise higher returns) as they select their investments more carefully(Byrnes, Miller and Schafer, 1999; Beckmann and Menkhoff, 2008). Even though women are risk averse in their approach, they are less prone to incurring losses from overconfidence and overreaction. More often, they invest for income rather than growth objectives (Jaiswal and Kamil, 2012). The difference in risk taking behaviour between male and female directors is a function of knowledge disparities and should contribute to diverse points of view and encourage innovativeness.

The second group of literature, which focus on board diversity, document the beneficial impacts of women involvement in leadership positions of firms. Studies show that women bring new ideas, engage in superior information search and creativity (Burgess and Tharenou, 2002; Hillman, Shropshire and Cannella Jr, 2007). A more recent study by Bednar, Gicheva and Link (2021) investigates the impact of gender on firms' innovative performance resulting from research-funded projects. Results show that projects led by female principal investigators have a higher chance of being commercialised. In a study of Austrian start-up firms, Weber and Zulehner (2014) find that firms with a low share of female employees compared to the industry average are likely to fail or have shorter survival rates. This implies that women were more effective in handling innovative projects. In the context of engagement, Kuhn and Villeval (2015) show that women are more inclined to cooperate than men. They are more concerned with stakeholder benefit and tend to make decisions that are stakeholder oriented. Social media platforms encourage this cooperation through client value perceptions that influences feedback and collaboration (Carlson et al., 2018). Hence, female directors are more likely to be interested in social media adoption than their male counterparts. Ughetto et al. (2019) further suggest that women executives are more likely to benefit from social media than their male counterparts because social media provides surprising and equal opportunities for

them to engage without cultural boundaries limiting their impact. Given the above discussion the following hypotheses are formulated.

Hypothesis 3: The proportion of female directors is negatively related to the likelihood of adopting social media.

Hypothesis 4: Female CEOs increase the firm's likelihood of adopting social media.

Finance is at the centre of innovation; the decision to spend and raise capital fund innovation capacities is done at the firm level (Story, Boso and Cadogan, 2015). Social media adoption is a costly investment that requires a substantial amount of resources. It can overstretch budgets, and its effective adoption relies on the synergy of firm capital, financial and human resources. (Rosenbusch, Brinckmann and Bausch, 2011). The amount of resources firms devote to social media activities vary on their cost structure and access to financial resources. Every stage in the social media adoption process requires a different set of capital and human resources. Availability of finance minimises specific bureaucratic processes that may discourage investment in social media (more especially if social media investments are uncertain and not guaranteed). The intuition then is that higher cash increase the likelihood of firms to join social media.

Lyandres and Palazzo (2016) suggest that internal cash holdings are essential for financing innovations. Hence, innovative firms tend to maintain higher cash reserves. Moreover, in a risk environment, as projects uncertainty increases, internal cash holdings increase the likelihood of firms adopting and developing innovations. In the case of South African firms, where many of the firms rely on bank financing (see Gwatidzo and Ojah, 2014), internal cash holdings provide a better source of financing. However, due to the uncertain nature of returns from social media investments, lenders are less interested in funding firms to adopt social media; hence they increase interest rates, reduce loan amounts and shorten maturities (Ojah and Pillay, 2009; Sorge, Zhang and Koufopoulos, 2017), which is not ideal for long term social media investments that require substantial capital outlay.

Looking at social media adoption as an innovation practice, literature on the direct impact of access to financial resources on innovation provide mixed evidence. On the one hand, some studies suggest that firms with greater access to financial resources are more innovative (Hoegl, Gibbert and Mazursky, 2008; Story, Boso and Cadogan, 2015). In the context of social media adoption, these firms can acquire ICT equipment and hire the expertise that enables them to

extract value from social media. Hence are more likely to adopt social media. On the other hand, a group of studies report a positive association between financial constraints and successful innovation practices (Kamien and Schwartz, 1978; Damanpour, 1991). Hence, variations in financial constraints are expected to result in differences in social media adoption. Thus, it is reasonable to expect differences between high cash and low cash firms. Accordingly, it is hypothesised as follows:

Hypothesis 5: There is a significant interaction of firm cash holdings on the relationship between directors and the likelihood of adopting social media.

One most expected utility of social media adoption is that social media use can reduce uncertainty by reducing information asymmetry (Nguyen et al., 2015). To gain global competitiveness, firms take advantage of institutional conditions in their respective countries in their approach. While developed markets are more connected informationally, developing markets can use social media to increase their information capacity. Firms can use social media to forecast prices (De et al., 2014), predict risks (Sprenger et al., 2014; Fan, Talavera and Tran, 2020) and communicate corporate information. The intuition hence is that high risk firms are more likely to benefit from social media use. Therefore a higher probability of adopting social media is expected among high risk firms. But social media adoption brings its own associated risks which include reputation risk and security risk. Social media adoption can increase returns but the uncertainty can result in reduced firm performance due to overstretched resources. Effective social media use requires that it is integrated into firm operations. However, this could be risky, as He and Wong (2004) suggest that failure of new projects incorporated in existing operations can be disruptive. There is a risk of firms overextending themselves without paying attention to the moderating effects of internal business risk. Hence, firms have to consider both the strategic, financial and precautionary effects of adopting social media.

Hypothesis 6: There is a significant interaction of firm risk on the relationship between directors and the likelihood of adopting social media.

4.3 Data, variables and methodology

This section presents the data, variables and methodology employed in this study.

4.3.1 Data and sample selection

The study focuses on South African listed on the JSE to ensure access to financial data for the study. The sampling period 2010 to 2020 is selected based on the availability of social media

information of firms. Although Facebook was created in 2004, it only became popular for companies in later years. To identify the sample firms, the study followed three steps. First, the study considers JSE listed firms that have adopted social media during the sample period 2010 to 2020. The firms were identified through a manual search of all JSE listed firms on Facebook to collect their Facebook ids. A total of 172 firms were identified and included in the sample as firms with social media presence for at least one year over the sample period. Then we proceeded to create a list of JSE firms that do not have a Facebook presence during the sample period.

Next, we collect the directors' information of JSE listed firms from Boardex. Boardex stores information of directors and executive managers of public listed firms and major private entities, mainly in the US, Europe and some emerging economies. Boardex provides information on personal and professional details and academic qualifications of directors and information on board structures. For the case of South Africa, Boardex contains information for JSE listed firms from the period 2004. For the purposes of this study, we collect information on the age and gender of directors and CEOs and the total number of directors sitting on a board for a given year.

Finally, the study merges directors' information from Boardex and information on Facebook adoption to financial data. Financial data is obtained from Worldscope through Datastream. The Worldscope database provides financial and profile data on public companies, and it takes into account a variety of accounting conventions which makes it suitable to use for comparisons across firms, industries and countries. Worldscope is the preferred source of financial data because of its wide coverage of listed firms (Ulbricht and Weiner, 2005). Firms with no board information were excluded from the merged sample.

Additional filters were applied to the data following standard practice in corporate finance literature. First, financial and utility firms were excluded from the sample. Utility and financial firms are governed by special regulations that affect their corporate finance decisions. Serfling (2014) applied the same approach. Second, all observations with missing director information are dropped from the sample. Third, all financial variables are winsorised at the upper 99% and lower 1% (Bloom, Bond and Van Reenen, 2007). The final sample, consisting of 984 firm-year observations, is an unbalanced panel where each firm contributes at least two years of observations. Appendix 4A presents the variables used in this study and their definitions.

4.3.2 Variables and measures

Dependent variable

The main dependent variable in this study, *Facebook*, indicates whether a firm has adopted social media or not. It is operationalised as a dummy variable coded 1 if the firm adopts Facebook and 0 otherwise. The study considers Facebook participation as a proxy for social media because it is the most popular social media platform in South Africa (apart from WhatsApp and YouTube) with a penetration rate of 86.7% by 2020 compared to Instagram, Twitter and LinkedIn with just 70.2%, 59.2% and 49% respectively (BussinessTech, 2021; Statista, 2021). Also, Ornico and World Wide Wox (2021) report that 65.8% of firms spend most of their advertising budget on Facebook, whereas 18% spend on LinkedIn and 5.4% on Twitter. The additional analysis explores the role of directors on the social media activities of firms. Specifically, the study explores the impact of directors on Facebook Posts and Facebook Sentiments. Facebook Posts measure the total number of a firm's posts. Facebook sentiments on a firm's posts are measured by the difference between total daily positive reactions (Likes, Love, Wow and Care) and negative reactions (Angry and Sad) to a firm's posts.

Independent variables

This study has four independent variables: directors age, the proportion of female directors on the board, CEO age, and the CEO gender. The data used to construct the variables is collected from Boardex. Following the literature in corporate finance, the age of directors is determined by calculating the average age of all directors sitting on a company board in a given year (Wiersema and Bantel, 1992; Xu, Zhang and Chen, 2018). The proportion of female directors is measured as the total number of female directors sitting on a board each year, scaled by the total number of directors. CEO age refers to the age of the chief executive officer of the company, and the CEO gender is an indicator variable that equals 1 if the company's CEO is female and 0 otherwise. For further analyses, additional dummies are generated to indicate the change in CEO and the change to younger CEO and to older CEO.

Control variables

Adoption of social media by firms might be contingent upon certain firm characteristics and operating conditions. The study includes several control variables to minimise omitted variable bias. Based on previous literature, the study controls for firm size, profitability, risk and growth opportunities. Literature suggests that larger companies tend to have more efficient processes

and greater financial resources, and they do not depend on single individuals for technical/operational capabilities. They are likely to make social media integration a business priority (Ketchen Jr, Ireland and Snow, 2007; Teece, 2012). Hence, a positive impact of size is expected. Appendix 4A presents the variables definitions and sources. Further analyses in this study explore the role of directors on the likelihood of firms adopting social media contingent on the availability of financial resources and firm-specific risk. Cash is used to proxy the availability of immediate financial resources to fund social media activities, and sales volatility indicates firm specific risk.

4.3.3 Summary statistics

Table 4.1 reports the descriptive statistics, means, standard deviations, minimum, maximum, median, 25th and 75th percentile for the dependent variable, the likelihood of firms adopting social media, and for the independent and control variables. The first three rows show the summary statistics of the dependent variables used in this study. The mean probability of firms adopting social media (*Facebook*) in the sample firms is 34%, and the standard deviation is 47%. *Facebook Posts* and *Facebook Sentiments* have fewer observations as they only relate to firms that have adopted social media during the sample period.

Table 4.1 Summary statistics

	Obs	Mean	Stdev	Min	P25	P50	P75	Max
Facebook	1180	0.3398	0.4739	0.0000	0.0000	0.0000	1.0000	1.0000
Facebook Posts	401	5.0913	5.6285	0.0000	0.0000	2.8904	10.4674	16.1626
Facebook Sentiments	401	8.2553	3.1713	0.0000	6.3544	8.4762	10.4883	14.4632
Directors Age	1180	60.18	5.4120	42.54	56.71	60.46	63.75	78.00
Female Directors	1180	0.2033	0.1236	0.0000	0.1250	0.2000	0.2860	0.7000
CEO Age	1180	59.53	8.1029	33.00	54.00	60.00	64.00	89.00
CEO Gender	1180	0.0873	0.2824	0.0000	0.0000	0.0000	0.0000	1.0000
Size	1180	15.8934	1.5974	11.7581	14.7757	15.9759	17.0183	20.2895
Return on Assets	1175	0.0957	0.1142	-0.4125	0.0539	0.0958	0.1434	0.9210
Growth	1177	2.2104	2.2534	0.0214	0.8630	1.4208	2.6234	17.8125
Cash	1180	0.1059	0.0920	0.0001	0.0393	0.0820	0.1421	0.4977
Firm Risk	1180	0.6572	0.6747	0.0055	0.2236	0.4661	0.8027	3.9623

This table presents the number of observations (N), mean, standard deviation, median, 25th and 75th percentile for managerial and financial characteristics used in this study. All variables used are defined in Appendix 4A. Financial variables are winsorised at the lower 1st and upper 99th percentile. The sample consists of 175 South African firms listed on the JSE. All variables used are defined in Appendix 4A.

The next four rows summarise the director characteristics used in this study. The average age of directors in the sample firms is 60. Given that the retirement age in South Africa is 60 years, this implies that, on average, the boards of South African firms comprise of older directors.

The same applies to the average age of the CEOs in the sample under study. The CEO ages in the sample firms are skewed to the left, the median age is 60 years while the minimum is 33 years. The standard deviation is large at 8.1. On average, the sample firms show that there are fewer female CEOs and fewer female directors.

The next five rows show the statistics of the control variables and contingencies. The average firm in the sample has a size, measured as the logarithm of total assets, of 15.9, whereas the median firm has a size of 16. The means for the return on assets and firm growth are relatively standard, and the variables vary considerably. The means (median) for cash holdings and firm risk 0.1 (0.08) and 0.66 (0.47), respectively.

Table 4.2 Correlations

	1	2	3	4	5	6
1. Facebook	1					
2. Directors Age	-0.1513	1				
3. Female Directors	0.1669	-0.2699	1			
4. CEO Age	-0.0554	0.5999	-0.1522	1		
5. Female CEO	0.0134	-0.1241	0.2173	-0.1866	1	
6. Size	0.1870	0.0911	0.2006	0.0917	0.0043	1
7. Return on Assets	0.1033	0.0540	0.0579	-0.0039	-0.0104	-0.0026
8. Growth	0.2868	0.0967	0.0635	0.0812	-0.0127	0.0851
9. Cash	-0.0617	0.1011	-0.0151	0.0615	0.0332	-0.2445
10. Firm risk	0.0803	0.1325	-0.0515	0.0922	-0.0211	-0.0842

This table presents the correlations for managerial and financial characteristics used in this study. Data is measured as of fiscal year ends. Financial variables are winsorised at the lower 1st and upper 99th percentile. The sample consists of 175 South African firms listed on the JSE. All variables used are defined in Appendix 4A.

Correlations (continued)

	7	8	9	10
7. Return on Assets	1			
8. Growth	0.4732	1		
9. Cash	0.1500	0.0327	1	
10. Firm risk	0.0485	0.2733	0.0430	1

This table presents the correlations for managerial and financial characteristics used in this study. Data is measured as of fiscal year ends. Financial variables are winsorised at the lower 1st and upper 99th percentile. The sample consists of 175 South African firms listed on the JSE. All variables used are defined in Appendix 4A.

Table 4.2 provide the correlations statistics of the variables used in this study. The correlations suggest a negative relationship between the directors' and CEO age and the likelihood of adopting social media. The *Female Directors* and *Female CEO* variables indicate a positive relationship with the likelihood of firms adopting social media. The study examines whether this holds after controlling for relevant determinants of social media adoption.

4.3.4 Econometric specification

To estimate the impact of directors on the likelihood of adopting social media, the study considers both logit and probit models. Empirical literature in finance, where the dependent variable is dichotomous, provides the logit and probit models to predict the dependent variable (see, for instance, (Géczy, Minton & Schrand, 1997; Calomiris & Carlson, 2017). Although theory and empirical literature provide some guidance on the choice of models, the choice between logit and probit models is not clearly indicated by empirical evidence. The main difference between the two models is that the probit model assumes a normal distribution of random variables, whereas the logit model does not (Lehutová, 2011; Klieštik, Kočišová & Mišanková, 2015a). The dependent variable, social media adoption, that the study seeks to explain using directors' characteristics takes a discrete value. If a firm adopts social media, it takes 1 and 0 if the firm has not adopted social media.

For this reason, the study employs adjusted regression analysis, which predicts the probability of firms adopting social media (Spuchl'áková and Cúg, 2014). Logit regression does not assume normal distribution, hence it eliminates the disadvantages of discriminant analysis, and it is preferred to probit because of its simplicity and interpretability (Klieštik, Kočišová and Mišanková, 2015). Industry/sector fixed effects are included to account for unobserved heterogeneity across industries. According to Luo, Zhang and Duan (2013) the use of social media varies across industries, innovative industries leverage on social media to introduce and promote their products. For example, the high tech sector where firms are constantly introducing new products are more likely to adopt social media than other industries.

The hypotheses in this study are investigated by estimating variants of the following baseline model of social media adoption.

$$Facebook_{i.t} = \beta_0 + \beta_1 Director_{i,t} + \beta_2 Size_{i,t} + \beta_3 ROA_{i,t} + \beta_4 FirmRisk_{i,t} + \beta_5 Growth_{i,t} + f_t + \varepsilon_{it} \quad (4.1)$$

where subscripts i and t denote individual firms and year, β indicates parameters to be estimated, and ε is the idiosyncratic error term. $Facebook$ is an indicator variable equal to 1 if a firm adopts social media and 0 otherwise. *Director* variable indicates the individual director' characteristics. Regression controls include size, return on assets, firm risk and growth opportunities. The coefficient of interest β_1, measure the sensitivity of firms' likelihood to adopt social media to director characteristics (Kamstra, Kennedy and Suan, 2001).

Further analyses examine the impact of director characteristics on firm social media activities. The study employs the two-step Heckman selection model proposed by Heckman (1979) to estimate the relationship. The first step account for the likelihood of firms adopting social media. We examine the effect of director characteristics and firms' characteristics on the likelihood of firms adopting social media. The second stage then examines the effects of director characteristics on social media activities. Following the Heckman procedure, we include return on assets and size in the first condition model but not the second. Return on assets and firm size would capture the firm's ability to invest in social media platforms. At the same time, it may not directly drive the volume of posts or determine the public sentiments. The Heckman model is suitable because of the potential sample selection bias. The dependent variables *Facebook Posts* and *Facebook Sentiments* are only available for firms that have adopted social media, which is a proportion of the full sample. Heckman model helps resolve the potential sample selection bias (Certo et al., 2016).

To determine the interaction role of cash holdings and risk in firm social media decisions, we explore the impact of cash and risk on the likelihood of firms adopting social media. Finally, the baseline equation is modified to include the interaction effect of the availability of financial resources and business risk. The modified equation is presented below.

$$\begin{aligned} Facebook_{i.t} = {} & \beta_0 + \beta_1 Director_{i,t} + \beta_2 Inter_{i,t} + \beta_3 Inter_{it} \times Director_{i,t} \\ & + \beta_4 Size_{i,t} + \beta_5 ROA_{i,t} + \beta_6 FirmRisk_{i,t} + \beta_7 Growth_{i,t} + f_t \\ & + \varepsilon_{it} \end{aligned} \qquad (4.2)$$

The coefficient of interest β_3 measure the interaction effect of the interaction variable on the relationship between the director characteristics and the likelihood of adopting social media.

4.4 Empirical results

This section presents the empirical results of the analyses in this study. The hypotheses are tested on 175 South African listed firms. Full information on the variables is presented in the summary statistics in different steps. The section begins by estimating the baseline equation, followed by further analysis and robustness checks.

4.4.1 The impact of director characteristics on the likelihood of adopting social media – baseline model

Table 4.3 reports the marginal changes in the probability of social media, implied by the logit coefficient estimates resulting from a unit change in the directors' characteristics and control

variables. The dependent variable *Facebook* is an indicator variable that takes the value of one if the firm has adopted social media and zero otherwise. The table presents results for the different sets of logit regressions. Column (1) reports marginal sensitivities of the probability that a firm adopts social media to changes in directors' age and control variables. The derived marginal effect at the mean for the age of directors suggests that a unit increase in the average age of directors decrease the likelihood of firms adopting social media. Accordingly, the first hypothesis is supported; results confirm that a firm with older directors is less likely to adopt social media.

Table 4.3 Director characteristics and the likelihood of adopting social media

Facebook	(1)	(2)	(3)	(4)	(5)
Directors Age	-0.207***				-0.145
	(0.080)				(0.090)
Female Directors		0.116***			0.114***
		(0.043)			(0.041)
CEO Age			-0.070*		-0.042
			(0.041)		(0.048)
CEO Gender				-0.349	-0.890
				(0.883)	(0.925)
Firm Risk	2.373***	2.166***	2.092***	2.153***	2.481***
	(0.894)	(0.755)	(0.797)	(0.791)	(0.798)
Size	2.493***	2.021***	2.208***	2.129***	2.319***
	(0.836)	(0.519)	(0.547)	(0.576)	(0.498)
ROA	-2.218	-3.018	-1.527	-1.537	-2.989
	(4.901)	(4.733)	(4.520)	(4.373)	(4.079)
Growth	1.640***	1.658***	1.702***	1.622***	1.662***
	(0.376)	(0.293)	(0.348)	(0.344)	(0.302)
Industry FE	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes
Observations	984	984	984	984	984
Firms	175	175	175	175	175

This table reports the marginal effects of the regressors on the likelihood that a firm adopts social media. The dependent variable Facebook is the binary variable equals one if a firm has adopted Facebook and zero otherwise. The main independent variables are directors' characteristics indicated by the *Directors Age, Female Directors, CEO Age* and *CEO Gender*. Columns (1) through to (4) reports marginal effects of directors age, the proportion of female directors, CEO age and CEO gender, respectively. In column (5), the model reports the marginal effects of the four explanatory variables on the likelihood that a firm adopts social media. The standard errors are given in parenthesis. * denotes significance at the 10% level, ** indicates significance at 5% level, and *** indicates significance at 1% level. The sample consists of 175 South African firms listed on the JSE. Variables used are defined in Appendix 4A.

The third hypothesis predicts a positive association between the proportion of female directors on the board and the likelihood of firms adopting social media. As can be seen from column (2), the marginal effect at the mean for the proportion of female directors is positive, suggesting that a unit increase in the number of female directors will increase the likelihood of firms adopting social media. Accordingly, the third hypothesis is supported.

Columns (3) and (4) in Table 4.3 report the regression estimates for the impact of CEO characteristics on the likelihood of adopting social media. The second hypothesis predicts that CEO age is negatively related to firms' likelihood of adopting social media. Column (3) reports a negative marginal effect at the mean for CEO age, indicating that an increase in CEO age decreases the probability of adopting social media. This result is consistent with Serfling (2014) prediction that risk tolerance reduces with age. Finally, hypothesis 4 predicts a positive effect of female CEOs on the likelihood of adopting social media. The derived marginal effect shows that the probability of a firm adopting social media is about 0.34 times lower in firms with female CEOs than firms with male CEOs. Therefore, the fourth hypothesis is not supported.

Column (5) presents the marginal effects at the mean for the four independent and control variables. The main explanatory variables retain the direction of the signs but with non significant impact except for the proportion of female directors variables. The marginal effects of the control variables are as expected. Firm risk has a positive marginal effect on the likelihood of firms adopting social media, suggesting that when firms are faced with high idiosyncratic risk, they seek alternative ways of managing the risk or countering the negative impacts of operating under high risk. The results also show positive marginal impacts of size and growth opportunities suggesting that a one-unit increase in firm size and growth opportunities increase the likelihood of adopting social media. The effect of size can explain the low level of social media adoption by firms in South Africa; the market is dominated by small and medium-sized firms. Contrary to predictions in this study, the coefficient of profitability is negative, indicating that an increase in profitability reduces the likelihood of firms adopting social media. This coefficient is surprising given the substantial amount of resources required to adopt social media. But one would argue that managers get comfortable when a firm is earning higher profits; innovation is not urgent.

4.4.2 The impact of directors' characteristics on firm social media activities

The previous section provides the extensive margin of the impact of director characteristics on firms' social media decisions. This section further investigates whether the director

characteristics influence the actual social media activities. Table 4.4 reports estimates of the two-step Heckman selection model for the impact of director characteristics on the volume of posts on social media. The dependent variable *Facebook Posts* measures the average number of firm posts.

Column (1) through to (4) reports the individual impact of director characteristics, and column (5) report the combined effect. The results show a negative impact of *Directors Age* and *CEO Age* on *Facebook Posts,* indicating that firms with older directors and older CEOs are less active on social media. These findings suggest that older CEOs and directors are more likely to introduce policies that discourage frequent social media communication. There are two possible explanations for this finding. The first explanation could be the risk aversion nature of older executives, which makes them more aware of the risks associated with social media that its value (Serfling, 2014). Second, the previous finding in Table 4.3 suggests that older executives are less likely to adopt social media; hence if they find themselves in firms that have adopted social media, they may limit its use.

Table 4.4 Director characteristics and social media posts

Facebook Posts	(1)	(2)	(3)	(4)	(5)
Directors Age	-0.257***				-0.289***
	(0.067)				(0.077)
Female Directors		0.079***			0.066**
		(0.026)			(0.027)
CEO Age			-0.013		0.070
			(0.039)		(0.044)
Female CEO				-0.995	-1.345
				(1.034)	(1.033)
Controls	Yes	Yes	Yes	Yes	Yes
Observations	984	984	984	984	984
lambda	-1.850**	-0.501	-0.732	-0.643	-1.462

This table reports estimates of the Heckman selection model for the impact of directors' characteristics on firms Facebook posts. The dependent variable *Facebook Posts* measure the volume of firm Facebook posts. The main independent variables are directors' characteristics indicated by the *Directors Age*, *Female Directors*, *CEO Age* and *CEO Gender*. Columns (1) through to (4) reports marginal effects of directors age, the proportion of female directors, CEO age and CEO gender, respectively. In column (5), the model reports the combined effect of the four explanatory variables on Facebook posts. The regressions include industry and year fixed effects. The standard errors are given in parenthesis. * denotes significance at the 10% level, ** indicates significance at 5% level, and *** indicates significance at 1% level. The sample consists of 175 South African firms listed on the JSE. Variables used are defined in Appendix 4A.

Regression estimates on the impact of gender suggest that the proportion of female directors on the board is positively associated with firm social media posts. However, firms with a female CEO are less active on social media. Given the negative impact of female CEO, the positive impact of female directors on social media activities of firms might be an indicator of the value of gender diversity in a firm and not necessarily female directors. Column (5) presents the combined impact of directors and CEO characteristics on Facebook posts. The results are largely unaltered except for female directors, which is less significant and CEO Age which returns a different sign. The lambda is only significant in column (1), which reports the impact of directors' age. Although the non significance of lambda may indicate the absence of sample selection bias and that the OLS would have been a superior estimator, in the case of this study, it could be due to the small sample size (Certo et al., 2016). Appendix 4B presents OLS estimates of the impact of director characteristics on firm Facebook posts. The results for directors' and CEO age are similar to results in Table 4.4, but the effect of the proportion of female directors is less significant, and the impact of *Female CEO* is more significant.

After examining the impact of director characteristics on firm social media posts, the study further explores the effects on public sentiments. Public sentiments are essential as they indicate the value and relevance of firm social media posts to the public, which may reflect in firm stock market performance. Table 4.5 reports estimates of the two-step Heckman selection model for the impact of director characteristics on public sentiments on social media posts. The dependent variable *Facebook Sentiments* indicate the positive sentiments on firm Facebook posts.

Column (1) through to (4) reports the individual impact of director characteristics, and column (5) report the combined effect. The results show a negative impact of *Directors Age* on *Facebook Sentiments* suggesting that firms with, on average older directors on the board are less likely to communicate interesting and relevant information to the public that attracts positive reactions than firms with younger directors. This finding can be attributed to two reasons, first to the positive correlation between the volume of posts and sentiments and second to the risk-averse nature of older executives, which may make them withhold information that would attract unwanted attention to the company.

A higher proportion of female directors on the board is associated with more positive sentiments, whereas female CEOs attract fewer social media sentiments. The presence of more female directors on the board contributes to diverse points of view and encourages firm

innovativeness. Column (5) presents the combined impact of directors and CEO characteristics on *Facebook Sentiments*, respectively. The results are largely unaltered. Lambda is significant in all the models, suggesting sample selection bias and indicating the strength of the exclusion parameters (Cohen, West and Aiken, 2014; Guo and Fraser, 2014). Appendix 4C presents OLS estimates of the impact of director characteristics on firm Facebook sentiments. The estimates show a more significant impact of the average age of directors and a less significant impact of the proportion of female directors on Facebook sentiments. CEO age returns a different sign, whereas the impact of *Female CEO* is significant.

Table 4.5 Director characteristics and social media sentiments

Facebook Sentiments	(1)	(2)	(3)	(4)	(5)
Directors Age	-0.059*				-0.068*
	(0.035)				(0.041)
Female Directors		0.043***			0.040***
		(0.014)			(0.014)
CEO Age			0.010		0.036
			(0.020)		(0.023)
Female CEO				-0.029	-0.126
				(0.530)	(0.536)
Controls	Yes	Yes	Yes	Yes	Yes
Observations	984	984	984	984	984
lambda	-3.333***	-2.974***	-3.006***	-3.059***	-3.095***

This table reports estimates of the Heckman selection model for the impact of directors' characteristics on firms Facebook sentiments. The dependent variable *Facebook Sentiments* reflects the positive reaction to a firm' Facebook posts. The main independent variables are directors' characteristics indicated by the *Directors Age, Female Directors, CEO Age* and *CEO Gender*. Columns (1) through to (4) report the impact of directors age, the proportion of female directors, CEO age and CEO gender, respectively. In column (5), the model reports the combined effect of the four explanatory variables on Facebook sentiments. The regressions include industry and year fixed effects. The standard errors are given in parenthesis. * denotes significance at the 10% level, ** indicates significance at 5% level, and *** indicates significance at 1% level. The sample consists of 175 South African firms listed on the JSE. Variables used are defined in Appendix 4A.

4.4.3 Further analyses

This section presents further analyses on the impact of director characteristics on the likelihood of adopting social media. Specifically, this section examines whether directors and CEOs consider the availability of financial resources or the business operating risk when adopting social media. The study employs logistic regression to investigate whether the availability of financial resources and the presence of firm risk might moderate the effects of director

characteristics on the likelihood of firms adopting social media. Table 4.6 presents the estimated results. Columns (1) and (2) presents the moderating role of cash holdings on the link between director characteristics and the likelihood of adopting social media. Logistic regression estimates in column (1) show that the relationship between directors age and the probability that firms adopt social media does not depend on the availability or level of firm cash holdings. Column (2), however, indicates a significant interaction of cash on the relationship between the proportion of female directors and the probability that firms adopt social media.

Columns (3) and (4) reports the logistic estimates for the interaction effect of firm risk on the link between director characteristics and the likelihood of adopting social media. Column (1) shows no significant interaction effect of firm risk on the relationship between the average age of directors and the likelihood of firms adopting social media. Column (2) reports the interaction effects of firm risk on the relationship between the proportion of female directors and the probability that firms adopt social. Findings in this section partly contradict hypothesis 5 and hypothesis 6 that suggest that the adoption of social media is contingent upon financial resources and operating risks. However, remain consistent with the prediction that female directors are more aware of the business conditions when making decisions.

Table 4.6 The moderating role of cash and risk

	Cash		Risk	
Facebook	(1)	(2)	(3)	(4)
Directors Age	-0.108***		-0.116***	
	-0.038		-0.031	
Directors Age*Interaction	0.07		0.248	
	-0.251		-0.297	
Female Directors		-0.441***		-4.437***
		-0.17		-1.481
Female Directors*Interaction		2.047**		43.449***
		-0.952		-15.35
Controls	Yes	Yes	Yes	Yes
Observations	984	984	984	984
Pseudo R2	0.133	0.113	0.134	0.116

This table presents estimates for the moderating role of cash and risk on the relationship between director characteristics and the likelihood of firms adopting social media. Columns (1) and (2) report the moderating role of cash holdings on the impact of *Directors Age and Female Directors,* respectively. Columns (3) and (4) report the moderating role of firm risk on the impact of *Directors Age and Female Directors,* respectively. Standard

Errors are clustered at the firm level. The standard errors are given in parenthesis. * denotes significance at the 10% level, ** indicates significance at 5% level, and *** indicates significance at 1% level. The sample consists of 175 South African firms listed on the JSE. Variables used are defined in Appendix 4A.

4.4.4 Robustness checks

This section tests the sensitivity of results presented in Table 4.3 (baseline analysis) by employing alternative estimation methods First, the study uses the fixed effects panel logit estimator. The number of observations drops to 327 because the fixed effects panel logit estimator requires a change in the value of the dependent variable over two continuous years (Wang, Han and Huang, 2020). The baseline results, reported in Table 4.7, hold that the coefficients for *Directors Age* and *CEO Age* remain significantly negative, and the coefficient for *Female Directors* is significant and positive. The *Female CEO* variable retains the negative and non-significant coefficient.

Table 4.7 Robustness tests -fixed effects panel logit model

Facebook	(1)	(2)	(3)	(4)	(5)
Directors Age	-0.328***				-0.284***
	(0.063)				(0.073)
Female Directors		0.159***			0.138***
		(0.033)			(0.037)
CEO Age			-0.045*		0.018
			(0.026)		(0.033)
Female CEO				-0.052	-0.734
				(0.613)	(0.740)
Controls	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	327	327	327	327	327
Firms	41	41	41	41	41
Pseudo R2	0.439	0.410	0.303	0.290	0.507

This table reports the marginal effects of the regressors on the likelihood that a firm adopts social media. The dependent variable Facebook is the binary variable equals one if a firm has adopted Facebook and zero otherwise. The main independent variables are directors' characteristics indicated by the *Directors Age*, *Female Directors*, *CEO Age* and *CEO Gender*. Columns (1) through to (4) reports marginal effects of directors age, the proportion of female directors, CEO age and CEO gender, respectively. In column (5), the model reports the marginal effects of the four explanatory variables on the likelihood that a firm adopts social media. The logit regressions include firm fixed effects. The standard errors are given in parenthesis. * denotes significance at the 10% level, ** indicates significance at 5% level, and *** indicates significance at 1% level. The sample consists of 175 South African firms listed on the JSE. Variables used are defined in Appendix 4A.

Next, the study tests the baseline results using a parsimonious OLS model with industry and year fixed effects and OLS regression with control variables. The models in Table 4.8 test the impact of director characteristics on the likelihood that a firm adopts social media without

controlling for other firm characteristics. Consistent with findings in the baseline model, the results in Table 4.8 show that older directors and older CEOs reduce the likelihood of adopting social media, whereas the proportion of female directors increase the likelihood of adopting

The female CEO is associated with a lower probability of adopting social media. The results are more pronounced in Table 4.10, which includes control variables. Thus, the results confirm the robustness of the findings that directors age and CEO age have a negative impact on the likelihood of adopting social media, and the proportion of female directors has a positive effect. Appendices 4D to 4F present additional robustness tests, whose results are consistent with those reported in Table 4.3 (baseline analysis).

Table 4.8 Robustness tests – OLS regression model

Facebook	(1)	(2)	(3)	(4)
Directors Age	-0.006**			
	(0.003)			
Female Directors		0.004***		
		(0.001)		
CEO Age			-0.002*	
			(0.001)	
Female CEO				-0.017
				(0.032)
Controls	No	No	No	No
Industry FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Observations	989	989	989	989
R-squared	0.796	0.797	0.795	0.795

This table reports the marginal effects of the regressors on the likelihood that a firm adopts social media. The dependent variable Facebook is the binary variable equals one if a firm has adopted Facebook and zero otherwise. The main independent variables are directors' characteristics indicated by the *Directors Age, Female Directors, CEO Age* and *CEO Gender*. Columns (1) through to (4) reports marginal effects of directors age, the proportion of female directors, CEO age and CEO gender, respectively. The OLS regressions include industry and year fixed effects but excludes control variables. The standard errors are given in parenthesis. * denotes significance at the 10% level, ** indicates significance at 5% level, and *** indicates significance at 1% level. The sample consists of 175 South African firms listed on the JSE. Variables used are defined in Appendix 4A.

4.5 Discussion and implications

Literature confirms that social media is beneficial to firm growth and success by reducing information asymmetry and aiding the innovation process. However, there is no evidence on the determinants of social media adoption by firms. Further, there is limited evidence on the role of directors. This study seeks to answer two questions. First, whether the characteristics of

directors influence firms likelihood of adopting social media. Specifically, does the age and gender of directors and CEOs impact the likelihood of firms adopting social media? Second, the study aims to examine the moderating role of cash holdings and risk on the impact of directors and the probability that a firm adopts social media. The empirical results indicate general support for the negative link between directors and CEO age and the likelihood of firms adopting social media. This finding is also consistent with recent studies that report a negative impact of directors' age on innovativeness (Barker III and Mueller, 2002; Bucciol and Miniaci, 2011). However, the sensitivity of the probability that firms adopt social media is greater for average board age than it is for the age of the CEO only. The positive impact of the proportion of female directors is consistent with findings by (a) Bednar, Gicheva and Link (2021), who report that female executives are more proactive hence likely to push for innovations and ideas; and (b) Kuhn and Villeval (2015), who report that women are more inclined to cooperate and engage with stakeholders, hence are more likely to adopt social media. However, the study did not find a statistically significant link between female CEOs and the likelihood of firms adopting social media. The sensitivity of the probability of firms adopting social media to CEO characteristics compared to board characteristics suggest that the board of directors is more effective in making social media decisions than the CEO alone.

The change in CEO increases the likelihood of firms adopting social media, both for change to younger and change to older CEO. Given the findings above that older directors and older CEOs reduce the probability that firms adopt social media, one would expect the coefficient for change to older CEO to be less significant and less pronounced than the coefficient of change to younger CEO. The results, although they contradict with the hypothesis in this study, they agree with previous literature, which suggests that older executives are more confident in implementing activities that do have measurable and certain returns than younger executives who are more worried about their careers and reputation (see, for instance, Scharfstein and Stein, 1990; Hirshleifer and Thakor, 1992; Zwiebel, 1995).

Further analyses examine the board characteristics using a contingency approach. The theoretical and empirical review provides evidence that board characteristics do not consistently impact corporate decisions such as innovation decisions. Rather, their effect is contingent upon business operating conditions and the availability of resources. The findings in this study do not provide evidence in support of this. Rather the results show that only the impact of female directors is moderated by cash and risk. The impact of age and CEO

characteristics do not depend on cash or risk levels. A key implication of this finding is that firms' cash resources and business risk may not always make a difference in terms of the influence of director characteristics on social media adoption. While female directors are likely to take these into account when making social media decisions, age is not really a factor. This finding has two more implications. First, the finding implies that having female directors on the board result in more informed decisions as firms will consider the availability of financial resources and the business operating risks before taking on innovative ventures such as adopting social media. Second, the non-significant impact on the rest of the variables suggests that directors are not fully utilised in the monitoring of corporate decisions for the sample firms. Previous studies indicate that it may be because of passive directors (Xie, Liu and Qiu, 2012; Tao et al., 2019).

Some managerial implications can be inferred from this study. Empirical results suggest that female directors are particularly more useful for innovation, and their impact depends on the availability of financial resources and the risk levels of the firm. At the same time, both younger and older directors' decision to adopt social media is not affected by business operating conditions. The combined interpretation of these results suggests that the ideal board structure for innovation oriented firms is one with more female directors for careful decision making and, on average, younger directors as they are more innovative. In order to fully benefit from social media, firms should define their objectives, observe the outcome, and adjust objectives accordingly.

4.6 Conclusion

The study constructs measures of board characteristics in listed firms in South Africa. It examines the individual and direct impact of age and gender on the probability of adopting social media. The measures of board characteristics are estimated based on each director's profile and averaged for the company. Section 2 of this study explains how the adoption of social media is regarded as innovativeness of the firm. Further, the section identifies the determinants of social media adoption and the channels through which board characteristics can impact the decision to adopt social media. Logistic regression is used to estimate the social media adoption model to determine the individual impacts of board age, board gender, CEO age and CEO gender. The results show that average board age and CEO age have a negative and significant impact on the likelihood of adopting social media. At the same time, the

proportion of female directors is significant and positively correlated. Overall, this study suggests that firms need to appoint board structures that align with their organisational goals.

Several theoretical contributions emerge from this study. First, the discussion in the literature section unearths the value of social media in the innovation process and further links social media to the age and gender of directors. Further, the discussion provides an analysis of the channels through which firms may enhance innovation using social media and the process through which firms can capture value from social media. The discussion and the findings define the role of company directors beyond financing decisions. Second, the study adds to and expand existing literature on board structure and organisational outcomes. Few studies evaluate the role of directors on the social media activity of firms. This research offers a novel approach to evaluating the role of directors in the social media adoption process. It also provides a guideline of appropriate board structure for innovation oriented firms that seeks to implement and achieve maximum benefit from social media use. Further, the study explores the role of finance and firm risk in social media decisions, giving insight into the effect of board characteristics from a contingency perspective. The role of finance in these decisions remain unexplored.

This study suffers from several limitations. First, the study is based on a sample of South African firms. Hence, it cannot be generalised in multiple contexts. Multiple country studies would offset the potential risk of generalising. The findings of this study are limited to the extent that the study focuses on listed firms, and the definition of social media presence is based on Facebook. Future research may look at firms' presence on any of the available social media sites and explore the variation of the impacts based on the different social media platforms. Future studies should also seek to extend these findings, specifically exploring social media uses for innovation in different industries.

Chapter 5. Summary and conclusion

This thesis studies the dynamics of corporate cash holdings and risk. Extant studies in corporate cash holdings examine the dynamics of cash holdings focusing on the various determinants and moderating factors. Unlike existing studies in cash holdings, this thesis gives particular attention to the sources of risk. Specifically, the study considers information asymmetry as a significant source of risk, more so in developing market context[11], and further explores how firms can reduce information asymmetry using social media. In exploring this, the thesis offers a deductive approach to managing the relationship between risk and cash holdings. Firms can use social media to manage informational risk, which reduces idiosyncratic risk and consequently the need to hold cash. If social media can manage the idiosyncratic risk that directly impacts cash holdings, then it can indirectly influence firm cash holdings decisions.

The first empirical study investigates the direct impact of idiosyncratic and macroeconomic risk on corporate cash holdings. The study employs sales volatility and cumulative sales volatility to proxy idiosyncratic risk. Macroeconomic risk is measured by the annualised conditional variance series generated from the GARCH models for financial market prices and the PPI. These measures are not unique to this study as they have been applied in previous literature. Given the data structure, the study employs two-step system dynamic panel data models (GMM) to estimate the association between risk and cash holdings. GMM is preferred because they control for heterogeneity across firms and mitigate potential endogeneity. GMM estimate model in both levels and difference, thereby retaining variations among firms (Blundell and Bond, 1998, 2000). Lagged regressors are used as instruments for the level equations.

The findings suggest that the effect of idiosyncratic risk on cash holdings is positive and significant, suggesting that firms tend to increase their cash holdings when operating in periods of high risk. This finding holds true regardless of the alternative measures of cash holdings or idiosyncratic risk. A subsample analysis of financially constrained firms versus unconstrained firms shows that corporate cash holdings' sensitivity to changes in risk is more pronounced in financially constrained firms. Financial constraints or limited access to external finance increase reliance on internal financing sources such as cash reserves (Guariglia and Yang,

[11] Colombage (2009) suggests that information asymmetry is prevalent in developing economies.

2018). Hoarding cash due to changes or increase in risk implies that firms bypass or postpone value enhancing and growth enhancing investment projects.

The effect of macroeconomic risk on corporate cash holdings is negative and not significant for the full sample. Firms utilise cash holdings during periods of macroeconomic uncertainty. This makes sense because macroeconomic shocks cause panic in the debt and equity markets. As a result, creditors are less willing to lend, whereas investors are hesitant to invest, firms resort to retained earnings to finance their operations. In the subsample analysis, the results show that financially constrained firms exhibit greater sensitivity to changes in macroeconomic risk. Overall, the study implies that changes in idiosyncratic risk are more likely to alter corporate finance decisions than macroeconomic risk. The increase in cash holdings implies an increase in the opportunity cost of investment returns forgone. Hence, to minimise the costs of holdings cash, firms should pursue risk management strategies focused on reducing idiosyncratic risk.

Having established the direct impact of risk on the cash holdings behaviour, the second empirical study explores social media as a determinant of idiosyncratic risk, abnormal returns and stock liquidity. Extant studies provide convincing evidence on the role of social media in reducing information asymmetry. Asymmetric information creates frictions in the equity and debt markets, increasing the cost of capital and causing constraints to accessing finance for uninformed firms. Social media was chosen specifically for its documented role in reducing information asymmetry, the increasing use of social media globally and in South Africa in particular and the established value of social media in firm performance. Hence, the study investigates the direct impact of firms' posts on Facebook, public reaction to the posts and sentiments on the firm's stock indicators – abnormal returns, idiosyncratic risk and stock liquidity. The three measures indicate firm performance on the stock market, which largely depends on information[12].

The Facebook indicators are constructed from firm-specific daily Facebook data obtained from Crowd Tangle. Employing linear regression models with industry and time dummies, the study shows that social media indicators can predict firms stock market indicators. Specifically, the results show that the volume of posts on social media is negatively associated with firm stock liquidity and abnormal returns and positively associated with idiosyncratic risk. This finding

[12] Informed investors trade on information gathered (information on future cash flows), uninformed investors do no trade (Easley, Hvidkjaer and O'hara, 2002; Easley and O'hara, 2004)

suggests that the more information a firm discloses on social media, the higher the risk exposure. The quality of information may determine the reaction of investors and their attitude towards the firm. If a firm informs the public more about its operations, it increases its reputation risk. Changes in information cause shifts in stock prices and idiosyncratic returns resulting in higher idiosyncratic volatility. However, the results show that public reactions are positively associated with firm stock market performance, that is, stock liquidity and abnormal returns. And the reactions reduce the idiosyncratic risk associated with firms. Thus, the ability of a firm to attract positive sentiments on social media is imperative as it increases its stock market performance and reduces the volatility of its returns. Further analyses distinguish between small firms versus large firms and high-risk firms versus low-risk firms. The results show that small firms and high-risk firms exhibit more significant elasticities to changes in Facebook indicators.

The study contributes to the literature by highlighting the importance of public sentiments and firm social media activities on stock market performance. This is particularly important for firms as potential investors may use public sentiments on Facebook to make investment decisions, reflecting in the firms' liquidity and abnormal returns and volatility. The findings also suggest that the role of social media in reducing information asymmetry is particularly important for small firms. Hence, social media adoption is more relevant in South Africa, which is characterised by young and small firms. Social media may play a critical role in the growth of these firms and, consequently, economic growth. While firms need to adopt and correctly utilise social media to extract maximum value, policymakers also play a role. Wide internet coverage and affordable data rates increase social media use.

After establishing the value of social media in predicting stock liquidity, idiosyncratic risk and abnormal returns, the next empirical study further investigates firms' decisions to adopt social media. In principle, just like any other investment project, firms will adopt social media if the costs are less than the benefits of adopting social media. The decision to adopt social media is a top management decision that requires the approval of the board. Specifically, the study investigates how director characteristics determine firms' decision to adopt social media.

The study begins by reviewing both the theoretical and empirical studies that provide interlinkages between social media and corporate finance and documents the corporate value of social media. Documented evidence from the literature suggests that social media is valuable for innovation, prediction and information gathering. The empirical analysis in this study

employs a panel logit model with Facebook as a dependent variable indicating social media adoption by firms. The main independent variables indicate the age and gender of directors and CEOs. Estimates of the logit regression models show evidence of a negative impact of directors and CEOs age on the likelihood of adopting social media. However, the findings also show a positive effect of the proportion of female directors on the likelihood of adopting social media. Firms with more female directors on the board are more likely to consider social media for information dissemination and gathering. This evidence is robust to alternative regression techniques and specifications.

The study further explores the impact of directors' characteristics on firm social media activities using the Heckman selection model. The results show that firms with older directors and older CEOs are associated with fewer social media posts, and the firms receive fewer positive sentiments. At the same time, firms with a higher proportion of female directors post more and have more social media likes. These findings confirm that older directors and older CEOs are not interested in social media activities. The negative impact of female CEO on both the likelihood to adopt social media and firm social media activities imply that female executives are less likely to push for social media decisions as an individual. This concurs with the risk-averse nature of female managers given the long term and uncertain nature of social media investments.

Overall, Chapter 4 suggests that age and gender are important determinants of social media adoption. However, the role of the CEO is less significant than the role of the board. The study adds to and expand existing literature on board structure and organisational outcomes and offers a novel approach to evaluating the role of directors in the social media adoption process. It also provides a guideline of appropriate board structure for innovation oriented firms that seek to implement and achieve maximum benefit from social media use. Further, the study explores the role of finance and firm risk in social media decisions, giving insight into the effect of board characteristics from a contingency perspective. The role of finance in these decisions remain unexplored.

The thesis suffers from several limitations. First, the thesis is based on a sample of South African firms. Hence, it cannot be generalised in multiple contexts. Multiple country studies would offset the potential risk of generalising. Second, the findings of this thesis are limited to the extent that the thesis focuses on listed firms. It would be interesting to investigate the heterogeneity of corporate decisions in private firms. Few studies examine the dynamics of

corporate finance decisions in private firms (see, for instance, Xie et al., 2017). Third, the definition of social media is based on Facebook. Future research may look at firms' presence on any available social media sites and explore the variation of the impacts based on the different social media platforms. Also, the social media content in the sample may vary depending on the posts. While most posts are likely to contain firm related information, some relate to specific events, and the public reaction generated from such posts is not firm related.

Fourth, processing social media information to make it comparable to financial information is time-consuming and complex; more efficient procedures would allow for data processing and analysis in real time. Finally, the generalisability of results could be extended to industry-level analyses. While the thesis excludes media companies, there are still companies that tend to generate more media content than others due to the structure of their operations. There are also industries whose operations do not prioritise information dissemination. Future research could explore the influence of social media in specific industries. Also, the research designs used in evaluating the impact of social media do not comprehensively assess causality. Natural experiments in future research could address that. Finally, the social media content may vary depending on the posts. While most posts are likely to contain firm related information, some posts relate to specific events. The public reaction generated from such posts are not firm related and may be attributed to the public interest in the event and not the firm. This analysis does not control for such events. Future research could control for main events such as political events, outbreaks/pandemics or even festival celebrations.

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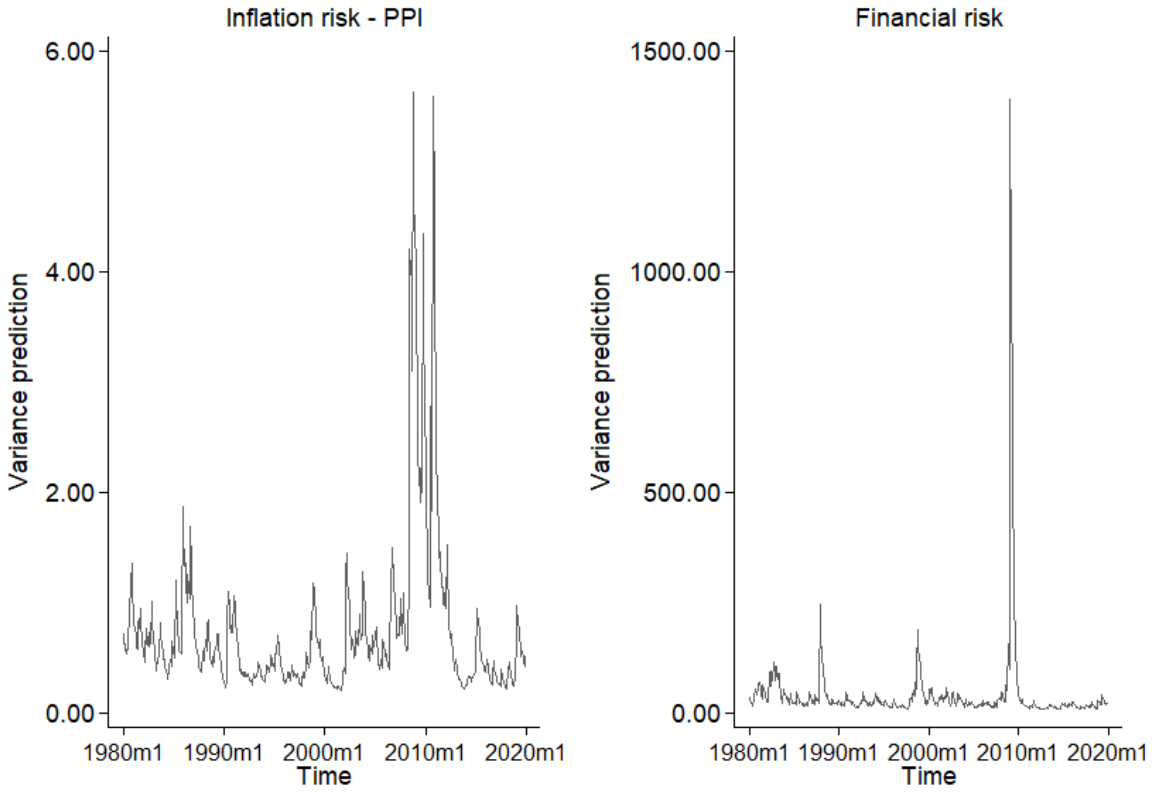
Appendices

Appendices to Chapter 2
Appendix 2A: Variable definitions

Variable	Definition
Dependent Variables	
Cash1	Cash and short-term investments (WC02001) scaled by total assets (WC02999).
Cash2	Cash and short-term investments (WC02001) scaled by total assets (WC02999) less cash and short-term investments.
Explanatory Variables	
Cumulative Sales Volatility	Cumulative standard deviation of residuals from the AR(1) sales (WC01001) model.
Sales Volatility	Absolute value of residuals from the sales (sales (WC01001) scaled by total assets (WC02999) model
Inflation Risk	Conditional variances of the Producer Price Index derived from the ARCH/GARCH model.
Financial Risk	Conditional variances of the Financial Market Prices (Equities) derived from the ARCH/GARCH model.
Control Variables	
Size	Logarithm of the total assets (WC02999)
Leverage	Total debt (WC03255) scaled by total assets (WC02999).
Market to Book	Market capitalisation (WC08001) plus total liabilities(WC03351) scaled by total assets (WC02999).
Dividends	Total dividends (WC04551) paid scaled by total assets (WC02999).
Cash Flow	Operating income (WC01250) plus depreciation and amortization (WC01151) scaled by total assets (WC02999).
WW Index	An index measure for financial constraints.
KZ Index	An index measure for financial constraints.

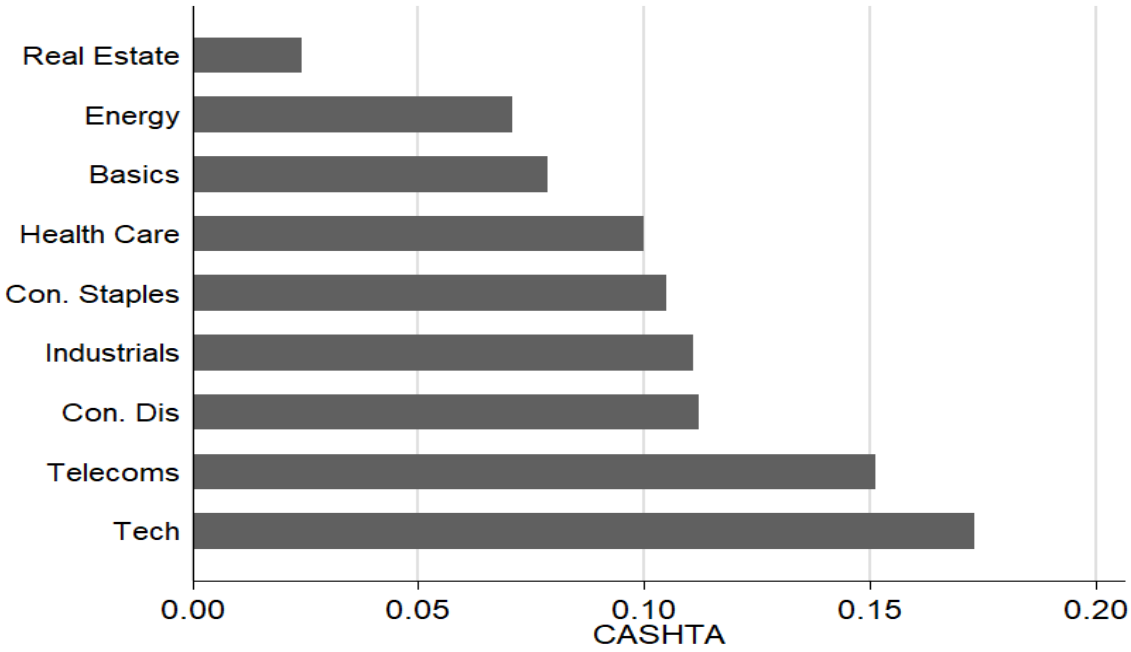
The table lists the definitions of all variables used and the account items from DataStream (in parenthesis).

Appendix 2B: Macroeconomic risk measures



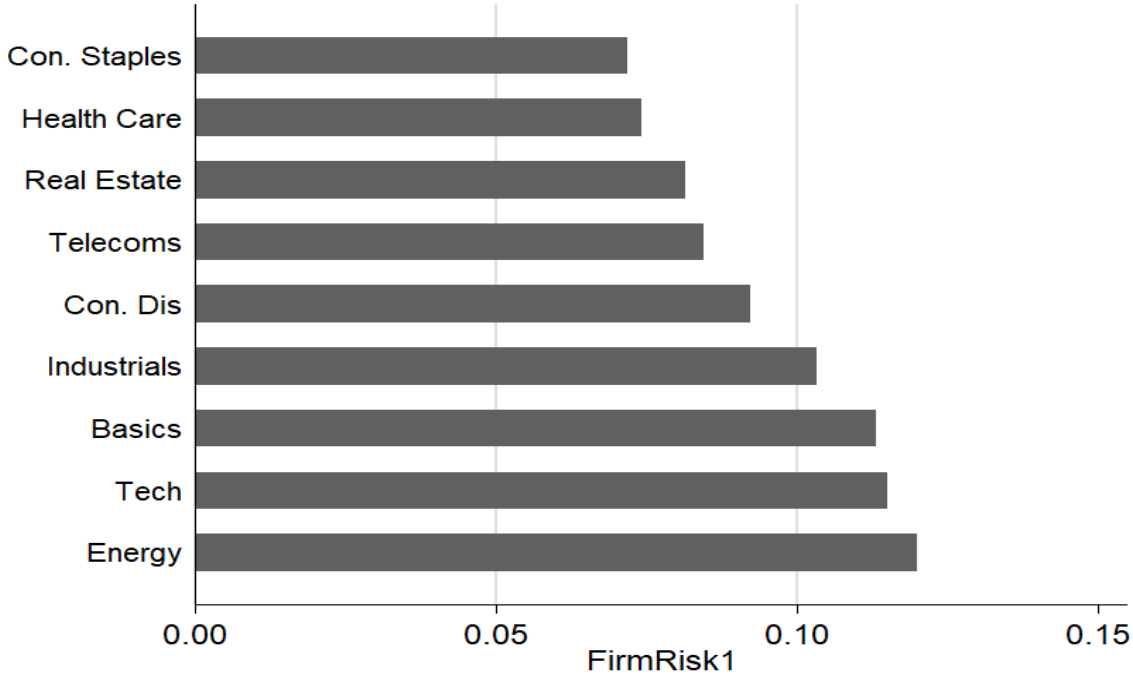
The figure show the trend for the macroeconomic measures over time.

Appendix 2C: Industry distributions of cash and risk



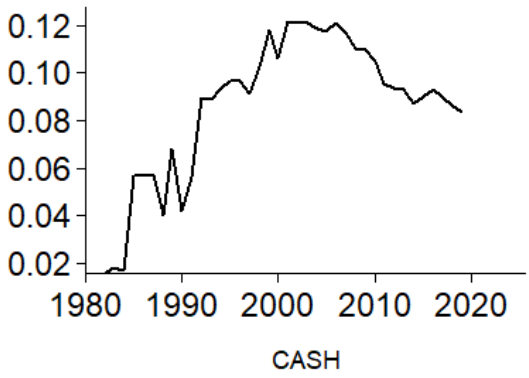
The figure shows the distribution of cash holdings across industries. Cash holdings is measured as cash and cash equivalents scaled by total assets.

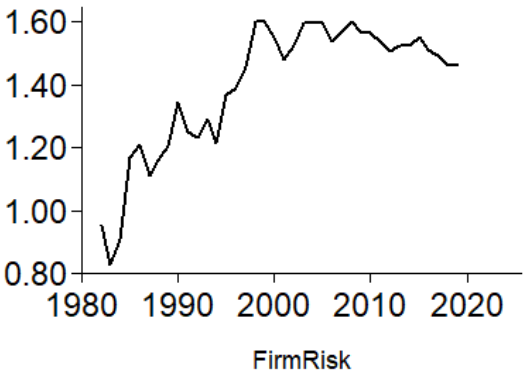
Appendix 2C (continued): Industry distributions of risk

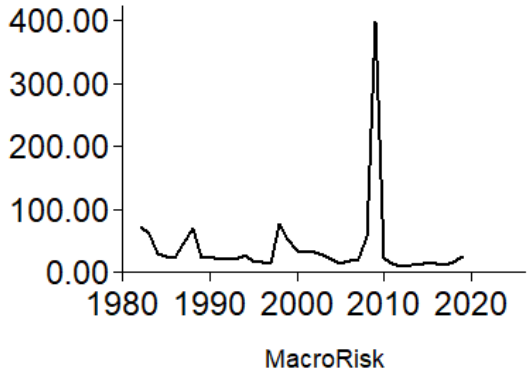


The figure shows the distribution of firm risk across industries. Firm risk is the standard deviation of residuals from the AR(1) sales model.

Appendix 2D: Evolution of cash holdings and risk

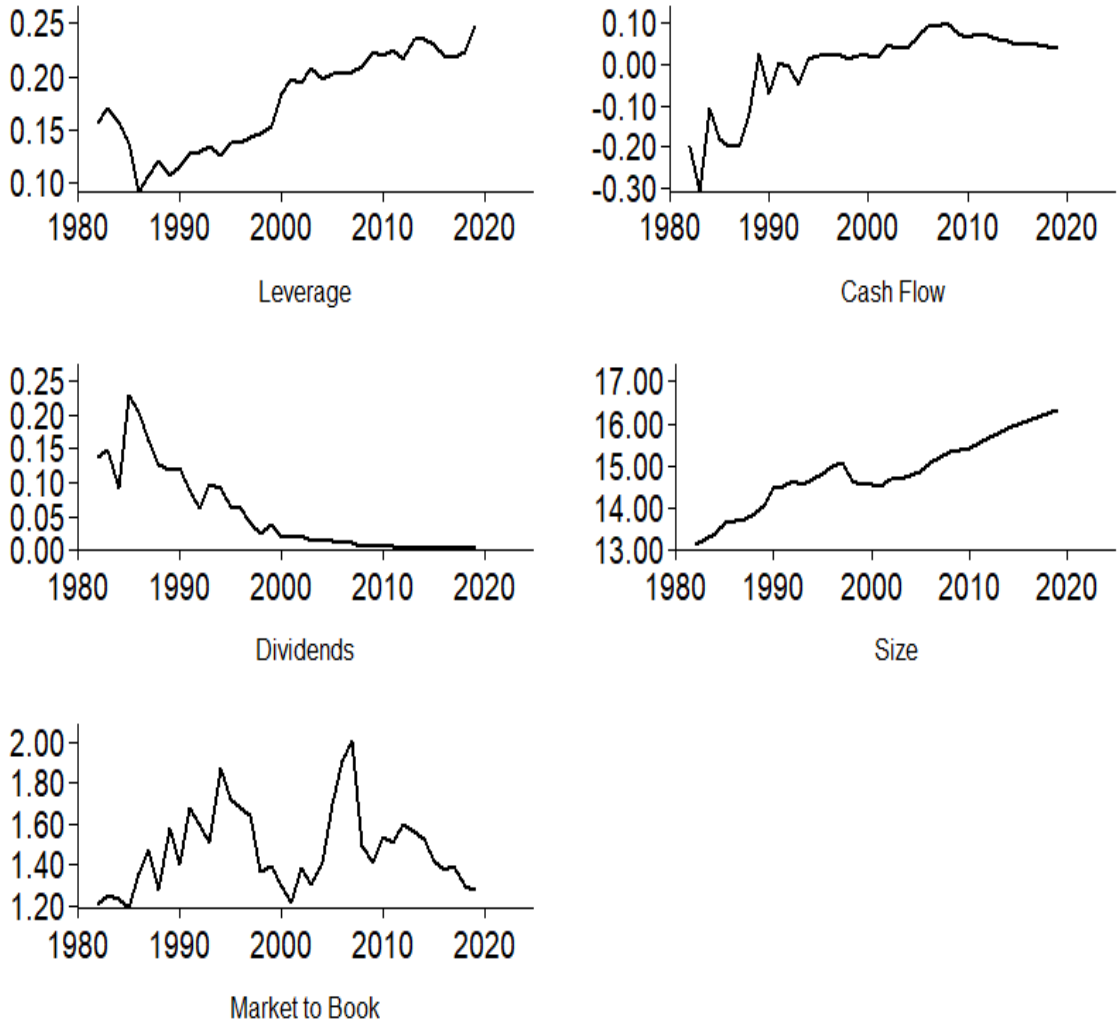






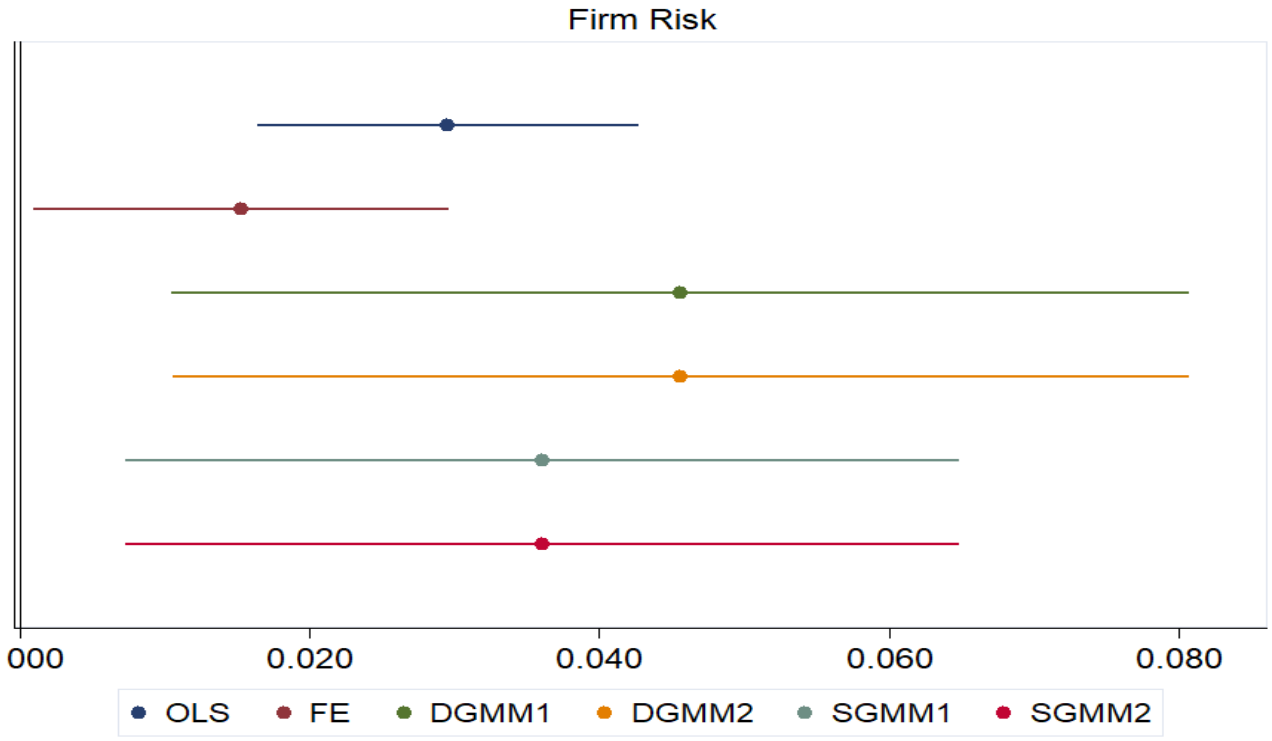
The figures show the evolution of cash holdings, firm risk and macroeconomic risk over the sample period.

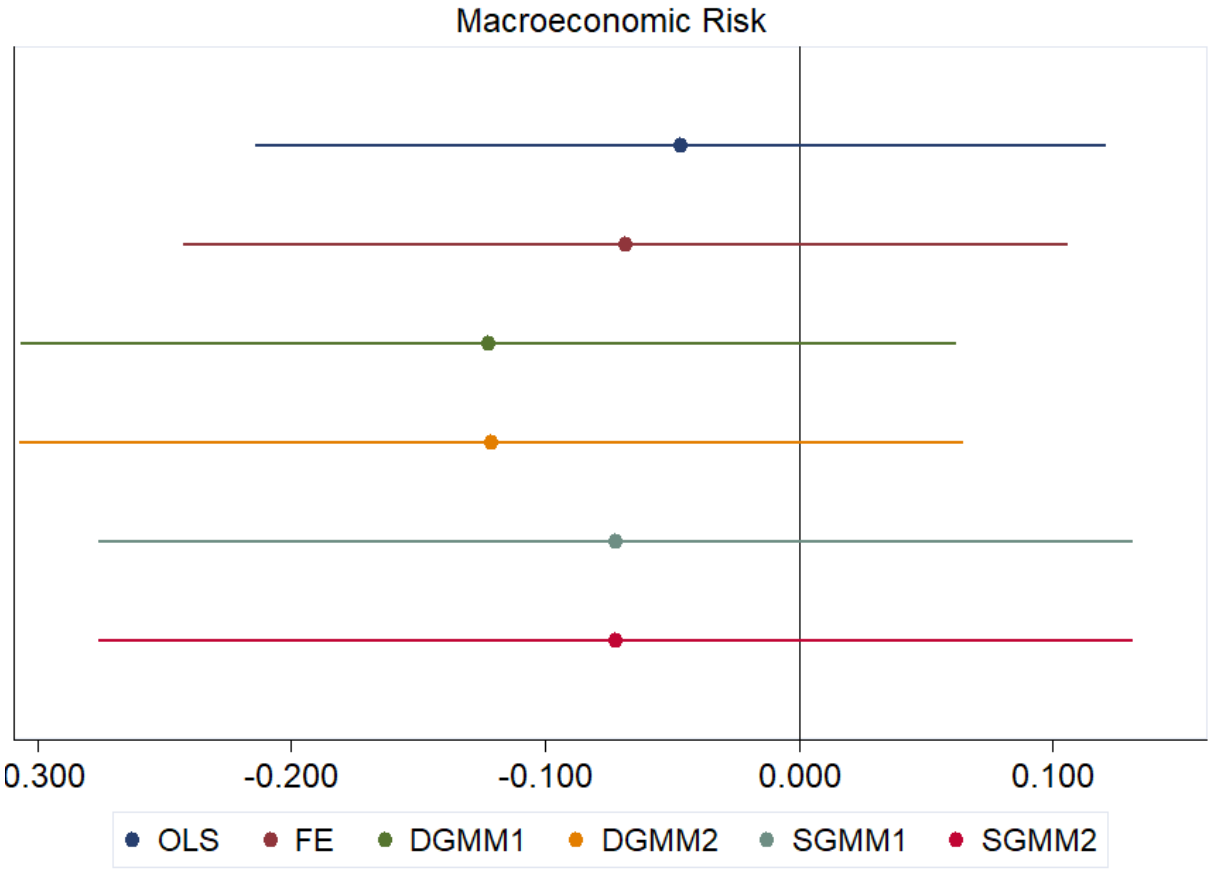
Appendix 2E: Evolution of firm characteristics



The figure shows the evolution of firms' characteristics over the sample period.

Appendix 2F: Confidence intervals for the coefficients of risk





Appendices to Chapter 3
Appendix 3A: Variable Definitions

Variable	Definition
Dependent Variables	
Abnormal returns	Residuals generated from the extended Fama-French model.
Idiosyncratic risk	Standard deviation of residuals generated from the extended Fama-French model.
Effective spread	Effective spread - stock price less the bid ask price midpoint scaled by the bid ask price midpoint.
Facebook metrics	
Volume of Posts	Total number of firm's Facebook posts.
Sentiments	The difference between positive and negative reactions on firm's posts.
Likes	Total likes on a firm's Facebook posts.
Shares	Total shares on a firm's Facebook posts.
Comments	Total comments on a firm's Facebook posts.
Photo	Total number of pictures/photo a firm posts in a given day.
Video	Total number of videos a firm posts in a given day.
Link	Total number of links a firm posts in a given day.
Score	Overperformance of a firm's Facebook post relative to similar posts from the same page.
Control Variables	
Excess return	Difference between firm stock returns and market return.
Market Capitalisation	Logarithm of a firm's market capitalisation.
Size	Logarithm of the total assets and the logarithm of market capitalisation.
Price	Logarithm of the stock price.
Market to book	Price to book value of assets obtained from Datastream
Factors	Fama-French 5 factors, the Cahart Momentum factor and market return.

The table lists definitions of all variables used in this study

Appendices to Chapter 4
Appendix 4A Variable definitions

Variable	Definition
Dependent Variables (source – Crowd Tangle)	
Facebook	Indicator equals 1 if a firm has adopted Facebook
Facebook Posts	Total number of firm's Facebook posts.
Facebook Sentiments	The difference between positive and negative reactions on firm's posts.
Director characteristics (source - Boardex)	
Board Age	Average age of directors sitting on a board in a given year.
Female directors	Number of female directors scaled by total number of directors sitting on a board.
CEO Age	The age of the chief executive officer of a firm.
CEO Gender	Indicator variable equals 1 if a firm has a female chief executive officer.
Firm Variables (source - Datastream)	
Size	Logarithm of the total assets (WC02999)
Return on Assets	Earnings before interest and tax (WC18191) scaled by total assets (WC02999)
Market to Book	Market capitalisation (WC08001) plus total liabilities (WC03351) scaled by total assets (WC02999).
Cash	Cash and short term investments (WC02001) scaled by total assets (WC02999).
Firm risk	Standard deviation of residuals from the sales (WC01001) model.

The table lists definitions of all variables used in this study

Appendix 4B: OLS estimates of the impact of director characteristics on Facebook posts

Facebook Posts	(1)	(2)	(3)	(4)	(5)
Directors Age	-0.250***				-0.271***
	(0.069)				(0.079)
Female Directors		0.071**			0.051
		(0.035)			(0.035)
CEO Age			-0.027		0.027
			(0.038)		(0.042)
Female CEO				-1.923**	-2.314**
				(0.894)	(0.902)
Controls	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes
Observations	359	359	359	359	359
Firms	78	78	78	78	78
R2	0.203	0.1507	0.1467	0.1548	0.1866

This table reports regression estimates for the impact of directors' characteristics on firms Facebook posts. The dependent variable *Facebook Posts* measure the volume of firm Facebook posts. The main independent variables are directors' characteristics indicated by the *Directors Age*, *Female Directors*, *CEO Age* and *CEO Gender*. Columns (1) through to (4) reports marginal effects of directors age, the proportion of female directors, CEO age and CEO gender, respectively. In column (5), the model reports the combined effect of the four explanatory variables on Facebook posts. The regressions include industry and year fixed effects. The standard errors are given in parenthesis. * denotes significance at the 10% level, ** indicates significance at 5% level, and *** indicates significance at 1% level. The sample consists of 78 South African firms listed on the JSE. Variables used are defined in Appendix 4A.

Appendix 4C: OLS estimates of the impact of director characteristics on Facebook sentiments

Facebook Sentiments	(1)	(2)	(3)	(4)	(5)
Directors Age	-0.084***				-0.097***
	(0.030)				(0.035)
Female Directors		0.035**			0.029*
		(0.017)			(0.017)
CEO Age			-0.002		0.017
			(0.016)		(0.018)
Female CEO				-0.746**	-0.868**
				(0.380)	(0.385)
Controls	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes
Observations	359	359	359	359	359
Firms	78	78	78	78	78
R2	0.232	0.227	0.218	0.2188	0.2457

This table reports the regression estimates for the impact of directors' characteristics on firms Facebook sentiments. The dependent variable *Facebook Sentiments* reflects the positive reaction to a firm' Facebook posts. The main independent variables are directors' characteristics indicated by the *Directors Age*, *Female Directors, CEO Age* and *CEO Gender*. Columns (1) through to (4) report the impact of directors age, the proportion of female directors, CEO age and CEO gender, respectively. In column (5), the model reports the combined effect of the four explanatory variables on Facebook sentiments. The regressions include industry and year fixed effects. The standard errors are given in parenthesis. * denotes significance at the 10% level, ** indicates significance at 5% level, and *** indicates significance at 1% level. The sample consists of 78 South African firms listed on the JSE. Variables used are defined in Appendix 4A.

Appendix 4D: Robustness tests for the impact of director characteristics on the likelihood of firms adopting social media

OLS regression model

Facebook	(1)	(2)	(3)	(4)
Directors Age	-0.015***			
	(0.002)			
Female Directors		0.009***		
		(0.001)		
CEO Age			-0.004***	
			(0.001)	
Female CEO				-0.004
				(0.034)
Controls	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Observations	984	984	984	984
R-squared	0.808	0.809	0.807	0.806

This table reports the marginal effects of the regressors on the likelihood that a firm adopts social media. The dependent variable Facebook is the binary variable equals one if a firm has adopted Facebook and zero otherwise. The main independent variables are directors' characteristics indicated by the *Directors Age*, *Female Directors*, *CEO Age* and *CEO Gender*. Columns (1) through to (4) reports marginal effects of directors age, the proportion of female directors, CEO age and CEO gender, respectively. The OLS regressions include industry and year fixed effects. The standard errors are given in parenthesis. * denotes significance at the 10% level, ** indicates significance at 5% level, and *** indicates significance at 1% level. The sample consists of 175 South African firms listed on the JSE. Variables used are defined in Appendix 4A.

Appendix 4E: Robustness tests for the impact of director characteristics on the likelihood of firms adopting social media

Logistic model

Facebook	(1)	(2)	(3)	(4)
Directors Age	-0.028***			
	(0.005)			
Female Directors		0.006**		
		(0.003)		
CEO Age			-0.008**	
			(0.003)	
Female CEO				0.055
				(0.066)
Controls	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Time FE	No	No	No	No
Observations	984	984	984	984

This table reports the marginal effects of the regressors on the likelihood that a firm adopts social media. The dependent variable Facebook is the binary variable equals one if a firm has adopted Facebook and zero otherwise. The main independent variables are directors' characteristics indicated by the *Directors Age*, *Female Directors*, *CEO Age* and *CEO Gender*. Columns (1) through to (4) reports marginal effects of directors age, the proportion of female directors, CEO age and CEO gender, respectively. The logistic regressions include industry fixed effects. The standard errors are given in parenthesis. * denotes significance at the 10% level, ** indicates significance at 5% level, and *** indicates significance at 1% level. The sample consists of 175 South African firms listed on the JSE. Variables used are defined in Appendix 4A.

Appendix 4F: Robustness tests for the impact of director characteristics on the likelihood of firms adopting social media

Random effects panel logit model

Facebook	(1)	(2)	(3)	(4)
Directors Age	-0.340***			
	(0.057)			
Female Directors		0.161***		
		(0.029)		
CEO Age			-0.108***	
			(0.021)	
Female CEO				0.292
				(0.504)
Controls	Yes	Yes	Yes	Yes
Observations	984	984	984	984
Firms	175	175	175	175

This table reports the marginal effects of the regressors on the likelihood that a firm adopts social media. The dependent variable Facebook is the binary variable equals one if a firm has adopted Facebook and zero otherwise. The main independent variables are directors' characteristics indicated by the *Directors Age*, *Female Directors*, *CEO Age* and *CEO Gender*. Columns (1) through to (4) reports marginal effects of directors age, the proportion of female directors, CEO age and CEO gender, respectively. The standard errors are given in parenthesis. * denotes significance at the 10% level, ** indicates significance at 5% level, and *** indicates significance at 1% level. The sample consists of 175 South African firms listed on the JSE. Variables used are defined in Appendix 4A.