The Effect of Twitter Dissemination on Cost of Equity: Evidence from Financial and Carbon Information

Mohammed Saad A Albarrak

A Thesis Submitted in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

Newcastle University Business School

August 2020

Abstract

The recent development of communication technology through social media, more particularly Twitter, has changed the way that firms communicate with investors. This channel has created an opportunity for firms to disseminate their information to investors on a real-time basis directly. This thesis aims to investigate whether firms can influence their cost of equity (COE) by broadly disseminating their information over Twitter. Employing a sample of non-financial firms with a Twitter account, listed on the US NASDAQ stock exchange over the period 2009-2015, the thesis comprises several objectives. The first objective investigates the effect of firms' dissemination of financial information (*iDisc*) over Twitter on the cost of equity. The results find evidence that firms' dissemination of financial information over Twitter (*iDisc*) significantly reduces the cost of equity. These results are pronounced for less visible firms that are relatively small in size, have a low analyst following and a small number of investors. Highly visible firms are less likely to benefit from *iDisc* influencing their cost of equity as other communication channels may have widely disseminated their financial information. Additionally, further tests are employed to investigate the influence of news magnitude on the examined relationship. The findings of the additional tests show a significant negative association between *iDisc* and cost of equity. The second objective is to investigate whether firms' dissemination of carbon-related information over Twitter, referred to as *iCarbon*, influences their cost of equity. The study finds that *iCarbon* is significantly and negatively associated with COE. Also, additional tests are applied to investigate whether Bloomberg's environmental (ENV) and environmental, social and governance (ESG) disclosure scores influence the relationship between *iCarbon* and cost of equity. The findings show a consistent negative association between *iCarbon* and cost of equity after determining the effect of ENV and ESG score. The findings of the thesis encourage managers to consider the benefits of directly disseminating financial and carbon information to stakeholders and potential investors over Twitter to reduce firm equity financing.

Thesis Outcomes

Published Papers

Albarrak, M.S., Elnahass, M., Papagiannidis, S. and Salama, A. (2020) 'The effect of twitter dissemination on cost of equity: A big data approach', *International Journal of Information Management*, 50, pp.1-16.

Albarrak, M.S., Elnahass, M. and Salama, A. (2019) 'The effect of carbon dissemination on cost of equity', *Business Strategy and the Environment*. Epub ahead of print.

Refereed Conferences Paper

Albarrak, M.S., Elnahass, M. and Salama, A. (2019) 'Tweeting Climate Change: Does it Matter? The Effect of Carbon Dissemination on Cost of Equity', *European Accounting Association,* Paphos, Cyprus. 29-31 May.

Seminar Presentation

Albarrak, M.S., Elnahass, M. and Salama, A. (2017) 'The Effect of iDisc on Cost of Equity', *Accounting, Governance and Accountability (AGA) research group at Newcastle University,* Newcastle, United Kingdom. 20 Nov.

Dedication

This thesis is dedicated to my parents, Saad Albarrak and Haya Alhudaib, who have been praying for me and supporting me with true blessing. I also dedicate this thesis to my beloved wife, Aljawharah Almuqrin, who constantly encourage and support me throughout my study. Further dedication to my brothers and sister, Abdulmohsen, Thamir, Ahood, Abdulaziz and Abdulrahman who have always been there for me.

Acknowledgment

I am sincerely grateful to Allah for all the blessing in my life and for honouring me to complete this thesis.

I would like to express my heartfelt gratitude to my supervisory team, Professor. Aly Salama and Dr. Marwa Elnahass, for giving the opportunity to study under their supervision and provide me with guidance, support, time and knowledge in order to complete this thesis. Their constructive feedback and comments have improved me as researcher and contributed to the quality of the work. Special thanks to Professor. Aly for all his support during PhD study. He always been and will be my mentor and a big brother to me.

I am also extremely thankful to Prof. Savvas Papagiannidis for his valuable comment and constructive feedback on the first empirical study (Chapter 3). His valuable comments assist me with increase my knowledge on social media and attribute to the quality of the thesis. I would also like to thank my panel members, Prof. Simon Hussain and Dr. Yan Zeng, and Dr. Caludia Gabbioneta for their constructive comments during my study at Newcastle University.

Special thanks to anonymous reviewers from *International Journal of Information Management* for their comments that help to improve my first empirical study (Chapter 3). The constructive feedback that I received from anonymous reviewers at *Journal of Business Strategy and the Environment* and in participating on *42nd Annual Congress of the European Accounting Association (EAA) Conference*, 29-31 May 2019 in Paphos, Cyprus have help me to improve the quality of the second empirical study (Chapter 4).

Special thanks to my family (my parent, wife, brothers and sister) that always provide me with tremendous support, motivation, guidance and prayer throughout my study. Without their support and encouragement, I would not be able to overcome the challenges and difficulty that I experienced during my study.

I am also thankful for Saudi Cultural Bureau and King Faisal University for funding my PhD study and provide me with financial support. Finally, I want to thank my friends and colleagues at Newcastle University who always been there for me and surround me with their help and support during my PhD journey.

Table of Contents

List of Tables

List of Figures

List of Abbreviation

2SLS	Two-stage least square
API	Application programming interface
AR(1)	First-order serial correlation
AR(2)	Second-order serial correlation
CDP	Carbon Disclosure Project
CEO	Chief Executive Officer
CO_2	Carbon dioxide
COE	Cost of equity
ENV	Environmental disclosure score
EPA	Environmental Protection Agency's
ESG	Environmental, social and governance disclosure score
FEPS	forecasted earnings per share
GHG	Greenhouse Gases
GMM	Generalized Method of Moments
iCarbon	Firm's dissemination of carbon-related information
iDisc	Firm's dissemination of financial information
Max	Maximum value
Mean	Mean value
Med	Median value
Min	Minimum value
N	number of observations
NASDAQ	National Association of Securities Dealers Automated Quotations
NYSE	New York Stock Exchange
OLS	Ordinary Least Squares
Reg FD	Regulation Fair Disclosure
RSS	Rich Site Summary
SD	standard deviation
SEC	The U.S. Securities and Exchange Commission
SIC	Standard Industrial Classification
US	The United State of America

Chapter 1. Introduction

1.1 Introduction

The development of information technology, particularly social media, has proliferated in the past decade, opening up new possibilities for information processing and decision making. This development of social media creates additional communication channels where users share views, exchange news, update status and express ideas on a frequent and timely basis. This shift in communication technology has influenced the ways in which firms communicate important information to investors (Lee *et al.*, 2015a). Among many social media platforms, Twitter has gained popularity recently with investors as a means of retrieving firm news, and many firms have increasingly used this channel to disseminate material information (Blankespoor *et al.*, 2014; Brunswick, 2014; Lee *et al.*, 2015a).

In April 2013, the US Securities and Exchange Commission (SEC) issued a statement allowing firms to use social media, such as Twitter, as an information medium for disseminating and discussing corporate disclosures that comply with Regulation Fair Disclosure (Reg FD). This statement follows Netflix's CEO action of disseminating of fundamental information on his social media account, and a debate was held on whether his actions had violated SEC regulations. However, this information caused an increase in Netflix's stock price by over 20%. Accordingly, this action has attracted attention regarding the use of social media as an important channel for disseminating firms' fundamental information. Given the rapid growth and increasing interest in social media, this thesis focuses on firms' adoption of social media as a channel for disseminating investor-related information, and its corresponding effect on the cost of equity.

1.2 Thesis Motivation and Importance

Social media platforms, such as Twitter, provide firms with various opportunities to improve their communications and connect with a large set of audiences including customers, partners and investors (Siikanen *et al.*, 2018). These online revolutionary channels also provide a large volume of information often called *big data* that potentially creates value for the firm (Raguseo and Vitari, 2018). More importantly, social media channels create opportunity for firms to engage in real time basis with investors and improve transparency (Bellucci and Manetti, 2017). In recent years, firms have started to consider the relevance of using social

media as "an integral component of firm communications" (Blankespoor *et al.*, 2014, p. 84). Typically, firms publicised their information through traditional media channels such as the press and conference calls. Recently, social media platforms have formed an additional key channel for information dissemination purposes. A survey of Fortune 1000 firms found that 93% of respondent executives believe that management participation on social media is vital to attract and connect with investors (Brandfog, 2016). Most notably, the increasing reliance on social media among individuals to access firm news and investment advice makes firms that fail to participate and connect with investors very noticeable (PR Newswire, 2015; Cade, 2018). Other researchers (see Lau and Wydick, 2014; Miller and Skinner, 2015) have argued that the rapid increase of social media will eventually overtake and weaken the roles of traditional media channels by reducing the interest in and resources available to them. Meanwhile, social media will become more important.

Considering the important role of using social media, the current study focuses on a popular social media platform, Twitter, which has been used increasingly in practice and in the recent literature (e.g. Bartov *et al.*, 2018; Cade, 2018; Jung *et al.*, 2018b). Among other social media platforms, Twitter has become a dominant tool for investor relation purposes (NIRI, 2013; Elliott *et al.*, 2018; Grant *et al.*, 2018). Approximately 84% of US firms in the third quarter of 2014 had Twitter accounts, and 70% of them had investor-related tweets (Investis, 2015). Twitter, as an information channel, has significantly lowered the cost of communication and changed the way investors acquire information (Jame *et al.*, 2016). The platform reduces the time that investors expend to "pull" information by allowing firms to "push" their information to investors directly and on a fast time basis (Blankespoor *et al.*, 2014). It also allows firms to have more flexibility and control over the decision to disseminate firm information, where they can choose the time, content and number of disseminated messages. These features allow firm information to achieve a wider reach to investors in a direct manner, on a timely basis, and at lower acquisition costs (Blankespoor *et al.*, 2014). Therefore, it is crucial for firms to acknowledge the benefits of Twitter to satisfy investors' demand for information and improve their firm's information environment. However, it is worth noting that the information provided on this platform should be transmitted in a short-message format. This feature means that firms use this channel mainly for dissemination purposes by highlighting or linking to information that has already been disclosed to the public. Whilst previous studies have investigated Twitter effects on capital market activities such as stock prices, returns and liquidity (Blankespoor *et al.*, 2014; Lee *et al.*, 2015a;

Bhagwat and Burch, 2016; Mazboudi and Khalil, 2017; Jung *et al.*, 2018b), by extending the literature, the thesis is motivated to investigate the value of disseminating firm information on Twitter by examining its association with the cost of equity.

The motivation behind understanding the effect on the cost of equity is because of several reasons. First, cost of equity (COE) is referred to as the discount rate or the internal rate of return that is applied on firm's future cash flows to determine firm market value (El Ghoul *et al.*, 2011; Lui *et al.*, 2016). Generally, it represents the rate of return that investors require for firms' riskiness and investments (El Ghoul *et al.*, 2018). As such, COE performs as a key element in firm investment decisions and the reduction of the COE should encourage firm managers to consider the benefit of disseminating firm information over Twitter. Secondly, Fourthly, academic literature (Botosan, 1997; Fu *et al.*, 2012) has supported this view, as inconclusive evidence has been obtained regarding the effects of firm information on the COE. Such mixed results fuel a continuing debate among scholars regarding the effect of firm information on the COE (Easley and O'hara, 2004; Hughes *et al.*, 2007; Lambert *et al.*, 2007; Lambert *et al.*, 2011; Cheynel, 2013; Lambert and Verrecchia, 2015). Whilst many studies (e.g. Kothari *et al.*, 2009a) examine how voluntary and mandatory disclosure influences the cost of equity, the association of firms' dissemination channels, specifically the Twitter social media platform, with investor-related information and COE is still under investigation.

Dissemination plays a critical role in expanding the spread of a firm's information, and more effectively meeting investor demand for information. In particular, stockholders' demand for information is escalated by information asymmetry and uncertainty between investors, which result in an increase in the COE (Kothari *et al.*, 2009a). This escalated demand for information and its effects on COE motivates both regulators and firm managers to improve the transparency of the firm information environment and to attempt to distribute that information to a greater number of investors through many information intermediary channels. Correspondingly, the SEC has encouraged firms to adopt technology channels as a mechanism for disseminating information, in an attempt to improve the transparency and efficiency of the market (SEC, 2008). Whilst firms may intend to rely on information intermediary channels managed by third parties, such as the press, these channels are inclined to provide coverage for firms that have already acquired major reader attention (Miller, 2006). This means that not all firms can benefit from such dissemination channels to connect

with potential investors. Firms, therefore, may use Twitter, an increasingly popular technology channel, which allows them to bypass other information intermediaries and disseminate their information directly to investors (Blankespoor *et al.*, 2014).

To examine the association of dissemination with COE, this thesis is divided into two main empirical chapters focusing on two types of information that firms disseminate on their Twitter accounts. This information is part of firm mandatory disclosure which is already known to the market, and which firms are not required to disseminate on Twitter. Hence, the effects of dissemination and disclosure can be differentiated. Firms use Twitter messages to broaden the dissemination of firm information rather than for revealing new information (Blankespoor *et al.,* 2014; Jung *et al.,* 2018). That is, Twitter messages are short (limited to 140 character) and they usually include quotes or links to press releases or conference calls. However, Twitter features allow firms to spread the dissemination of firm information and enhance investor attention (Hirshleifer and Teoh, 2003; Hirshleifer *et al.,* 2009; Blankespoor *et al.,* 2014). In addition, theoretical studies (Grossman and Stiglitz, 1980: Hong and Stein, 1999) suggest that the market efficiency of price discovery is not only affected by the information content but also by the information means that is used to spread firm information across investors. Hence, the speed with which the information is reflected in a firm's price depends on the number of investors who become informed in a timely manner (Twedt, 2016). Firm dissemination via Twitter allows firm information to reach a large set of current and potential investors (Blankespoor *et al.,* 2014; Jung *et al.,* 2018). Twitter features should improve the dissemination of firm information available to the market and may influence investors' beliefs about the firm's COE. By improving investor recognition and reducing information acquisition costs, which limit investor attention, the broader dissemination of information via Twitter should enhance investors' information, reduce information asymmetry and hence influence the COE

The first empirical chapter focuses on financial information, which firms increasingly disseminate on Twitter (Blankespoor *et al.*, 2014; Elliott *et al.*, 2018; Jung *et al.*, 2018b). This type of information receives stronger interest from investors, who find Twitter an important medium with which to look for such information (see Elliott *et al.*, 2018). Alternatively, firms' managers are required to communicate with market participants and report this type of information (Loughran and McDonald, 2014), providing that this information influences investors' decision making and investment behaviour towards the firms by allowing investors

to evaluate their financial performance, future cash flow and market value (Botosan, 1997; Barth and Schipper, 2008; Fu *et al.*, 2012; Schreder, 2018). Overall, financial information results in many economic consequences, and managers increasingly disseminate the information on Twitter to meet investor demand for the information (García-Sánchez and Noguera-Gámez, 2017; Grant *et al.*, 2018). Thus, the study examines the association between the dissemination of financial information (*iDisc*) on Twitter and the COE.

Traditionally, a firm's financial information has always been viewed as the key component of their value and the sole interest of investors. However, in the current knowledge-based era, non-financial information has increasingly gained importance within a corporation. In the second empirical study of this thesis, the focus is placed on a type of non-financial information being disseminated on the Twitter platform, i.e. carbon-related information. Environmental issues and liabilities related to climate change and carbon emissions have attracted growing research interest, given the major impact they have on ecosystems and human lives and health (Giannarakis *et al.,* 2017). This interest has become increasingly important to many firms, with some being penalised by investors for not reporting carbon information (Matsumura *et al.,* 2014). Recently, Volkswagen lost billions of dollars in penalties, fines and repair costs for their emission scandal. This scandal has harmed the firm's business in many countries (El Ghoul *et al.,* 2018), whereas firms with better complying of corporate social responsibility (CSR) help firms to enhance their reputations and value which can lead to reduce the cost of equity (El Ghoul *et al.,* 2011; Cahan *et al.,* 2015; Byun and Oh, 2018). Besides this backdrop of costs, closer attention from investors, media, regulators and environmental groups motivates many firms to make strategic investments to improve their environmental performance (El Ghoul *et al.,* 2018) and consider climate change as part of their management strategy (Weinhofer and Hoffmann, 2010; Sprengel and Busch, 2011). As Ng and Rezaee (2015) point out, "this interest has created opportunities and challenges for firms in their risk-return relationships with shareholders and other stakeholders" (p. 128). It also creates growing pressure on managers to comply with shareholders' information demands and gain legitimacy among their stakeholders. In particular, social media (e.g. Twitter), can be a suitable channel for firms to engage with stakeholders and a potential legitimation tool (Bellucci and Manetti, 2017; Deegan, 2019). Thus, managers have incentives to meet investor demand of information and gain legitimacy by strategically conveying messages about carbon related information.

Prior literature (Bellucci and Manetti, 2017) notes that Twitter can be a suitable communication channel for stakeholder engagement, and an instrument for legitimatisation. Others (Adams, 2002; Deegan, 2002; Bellucci and Manetti, 2017) also suggest that firms can use these instruments to impact the perceptions of stakeholders and society, and reduce the regulatory cost. As such, firms can use Twitter to disseminate carbon-related information to enhance society's and stakeholders' perceptions about the firm and also to enhance the firm's image (Clarkson *et al.,* 2011; Bellucci and Manetti, 2017). Disseminating carbon-related information over open platforms such as Twitter also allows firms to gain legitimacy by demonstrating that they are environmentally responsible organisations (Stanny, 2013). That is, Twitter allows firm information to reach a broad audience, including market participants, stakeholders and environmental support groups who care about climate change and firms' environmental information (Lee *et al.,* 2015). As such, dissemination over Twitter also allows firms to engage and improve dialogue with multiple audiences over carbon-related information, which enhances social support and the perceived legitimacy of firms (Seele and Lock, 2015; Lee *et al.,* 2018b). Consequently, the second empirical study focuses on the dissemination of information related to carbon emissions and climate change. Specifically, the study examines the effect on the COE of disseminating carbon-related information.

Given the importance of understanding social media in information communication (Blankespoor *et al.*, 2014; Miller and Skinner, 2015; Cade, 2018), the thesis is justified by the call of Kothari *et al.* (2009a) for more research into "technological innovation […] and changes in disclosure channels and the number and type of information intermediaries that continue to reshape disclosure and financial reporting practices and create new and exciting opportunities for research" (p. 1667). The thesis also follows the call of Jia *et al.* (2016) and Deegan (2019) for a study of the role of social media as a channel to connect audiences with firms, which is likely to influence corporate practices towards environmental issues and reporting.

Furthermore, the empirical studies will be based on the United States (US), as it is one of the leading countries in addressing regulations pertaining to firms' use of social media platforms. In addition, firms in the US show a higher adoption of social media (Zhou *et al.*, 2015) and early use of these platforms to disseminate firm information (Jung *et al.*, 2018b), which provides better coverage during the sample period. This thesis focuses specifically on firms

that are traded on the NASDAQ stock exchange, because of its relevance to this topic.[1] Specifically, NASDAQ is one of the main stock exchanges in the US after New York Stock Exchange (NYSE). It is also one of the major technology focused stock exchange in the US. Many technology firms are traded on the NASDAQ (Chen *et al.*, 2010; Leuz and Wysocki, 2016), those which have a greater likelihood of adopting new technology, and hence a higher probability of adopting Twitter (Debreceny *et al.*, 2002; Blankespoor *et al.*, 2014; Lee *et al.*, 2015a). Compared to the other main stock markets, such as the NYSE, the NASDAQ is dominated by relatively small firms, usually with a weaker information environment and a lower number of analysts following them (Bushee *et al.*, 2010; Dang *et al.*, 2018; Meshcheryakov and Winters, 2019), and hence face higher visibility concerns than firms in NYSE (Bushee and Miller, 2012). This concern is relevant for this study because information dissemination on the Twitter platform can increase a firm's visibility and information environment (Blankespoor *et al.*, 2014). Overall, the sample of the thesis provides a proper setting to examine the influence of disseminating financial/carbon-related information.

In essence, the thesis helps to extend the literature on the role of social media as an intermediary channel in the capital market, and provide a better understanding of how social media shapes firm information environment. Subsequently, the next section discusses the thesis aims and objectives.

1.3 Research Aims, Objectives and Questions

The thesis aims to investigate whether firms' dissemination of investor-related information through social media, particularly Twitter, has real economic market consequences. To assess this impact, the thesis empirically examines the impacts of disseminating two components of firm information, i.e. financial information and carbon-related information, on the COE. The thesis will assist researchers, managers and policymakers to understand the value added by information dissemination through Twitter, especially regarding firm equity financing. It also investigates the use of Twitter in enhancing the spread of firm information to existing and potential investors by providing a smoother access channel for information. Therefore, the aim of the thesis is to achieve the two following empirical objectives:

[1] NASDAQ – National Association of Securities Dealers Automated Quotations.

1) **To investigate the association between a firm's dissemination of financial information (*iDisc*) on Twitter and the cost of equity (COE).**

   This study seeks to find a significant association between firms' dissemination of financial information on Twitter and the COE. The study also investigates whether the association differs for highly visible and less visible firms. Less visible firms are usually neglected by the media, market participants and financial analysts; hence their small size and lower COE, as their information is less likely to reach a broad number of investors (Bushee and Miller, 2012; Blankespoor *et al.,* 2014). In contrast, highly visible firms are usually followed by financial analysts and have more media coverage. These firms tend to be large in size, have higher liquidity and lower COE. As such, firms that are less visible can benefit more from disseminating financial information over Twitter by reaching a larger set of current and potential investors. Furthermore, an additional investigation is conducted on whether news magnitude or tweet tone influence the association between dissemination of financial information (*iDisc*) on Twitter and the COE.

2) **To investigate the association of a firm's dissemination of carbon-related information (*iCarbon*) on Twitter and the cost of equity (COE).**

   This study aims to empirically examine whether disseminating carbon-related information on Twitter influences firm equity financing. Prior literature (Lee, Oh and Kim, 2013) has shown that firms that are more environment-ally responsible are more likely to adopt Twitter for stakeholder communication purposes. That is, Twitter allows firms to benefit by being more environmental responsible by increasing stakeholder awareness of their environmental activity. Furthermore, firms that are more environmental responsible receive more positive news and have a better media image (Cahan *et al.,* 2015). Therefore, the study investigates whether firm environmental (ENV) and environmental, social and governance (ESG) reporting scores influence the association between a firm's dissemination of carbon-related information (*iCarbon*) on Twitter and the COE.[2]

Financial and carbon information is known to the market as firms are required to report this information to the public. In addition, financial information is part of the mandatory

[2] The reporting scores reflect the amount of information that is reported by the firm about environmental (ENV) and environmental, social and governance (ESG) information and made available to the public.

disclosure requirement. In the case of carbon-related information, firms that emit at least 25,000 metric tons of CO_2 are mandated to report their emissions to the market. However, firms are not required to disseminate the information over Twitter, which means that the effects of dissemination and disclosure can be differentiated (Jung *et al.,* 2018). Hence, financial and carbon-related information are relevant for the study. Furthermore, firm dissemination over Twitter can be viewed as an extension of the firm's disclosure strategy (Jung *et al.,* 2018). Information about financial and carbon emissions can aid market participants in evaluating firms' riskiness, which allows them to make better investment decisions to maximise their wealth. This type of information has an influence on firms' value and the COE (e.g. Botosan, 1997; Dhaliwal *et al.,* 2011; El Ghoul *et al.,* 2011; Kim *et al.,* 2015; El Ghoul *et al.,* 2018). Both financial and carbon- related information attract great interaction from market participants (Ng and Rezaee, 2015). To achieve these aims and objectives, the following research questions are addressed in the thesis:

1) Does firm dissemination of financial information (*iDisc*) on Twitter influence firm cost of equity?
2) Does firm dissemination of carbon-related information (*iCarbon*) on Twitter influence firm cost of equity?

1.4 Findings of the Thesis

1.4.1 The effect of Twitter dissemination on cost of equity

The first empirical study examined whether a firm's dissemination of financial information (*iDisc*) on Twitter impacts their COE. By using a sample of 584 non-financial firms with Twitter accounts that are listed on the NASDAQ stock exchange, representing 1,737 observations, for the period 2009-2015, the study found that the dissemination of financial information on Twitter has a significant negative association with firm COE. The finding implies that enhancing the broadness of firm financial information through dissemination over Twitter allows firms to reduce their equity financing. The study collects some of the "big data", equal to 1,197,208 tweets from 584 firms' Twitter accounts from 2009 to 2015. The selection of the sample period allows us to avoid the financial crisis that caused a macroeconomic shock between 2007 and 2008. Although Twitter was launched in 2006, its popularity grew particularly in 2009 (Marwick and Boyd, 2011; Zhou *et al.,* 2015). Moreover, a small number of selected sample firms adopted Twitter before 2009. The study

also found that this effect of disseminating financial information (*iDisc*) over Twitter on COE is more pronounced for firms that are smaller in size, have a lower number of analysts' fellowship, and a smaller number of shareholders' investors. In other words, the effect of *iDisc* on COE is stronger for less visible firms that have a lower information environment and a greater need for additional channels of information dissemination. In addition, the study examined whether the news magnitude influences the association between *iDisc* and COE. Consistent with firms' strategic disclosure behaviour, the study expected that firms that missed an earnings forecast would have lower incentive to disseminate their news. The study also examined whether the tone expressed in *iDisc* tweets would influence the association between *iDisc* and COE. The empirical findings showed that *iDisc* is consistently negative with COE, whereas news magnitude and tweets tone had no significant influence on the results. Furthermore, the study showed that the effect of *iDisc* on COE is consistent, after using a different estimation measure for COE and *iDisc* and also considering additional control variables. For example, the results show that *iDisc* tweets that include hyperlink to more information (iDisc_Hyperlink) and that are disseminated to larger number of audiences, more specifically followers, (iDisc_Followers) have significant negative associations with the COE. Overall, the study found that the dissemination of financial information on Twitter allowed firm information to reach a broader number of investors directly, at a lower cost and with better accessibility, which, as a result, reduced the firm's COE.

1.4.2 The effect of carbon dissemination on cost of equity

The second empirical study examined whether a firm's dissemination of carbon-related information on Twitter has an impact on their COE. By using a sample of 584 non-financial firms with Twitter accounts that are traded on the NASDAQ stock exchange, representing 1,737 observations, for the period 2009-2015, the study found that the dissemination of carbon-related information (*iCarbon*) has a significant negative association with firm COE. This finding indicates that firms that gain legitimacy among stakeholders by disseminating their carbon information through Twitter to a broader set of potential investors, including environmentally concerned groups, are compensated with a lowering of their equity financing. The study also examined whether a firm's environmental (ENV) or environmental, social and governance (ESG) reporting scores have an influence on the effect of *iCarbon* on COE. That is, whether firms with better ENV or ESG reporting have greater incentive to disseminate their carbon-related information on Twitter. The findings showed that the impact

of *iCarbon* on COE is not influenced by firm ENV or by ESG reporting scores. These results indicate that dissemination has its own capital consequences to influence COE, which is not affected by the scores of firm ENV or ESG reporting. The robustness test of the study also shows consistent findings by considering different estimation measures for *iCarbon*. For instance, tweets with hyperlink facilitate easy access for more information. The result shows that *iCarbon* tweets that include hyperlink reduce the COE. Taking the retweet feature on Twitter, tweets are usually retweeted when other users want to share the information and show agreement and support for the information (Boyd *et al.*, 2010; Recuero *et al.*, 2011). As such, the retweet may improve the validity of the tweet causing greater impact on investor behaviour and perception (Cade, 2018). The findings of the study show that *iCarbon* tweets that are retweeted (iCarbon_Retweet) have a significant negative association with COE. Furthermore, the findings of the robustness check show consistent negative association by considering different COE measures and including additional control variables. Overall, the findings provide evidence that the *iCarbon* assists firms to reach a large group of audiences including current and potential investors and environmental concerned groups, allowing them to learn about firm carbon information, and hence, reward these more legitimate firms with a reduction on their COE.

In conclusion, the thesis found that dissemination of both financial and carbon information reduces a firm's equity financing. This thesis contributes to recent literature on firms' use of Twitter to disseminate financial information by showing that tweeting financial and carbon information is meaningful and beneficial to investors, as well as firms, by reducing the COE.[3]

1.5 Contribution of the Thesis

By meeting the objectives, the thesis contributes to the literature in a number of ways. Much research has examined the influence of disclosure level and the quality of different types of disclosure, including management forecast, financial, environmental, social and intellectual disclosures (e.g. Botosan, 1997; Botosan, 2006; El Ghoul *et al.*, 2011; Kim and Shi, 2011; Mangena *et al.*, 2016), and disclosure channels such as corporate websites and conference calls (Zhao *et al.*, 2009; Orens *et al.*, 2010). There is little evidence on firm dissemination of information activity and social media, i.e. Twitter. By investigating this association, the thesis

[3] In order to control the endogeneity problem between *iDisc* or *iCarbon* with COE, the study employs the two-stage least squares (2SLS) model and dynamic panel GMM estimator. The study also uses variance inflation factors (VIFs), and the Spearman and Pearson correlation matrix, which shows no spurious correlation problems.

also extends the studies that explore the importance of a firm's use of Twitter for the information environment and capital market. Prior researchers have examined the consequences of the dissemination and announcements of corporate news through Twitter on capital market characteristics, such as returns, liquidity and information asymmetry (Blankespoor *et al.*, 2014; Lee *et al.*, 2015a; Prokofieva, 2015; Mazboudi and Khalil, 2017; Jung *et al.*, 2018b). These studies show firm activity over Twitter can result in a reduction in information asymmetry and improvement in market liquidity among US technology firms and Australian listed companies (Blankespoor *et al.*, 2014; Prokofieva, 2015). Further studies (Lee *et al.*, 2015a; Mazboudi and Khalil, 2017) show that Twitter activity can attenuate negative market reaction, such as product recall and acquisition announcements. Meanwhile, Jung *et al.* (2018b) examined firm strategic decision to disseminate earnings news. It is still unclear whether firm dissemination activity over Twitter has an impact on the COE.

"The first empirical study contributes to the literature by examining the effect of firm dissemination of financial information (*iDisc*) over Twitter on the COE. The study also extends the literature by investigating how the association differs across firms with different visibility levels, in terms of market value, number of analysts' following and number of investors. These findings add to Al Guindy (2017), who examined the firm use of Twitter. The study was based on two binary variables of whether firms adopt Twitter and use Twitter to report financial information, and their effect on the cost of capital. Nevertheless, this thesis focuses more on dissemination rather than firm use of Twitter. The thesis also focuses on two different sets of information: financial and carbon related. Furthermore, using different measures of firm dissemination activity over Twitter, the thesis uses dissimilar COE estimates, control variables and estimation models. Meanwhile, Al Guindy (2017) uses Gebhardt, Lee and Swaminathan's (2001) model to estimate the cost of capital. Using a particular model may cause spurious results (Dhaliwal *et al.,* 2006; El Ghoul *et al.,* 2011). Hence, this thesis uses four different COE estimates to reduce any possible estimation error. Furthermore, Al Guindy (2017) did not control for press coverage which firm tend to use to disseminate firm information, whereas this thesis controls for many information intermediary channels, including the press. In addition, the thesis also extends previous literature by focusing on firms that are listed on NASDAQ and by selecting a longer sample period. The thesis also collects the big data of firm tweets, over a million firm tweets, for a longitudinal period of time to quantify the amounts of financial information that are disseminated over Twitter. Furthermore, the thesis also contributes to the literature by examining whether the

magnitude of firm news and the tone of the tweets influence the impact of a firm's dissemination of financial information (*iDisc*) over Twitter on the COE. These findings extend Kothari *et al.* (2009a), who found that the information content of different information intermediaries had different effects on COE, whereas this study examines the effect of dissemination and the tone of firm messages over a new information intermediary, Twitter.

Moving towards non-financial information, prior literature attempted to provide a better understanding of the influences of carbon emissions and climate change on the COE by studying the impact of carbon/climate risks and reporting (Chen and Gao, 2011; Kim *et al.*, 2015; Li *et al.*, 2017; Lemma *et al.*, 2019), temperature shock (Balvers *et al.*, 2017), environmental profile (Chava, 2014), environmental practices to reduce emissions (Gupta, 2018), and management of environmental risk (Sharfman and Fernando, 2008). Nevertheless, the second empirical study of the thesis extends the literature by focusing on the dissemination of carbon-related information (*iCarbon*). That is, dissemination has its own consequences on the capital market which is different from corporate disclosure (Bushee *et al.*, 2010). In addition, the study adds to prior literature by focusing on an essential relationship linked to carbon emissions and climate change by using Twitter and its association with COE. The study also contributes to the literature by further examining whether firm environmental (ENV) or environmental, social and governance (ESG) reporting scores influence the association of carbon-related information and COE.

Furthermore, most previous studies (e.g. Lee *et al.*, 2015b; Peng *et al.*, 2015; Zhou *et al.*, 2018) attempted to study the dissemination effect of carbon disclosure and communication over the media in emerging markets, as in the contexts of Korea and China. However, this study focuses on Twitter specifically, and on the US, a strongly developed country and financial market. Firms in the US are mandated to report their emissions if they emit at least 25,000 metric tons of CO_2. Such information does not need to be disseminated over Twitter, as it has been reported through other disclosure channels, which supports the use of Twitter purely for dissemination purposes.

Even though financial and carbon related tweets involve limited amount of information, the result show that both *iDisc* and *iCarbon* influence firm equity financing. These findings should extend previous studies (e.g. Bushee *et al.,* 2010; Drake *et al.,* 2014; Twedt, 2016) that show that dissemination has its own effect on the equity market. To the best of my knowledge, this thesis is the first to examine the association between firm dissemination

using Twitter and the implied COE (based on an average of four implied COE estimates). In particular, the thesis focuses on the dissemination of both financial information and non-financial information. Chapters 3 and 4 will describe in more detail the contributions of the two empirical studies, respectively.

1.6 Implication of the Thesis

The findings of the study provide several implications for firm managers, investors and regulators. While firm managers are still investigating the value of the corporate use of Twitter and social media, the thesis findings recommend firm managers to incorporate Twitter into their corporate reporting strategy. In particular, the findings of the first and second empirical study show that firm dissemination over Twitter has negative impact on the cost of equity. This implies that broader dissemination over Twitter should enhance the reach of firm information among investors which in turn would reduce the information asymmetry, increase investor awareness of the firm, reduce the investors' acquisition cost of information, enhance firm legitimacy and hence reduce the equity financing. These findings encourage firm managers to use Twitter more for disseminating both financial and carbon related information to reach investors directly and on a timely basis. Additionally, the finding of firm empirical study suggests that firms that are less visible should give more consideration to using Twitter for dissemination purposes. These firms would benefit more from using Twitter by reducing information acquisition costs and thus enhancing its visibility among investors. Similarly, these findings should interest investors who use Twitter for information processing. The findings of the thesis show that dissemination over Twitter is meaningful for investors, and firm managers should consider communicating and sharing their information with investors through Twitter.

Dissemination to wider coverage of investors can provide vital implications for market liquidity and efficiency (Bushee *et al.,* 2010). Peress (2014) finds that improving the dissemination of information can help investors to incorporate the information into the share price, which improves the efficiency of the market. That is, dissemination allows many investors to receive firm information in efficient time, which can help them to alleviate the information asymmetry and enhance investors' recognition and evaluation of the firm's value (Blankespoor *et al.,* 2014; Prokofieva, 2015). As such, improving dissemination can help to enhance trading activity and also enlarge investor base (Gao *et al.,* 2020). In addition, theoretical studies (Grossman and Stiglitz, 1980: Hong and Stein, 1999) suggest that the

market efficiency of price discovery is not only affected by the information content but also by the information means that extend the spread of firm information across investors. Hence, the speed with which the information is reflected in the firm's price depends on the number of investors who become informed in a timely manner (Twedt, 2016). Firm dissemination via Twitter allows firm information to reach a large set of current and potential investors (Blankespoor *et al.,* 2014; Jung *et al.,* 2018). Twitter features should improve the dissemination of firm information that would be available to the market and may influence investor beliefs about the firm's cost of equity (COE). By improving investor recognition and reducing the information acquisition cost that limits investor attention, broader dissemination via Twitter should enhance investors' information, reduce information asymmetry and hence influence the COE.

While regulators focus more on how information is used, there should be more consideration on the costs that market participation acquires for searching and processing information and how firm information reaches investors and market participants. New technology channels such as Twitter provide faster, inexpensive and better acceptability of information. This channel accelerates the delivery of firm information to a broad reach of investors at lower cost. This thesis suggests regulators expand mandatory disclosure requirements to include more technology which should attribute to a better capital market. Understanding the effect of dissemination over Twitter on COE should provide regulators and policymakers with insight into the benefit of using social media.

In response to the growing use of Twitter by firms for disseminating corporate information, regulators have issued several pieces of guidance for firms that use Twitter for disseminating material information. Although Reg FD requires firms to disclose material information in press releases or by filing 8Ks, there is no clear guidance for how firms should use Twitter to disseminate material information. However, in 2013, the SEC announced that firms can use Twitter to disseminate material information such as financial related information (SEC, 2013). Furthermore, the SEC made an announcement in 2015 which stated that Twitter can be used to attract investors' interest in stock or debt offering. This guidance supports firm use of Twitter by supplementing firm disclosure by enhancing the dissemination of firms' key information. In addition, the SEC has initiated many regulations to enhance investors' investment decisions such as electronic filing through eXtensible Business Reporting Language (XBRL) and reporting through corporate websites, which aims to improve

investors' awareness and to reduce information acquisition costs (Blankespoor *et al.,* 2018). Twitter can provide aid for investors by allowing them to receive firm information in fast, less expensive and direct messages, which allow them to receive firm information with a lower acquisition cost. This results in better investor awareness (Blanespoor *et al.,* 2014). Overall, these regulations aim to help investors to make better investment decisions and to make the market more liquid, efficient and transparent by using technology-innovated communication channels such as Twitter.

Explicit implications should also be provided to regulators and policymakers about climate change and carbon emission. Trump administration announced on 1 June 2017 that the US would withdraw from the Paris Climate Accord as it was claimed it would cause the country many economic disadvantages (The White House, 2019). As the formal withdrawal from Paris Agreement will occur in 2020, many researchers have chosen to examine the impact of this decision (see Wang and Sueyoshi, 2018). However, firms with better complying to CSR tend to have reputation and value form investors' perspective (El Ghoul *et al.*, 2011; Cahan *et al.,* 2015; Byun and Oh, 2018). Other reports show that climate change would have an impact on American society by causing potential damage to people's health and life and would cost the country billions of dollars (BBC News, 2019; Reidmiller *et al.,* 2018). However, the findings of the research will assist regulators and policymakers by showing that a firm's dissemination of climate change and carbon emission information will assess them with lower COE. This finding implies that dissemination of this information is perceived positively by the capital market participants and investors take climate change into their consideration. This suggests regulators and policymakers should implement more guidance towards climate change rather than withdrawing from environmental regulations.

In 2009, the Environmental Protection Agency (EPA) in the US began the Greenhouse Gas Reporting Program (GHGRP), which required firms to report their carbon emissions. Under this mandatory reporting of carbon emissions, firms that emit more than 25 thousand metric tons are required to report their emissions to the EPA each year. In response, the EPA publish these reports to assess research that attempts to link carbon emissions and climate change. Under this guidance, the EPA estimates that the majority of carbon emission firms in the US (approximately 85% to 90%) report to the EPA (EPA, 2013). That being said, the disclosure of carbon emissions before GHGRP was voluntary under the carbon disclosure program (CDP). In comparison to European firms, firms in the US are "not subject to a carbon

emissions cap-and-trade scheme whereby firms that emit GHG in excess of their allowances have to incur a monetary cost which may be expected to negatively impact their equity values" (Clarkson *et al.,* 2015; Cooper *et al.,* 2018, pp. 228). Even though greenhouse gas emissions are not toxic, they could have an impact on the society by influencing potential climate change (EPA, 2015). The EPA has also introduced a Clean Power Plan (CPP) that motivates firms to disclose carbon-related information. The CPP aims to establish "standards on carbon dioxide emission performance rates for new coal and natural gas-fired power plants" (Hsueh, 2019, p. 194). However, the CPP policy plan has subsequently reversed under President Trump's administration. Nonetheless, the findings of the thesis show that investors value carbon-related information because it reduces firms' equity financing. This finding suggests that managers and regulators should implement more plans for controlling carbon emissions.

Overall, the thesis findings strongly suggest that firm managers should actively disseminate financial and carbon-related information over Twitter to meet investor demand of information and improve the firm information environment. The findings also suggest that using Twitter as a controlled intermediary channel for *iDisc* and *iCarbon* purposes allows firms to reduce the information problem and uncertainty surrounding investors' expected rate of return. It also allows firms to gain legitimacy among their shareholders. In general, the research findings have shown that investors value firm dissemination of information, and this can benefit firm managers by resulting in a lower COE.

1.7 Structure of the Thesis

The structure of the thesis is as follows. Chapter 2 provides background information for Twitter. Chapter 3 presents the first empirical study. This chapter is composed of the following sections: introduction, background and literature review, hypothesis development, methodology, empirical results and analysis, and conclusion. Chapter 4 reports the second empirical study; this chapter includes the following sections: introduction, literature review, hypothesis development, methodology, empirical results and findings, and conclusion. Lastly, Chapter 5 provides a conclusion of the thesis by providing an overall summary of the main contributions and findings of the whole thesis. This chapter also includes a discussion of the practical implications of the thesis, and limitation and recommendations for further research.

Chapter 2. Background of Twitter

This chapter aims to provide an overview of Twitter as an information dissemination channel. The chapter is structured in two sections, first, providing broad aspects of Twitter definition and mechanism and second, discussing corporate use of Twitter as social network channels. The study focuses on Twitter, a subset of broad social media, which is classified as a social networking site. An overview of Twitter will be provided. Twitter has become a dominant tool of firms with regard to communicating with investors. The platform has experienced phenomenal success due to its early and high adoption rates. A potential explanation for its popularity can be partly based on the mechanisms, features and tools available to a Tweeter (a Twitter user), which will be explained in Section 2.2. As social media has caused a paradigm shift in the ways people communicate, connect, express and share ideas with each other, corporations have acknowledged these unique features and brought Twitter into use, mainly for the purposes of communicating and engaging with investors (Blankespoor, 2018). As a result, corporate use of Twitter platforms will also be discussed. Subsequently, an illustration of firm adoption of Twitter platforms, together with the regulations related to the corporate usage of this platforms, will be discussed. The chapter also reviews the motives for firm adoption of Twitter. Section 2.3.3 describes the determinants of firm disclosure components on social media. Once a firm has determined the information package, they select a channel to disseminate the information. Section 2.3.4 discusses firm dissemination channels in detail. Overall, an understanding of the mechanisms behind Twitter in particular, which motivate firm adoption of this channel will provide a solid foundation for a better understanding of the thesis at its latter stages.

2.1 Twitter Definition

In 1979, Tom Truscott and Jim Ellis created a discussion system called Usenet, which allowed worldwide Internet users to post messages to the public, yet the concept behind social media started around 20 years ago when Bruce and Susan Abelson created “Open Diary”, an old online site where many online diary writers were brought together into one community (Kaplan and Haenlein, 2010; Martinviita, 2016). At that time, a social network site was called a “weblog”, before being shortened to “blog”. As Internet and mobile use and availability among individuals increased, this added to the popularity of social media sites (Debreceny, 2015). This increase in popularity led to the creation of MySpace, Facebook and Twitter in 2003, 2004 and 2006, respectively, which in turn led to the coining of the term

"social media". Meanwhile, a list of these applications may provide an idea of what is meant by social media. A broad definition of social media describes a set of technological application platforms built on Web 2.0 which allow many users or groups of people to exchange and generate content (Kaplan and Haenlein, 2010; Lei *et al.*, 2019). The development of social media such as Twitter has allowed users to continuously interact, participate and engage in real-time conversation in collaborative way and with greater efficiency (Lei *et al.*, 2019). These platforms allow anyone with an account to provide feedback, make conversation, receive notifications and develop social bonds (Blankespoor *et al.*, 2014; Miller and Skinner, 2015; Blankespoor, 2018; Elliott *et al.*, 2018).

Twitter can be defined as application services that allow users (individuals) to create public profiles, articulate a list of shared connection users, and view and interact with users from their connection or within the application in short messages that is limited to 140 characters (Boyd and Ellison, 2007; Kaplan and Haenlein, 2010). This application helps users to connect with their pre-existing networks (e.g. friends and colleagues) and other users with shared interests (e.g. regarding politics, career or similar activities). Twitter also allow users to understand their connections and make them visible for other users. Nevertheless, the visibility of users' profiles may differ depending on users' preferences. For example, users in Twitter have the option to choose whether their profile is private ("followers only") or public ("everyone").

In recent years, interactive social media platforms such as Twitter became the dominant choice for communication among firms and individuals (Lee *et al.*, 2015a). As the thesis focuses on one of the most popular social media platforms, Twitter, an overview of this platform is provided in the next section.

2.2 An Overview about Twitter Platform

Twitter has rapidly become one of the most popular social media platforms since it was created in 2006. This platform has attracted around 320 million users, as a monthly average, sending approximately 500 million tweets per day (Jung *et al.*, 2018b; Twitter, 2013; Twitter, 2014; Twitter, 2015). This channel generates over one billion monthly visits to sites with embedded tweets (Leek *et al.*, 2017). Figure 2.1 shows the average number of active users (in millions) on Twitter from 2011 to 2015.

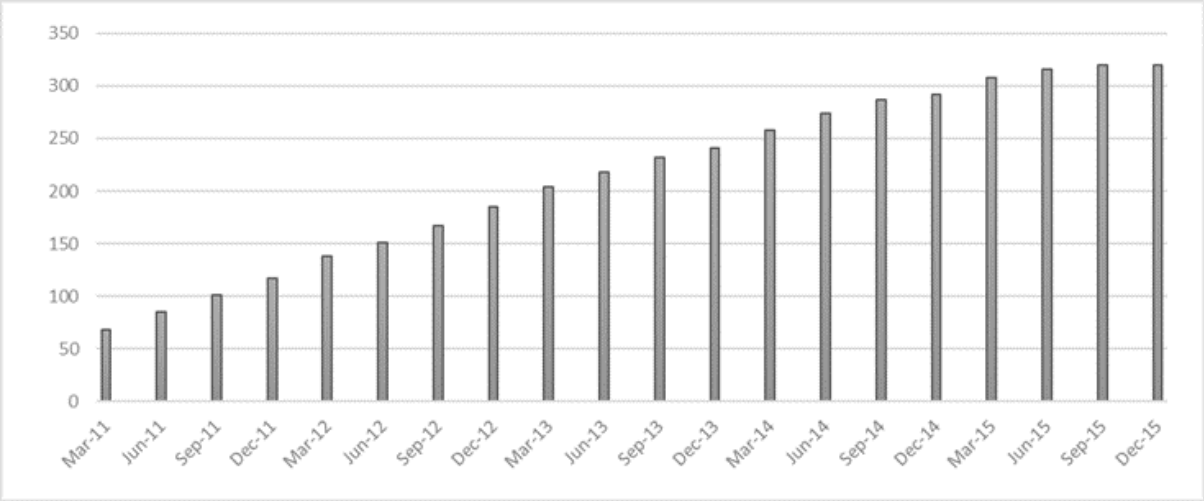

Figure 2.1 demonstrates the quarterly average active users on Twitter in million (source: Twitter.com)

Twitter can be described as both a micro-blogging site, as it allows users to post short messages via the website or mobile application, and a social network site, because it allows users to create a profile page and connect with other users (Thelwall *et al.*, 2011). That is, this platform can connect friends and interest groups in addition to adopting an information-sharing role (Sashittal *et al.*, 2015). Therefore, many celebrities and brand companies have adopted Twitter, creating at least one account. Typically, users using social media create accounts that carry their brand names followed by the "@" symbol (e.g. @Starbucks on Twitter, which has approximately 11.4 million followers). Among popular accounts on Twitter are Katy Perry (@katyperry), Justin Bieber (@justinbieber), Samsung Mobile (@samsungmobile) and Whole Foods (@WholeFoods), who have significant numbers of followers of 107, 10, 12.1 and 4.47 million, respectively.

On Twitter, users who create an account can share their identity and personal information by uploading and posting their picture, name, bio, location, website and date of birth on their profile page (Figure 2.2 shows an example of a user profile account on Twitter: @Starbucks). The profile page shows information about the account, such as the number of tweets, accounts followed (following), followers and likes. It also includes the "follow" button, which enables users to subscribe or follow each other with a simple click. Once a user becomes a follower of an account, he/she will receive the account's tweets on their Twitter timeline in a timely fashion. Thereby, the number of followers represents the number of Twitter users who have chosen to receive the account's tweets (Cade, 2018). This number usually represents user influence and popularity on Twitter (Kwak *et al.*, 2010; Lee *et al.*,

2013). Although users may be followed by many users, they do not have to follow these accounts in return. Therefore, the number of followers can be different from the number of accounts followed (following). The number of accounts followed represents the number of other users from whom the account user has opted to receive messages. This subscription feature enables Twitter to combine two aspects of social networking and news media (Lee *et al.*, 2013). That is, Twitter enables users to have two-way directional relationships by having multi-way conversation and sharing of interests, which is similar to other social media sites (for example, Facebook), and a one-way broadcasting relationship, as in media channels (for example, news broadcasts). However, the low message reciprocity between users suggests that the primary function of Twitter is to spread news and information (Kwak *et al.*, 2010; Thelwall *et al.*, 2011).

Figure 2.2 provides an example of Starbucks profile account on Twitter (@Starbucks).

The mechanism behind the Twitter platform allows users to communicate with each other by writing and sharing 140-character messages called "tweets" (Cade, 2018). Once a tweet is posted by a user, the message will be displayed on the user's profile, followers' home pages and Twitter's public timeline. This short message, the tweet, can contain text, images, hyperlinks, videos, hashtags (#) and/or cashtags ($). It may also include the "@" symbol, which is used to mention and interact with specific account holders. The hashtag and cashtag features are commonly used features that Twitter developed as an element of information flow (Sprenger *et al.*, 2014). The hashtag enables users to write and easily find messages about relevant topics or categories (e.g. #earnings, #emissions). Likewise, users can also write stock related messages by including a prefixed dollar sign and firm ticker symbol (e.g. users that tweet about the Starbucks corporation would include $SBUX). These features allow large audiences, including those with no Twitter account, to easily search for information. In addition, the short messages on Twitter make it an ideal channel to share opinions in a timely manner, whereas longer format channels involve a longer search time for users seeking reports or articles (Bartov *et al.*, 2018).

However, Twitter not only allows user followers to receive tweets, but also allows other users to repost and share others' tweets with their own follower list by simply clicking on the "retweet" button (Jung *et al.*, 2018b). The purpose of the retweet feature is usually related to information dissemination, enabling user tweets to reach a larger audience than merely the user's own followers list, as users tend to follow different accounts (Thelwall *et al.*, 2011). Furthermore, Twitter also allows users to show their liking of tweets through the "like" button (♡), or to engage in conversation by "replying" to the tweet (💬). Even though Twitter may be used for social purposes, these features of Twitter create multiple knock-on sharing effects that elevate the platform as a suitable information dissemination channel for different purposes, including political, economic and corporate purposes.

Twitter have gained popularity among individuals and become part of firm communication strategy. In addition to the widespread nature of Twitter platforms among individuals, an increasing number of firms have adopted many of these platforms as tools for communication. As Twitter is considered to be a social media platform, the next section attempts to provide a better understanding of corporate use of Twitter.

2.3 Corporate Use of Twitter

Since the development of online communication and the Internet, firms have been using different information technology channels to disclose material information and manage investor relations (Debreceny, 2015; Lei *et al.,* 2018; Lei *et al.*, 2019). For example, firms use their websites to provide information or make webcast conference calls (Ashbaugh *et al.*, 1999; Ettredge *et al.*, 2002; Bushee *et al.*, 2003). This abundance of information on the Internet leads investors to search various online channels to "pull" firm information (Miller and Skinner, 2015). For example, investors can search for firm information via Google search, Yahoo Finance, and the Electronic Data Gathering, Analysis and Retrieval system (EDGAR) (Das and Chen, 2007; Da *et al.*, 2011; Drake *et al.*, 2017; Lei *et al.*, 2019). Previous literature has suggested that these channels are associated with many capital market consequences, such as market volatility and liquidity, price discovery, trading volume and realised return (e.g. Da *et al.*, 2011; Drake *et al.*, 2012; Dimpfl and Jank, 2016).

However, Twitter has created new sources of corporate information that have changed the way that investors acquire information (Jame *et al.*, 2016). This channels not only provide firms with facilitating features to communicate with market participants, but also allow the market participants to publicise or express their opinions about the firm (Cade, 2018). Twitter may also work as information intermediaries for investors (Drake *et al.*, 2017). From the firm's perspective, Twitter can facilitate sending direct messages and having conversations with a large variety of audiences, bypassing other traditional media channels such as newspapers, television and radio (Lee *et al.*, 2015a). It also enables firms to engage with audiences in many disciplines directly and on timely manners. Firm activities on Twitter may include engaging with customers for advertising and marketing purposes (Lee *et al.*, 2018a). Firms may also use Twitter accounts for customer services, promotions, special offers and product information. Even though Twitter is widely used to facilitate business-to-customer communication, it may also provide firms with the opportunity to enhance their business-to-business (B2B) (Siamagka *et al.*, 2015). Accordingly, one third of B2B firms use Twitter to generate product demand (Wang *et al.*, 2016). In addition, many firms create social media accounts for career and employee recruitment purposes. For instance, Cree Inc (@CreeCareers) and Cynosure Inc (@CynosureCareers) have initiated Twitter accounts that mainly focus on career-related news.

Firms also use their Twitter accounts to communicate with stakeholders and market participants by conveying financial information (Zhou *et al.*, 2015; Jung *et al.*, 2018b). Social media platforms are also used by some firms to share non-financial information, such as corporate social responsibility (CSR) and climate change information (Schäfer, 2012; Eberle *et al.*, 2013; Reilly and Hynan, 2014; Manetti and Bellucci, 2016; Araujo and Kollat, 2018). Previous literature shows that firms with higher CSR ratings are more likely to adopt social media (Lee *et al.*, 2013), and firms with high environmental performance tend to use Twitter to highlight their prosocial behaviour (Huang *et al.*, 2016). Overall, using Twitter allows firms to connect and communicate with customers, partners and investors; advertise their products and services; and share, discuss and present their information, such as financial performance, CSR and/or climate change information.

Given firms' willingness to connect with a variety of audiences at lower cost, and in a highly timely manner, previous studies have shown that a considerable number of firms have adopted Twitter platforms. For example, Culnan *et al.* (2010) found that, among Fortune 500 firms, 53% of firms used Twitter, 46% used Facebook, 20% used blogs, and 11% used client-hosted forums. In addition, Zhou *et al.* (2015) showed that among US firms with social media accounts, Twitter was employed relatively early, with a higher adoption rate compared to other social media platforms. Jung *et al.* (2018b) found that S&P 1500 firms' adoption of Twitter surpassed their adoption of Facebook and other social media platforms. This research shows that firms prefer Twitter to other social media platforms, as a more effective communication channel. In addition, Twitter messages receive a higher response rate than Facebook posts, leading to longer user engagement (Zhou *et al.*, 2015). Twitter, as the most influential platform, which has been increasingly employed by firms to convey information, has been mentioned and approved by the SEC for corporate disclosure purposes. The following section provides more detail on social media guidance and regulation.

2.3.1 Regulation on twitter and other social media platforms

In 2000, Regulation Fair Disclosure (Reg FD) was enacted, requiring firms to disclose non-public material information to investors through recognised information distribution channels (e.g. filing 8-K with the SEC). Under this regulation, firms are required to publicly disclose material information at the same time that this information reaches a certain group of market participants or shareholders. A requirement is subjected to whether the information is distributed to selected parties intentionally or unintentionally. If it is intentional, then the

information must be disclosed simultaneously for all parties. If it is unintentional, then the information must be disclosed promptly. As the popularity of the Internet has increased, with many firms using their websites to supplement their public disclosures, the SEC, in August 2008, issued revised guidance for the Reg FD regulation regarding the use of websites being a qualified disclosure channel for material information. Under this regulation, firms need to meet some criteria for their website to qualify as a recognised channel for corporate disclosure. First, firms need to notify investors about using their website for corporate disclosure purposes. Second, firms need to ensure that the website is publicly available for investors and the market. Finally, firms must afford public investors and the market a reasonable period of time to react to the posted information (Alexander and Gentry, 2014; SEC, 2008). This guidance encourages managers to use information technology channels and promote a more transparent, liquid and efficient market (Blankespoor *et al.*, 2014).

In July 2012, Reed Hastings (the CEO of Netflix) posted a Facebook message on his personal account about the monthly viewing hours of Netflix in June:

> *"Congrats to Ted Sarandos and his amazing content licensing team. Netflix monthly viewing exceeded 1 billion hours for the first time ever in June. When House of Cards and Arrested Development debut, we'll blow these records away. Keep going, Ted, we need even more!"*

At that time, there was no explicit guidance regarding whether publishing such material information on social media complies with Reg FD. However, the SEC initiated an immediate investigation as to whether the Netflix CEO violated Reg FD by publishing this information on his social media account, and not filing the information on other regulatory channels. On 5th December 2012, the SEC made a Wells notice to notify the CEO and Netflix about bringing an enforcement action due to their violation of Reg FD (Dorminey *et al.*, 2015). Netflix defended its position by stating that the information posted on Reed Hastings' Facebook account was not material, and that the account is public for 200,000 users, including reporters (Alexander and Gentry, 2014). However, the SEC decided to not proceed with the investigation, and closed the case with no charges against Mr. Hastings and Netflix. Instead, the incident resulted in the creation of added guidance regarding firm use of social media, particularly the use of Twitter and Facebook, as mentioned in the statement, to disseminate key information complying with Reg FD (SEC, 2013a; SEC, 2013b). Furthermore, the SEC in 2015 also announced that firms can use Twitter to send messages to attract potential investor interest regarding firms' stock and debt offering. Following the

announcement of this guidance, a growing number of firms have begun to use social media to disseminate investor-related information and corporate events information (Lei *et al.*, 2019).

Overall, this guidance supports firm use of social media as a supplementary channel to disseminate material information. This use is expected to provide benefits for firms as a means to enhance the flow of their information. The motivation behind firm adoption of Twitter platforms is discussed in the following section.

2.3.2 Motives for firm adoption of twitter

The arrival of social media such as Twitter enables people with Internet access to publicly broadcast, share and exchange their opinions in virtual communities. The facilitating features of information dissemination allow users to publicise their opinions, which makes Twitter unique from traditional media channels. For instance, traditional media channels provide less accessibility for people and some firms to publish their own information, whereas Twitter allows user communication to be more visible. From other perspectives, Twitter allows firms to have direct and multi-way conversations with a large variety of audiences, such as customers, stakeholders and potential investors (Lee *et al.*, 2015a; Trinkle *et al.,* 2015). This channel not only allows firms to engage in less formal and more frequent conversations, but also allows them to receive ongoing feedback and comments, providing them with useful information (Kim and Youm, 2017; Misirlis and Vlachopoulou, 2018). The adoption of Twitter can also provide firms with potential advantages in enhancing their customer engagement, promotional mixes, product innovation, detection of customer complaints, and dissemination of firm news and information (Li, 2010a; Du and Jiang, 2014; Zhou *et al.*, 2015). Firms may also gain legitimacy by improving their engagement and dialog over Twitter (Seele and Lock, 2015; Castelló *et al.*, 2016; Bellucci and Manetti, 2017; Lee *et al.,* 2018b). Therefore, firms may perceive benefits from using Twitter in terms of improving their image, enhancing their sales activities, creating brand awareness, building reputation and increasing public interest (Culnan *et al.*, 2010; Kietzmann *et al.*, 2011; Kumar and Mirchandani, 2012; Marshall *et al.*, 2012; Rui *et al.*, 2013; Floreddu *et al.*, 2014; Ibrahim *et al.*, 2017; Elliott *et al.*, 2018).

Firms can use Twitter channels to build relationships and trust, promote brands, and create brand communities (Leek and Christodoulides, 2011; Kaplan, 2012). For example, firms may use Twitter to post a tweet about a new product, and customers may react to this post by providing comments or suggesting improvements. Customers may also “like” the tweet,

which would enhance the visibility of the tweet among their friends and followers, thus enlarging the promotional reach of the new product. Meanwhile, many firms use Twitter platforms to connect with potential customers. They also benefit from using Twitter by sharing knowledge with their employees (Salo, 2017). The engagement between firms and employees on social media during the working day provides firms with long-term benefits (Behringer and Sassenberg, 2015; Huang *et al.*, 2015). A Twitter platform can be used as a channel for employees to communicate, share knowledge, create ideas and collaborate (Kwahk and Park, 2016; Luo *et al.*, 2018).

In addition, there are many features of Twitter that make this communication channel unique and revolutionary for firms' communication. First of all, Twitter enables audiences to obtain required information at lower acquisition cost and on a timely basis. It also reduces the costs of printing and distributing firm information. This advantage allows improvement in the timeliness and usefulness of firm information (Drake *et al.*, 2017). Second, Twitter allows information to be available to a wider range of users, with unlimited access (Cade, 2018). Third, Twitter platforms are accessible from mobile phones and Internet browsers at anytime and anywhere (Blankespoor *et al.*, 2014). The accessibility of this platform on the Internet and mobile phones enables firms to reach a wide range of audiences at timely basis and lower communication cost. Fourth, firms can use Twitter for many purposes, such as customer communication, marketing, recruiting employees and managing investor relations (Cade, 2018). Fifth, Twitter allows users to improve the presentation of their messages by using different forms, such as graphics, videos, text or even audio. Sixth, while Twitter allows users to actively push information to market participants, it also allows users to search and retrieve more information by using the search engine (Miller and Skinner, 2015). This feature allows both users with Twitter accounts and non-registered users to access all posts relating to specific topics, users or firms.[4] Finally, Twitter allow users to engage with other users' messages (tweets) by liking, reposting (retweeting) and responding (replying) to their messages. This can add another perspective on how other users view the matter. Taking these features together, Twitter facilitates information dissemination and may influence people's perception in unexplored ways (Miller and Skinner, 2015).

Meanwhile, users' messages on Twitter may contain misleading information, rumours and other negatively perceived information about the firm, which can impose risks to the firms'

[4] However, users need to be registered with Twitter to make comments (Debreceny, 2015).

reputation and concern many public relation (IR) agencies (Cade, 2018). Firms can use their Twitter accounts to address any rumours or issues, and hence repair the reputational damage by demonstrating their ability to address any raised concerns, and lessen negative perception by showing empathy, sharing criticism, or even redirecting investor perception towards positive highlights (Lee *et al.*, 2015a; Cade, 2018). Lee *et al.* (2015a) demonstrated that Twitter enables firms to answer users' concerns and comments during product recall crises, allowing them to rebuild their reputational damage. Cade (2018) showed that firms can mitigate criticism on Twitter about the discretionary accrual adjustment by redirecting investors' attention to positive aspects of the firm disclosure. In addition, previous studies on management, psychology and accounting (see Elliott *et al.*, 2012; Cade, 2018) suggested that the adverse effects of negative events can be tempered by opening communication and helping individuals towards understanding the act that caused the negative event, and working towards overcoming any other related events. Even though Twitter may seem threatening for firms in case they lose control over what may be written about them on social media, thereby becoming reluctant to use social media (Investis, 2015), it can provide managers with a better understanding of users' demand for information and how they should respond to this issue. Furthermore, the continuous reliance of individuals on Twitter to receive news and investment advice means that firms failing to participate in conversations with market participants is noticed (Cade, 2018).

In addition, Twitter provides firms with opportunities to meet investors' demand of information and influence investors' perception of them. Firms can use this channel to gain benefits by gaining and maintaining investors' awareness through effective dissemination activity of investor-related information (Lee *et al.*, 2013). Therefore, this channel has become an essential part of firm communication and many investor relation (IR) agencies appear to have adopted Twitter for investor communication (Blankespoor *et al.*, 2014). Additionally, many institutional and retail investors use this channel for investment activity (see Brunswick, 2014; Elliott *et al.*, 2018). Bloomberg has incorporated Twitter messages about firms into its data service (Elliott *et al.*, 2018). This service allows market participants (e.g. traders and professional investors) to monitor the discussions raised about the firm on Twitter through the Bloomberg terminal (Alden, 2013). As social media has become an important channel for firm communication, the next section discusses firm use of social media for corporate disclosure.

2.3.3 Disclosure on social media

Firms provide disclosure as a form of financial reports to describe its economic condition (Healy and Palepu, 2001; Mayew, 2012). These reports can include many outlets such as financial statements, management discussions and analysis (MD&A), footnotes and other mandated filings. However, some firms may also provide additional information as voluntary disclosure, which can be defined as information that goes beyond the required regulations to provide accounting and other information deemed relevant to users' decision-making needs for the efficient operation of capital markets (Meek, Roberts, & Gray, 1995). Firms may also voluntary engage in communication to various stakeholders via conference calls or corporate website, for example.

However, before firm information is communicated to investors, firms determine an information package, which comprises: (1) the selection of information that can be included in the firm disclosure (e.g. the data that can be included such as the amount of sales or/and current earnings); (2) how the information is presented and structured (the mediums used, e.g. text, graphs or charts, and presentation attributes, such as tone, readability, volume, accent volume); and (3) who presents this information (a third party, the company, or the CEO, CFO or other management position). In this regard, social media may influence the composition of the firm information package (firm's information selection, presentation and presenter) (Blankespoor, 2018).

Firstly, social media platforms may affect firms' selection of information in many ways. The audiences of social media platforms can influence the types of information that are disclosed to investors. For example, firms may choose to disclose less complex information when the particular audience is less capable of handling sophisticated information. This behaviour is compatible with previous literature (Bushee *et al.*, 2003) which find that a firm's decision to open conference calls is to reach a broader range of retail investors (firms with less complex information). In contrast, firms with more complex information are less likely to have open conference calls, and more likely to target sophisticated investors. Second, social media enables firms to interact informally with users, which allows firms to use subjective (rather than objective) information. However, firms' selection of information over social media platforms create an interesting setting to understand how firm managers respond to different incentives.

Secondly, social media platforms may influence firms' selection of medium and presentation. In particular, every social media platform has a unique setting that encourages and facilitates specific mediums (text, video, audio or image). Facilitating features provide firms with greater flexibility in their choices than with other channels, such as conference calls or press releases. Second, disclosure narrative attributes can be affected by the greater informality, wide language intensity and expected presentation style (Blankespoor, 2018). The great flexibility of social media could affect the tone and the level of readability of a firm's messages. Finally, the greater facilities of social media platforms regarding non-text mediums may lead to the use of more non-verbal attributes in firm messages. These non-verbal behaviours may provide opportunity for management in their connecting with investors.

Lastly, social media platforms may provide firms with opportunities to be more personalised in a way that is different from physical presence. Many platforms allow the firm and its executive to have different accounts. This allows firm managers to build their personal reputation and have direct and personal interactions with investors.

Meanwhile, firms may consider the incentive to provide corporate disclosure when the benefits of a disclosure exceed its cost. Firms' dissemination decisions are unlike corporate disclosure decisions, which relate to firms' decisions to use a certain channel for distributing corporate information or not (Jung *et al.*, 2018b). The next section discusses more about dissemination on social media.

2.3.4 Dissemination on social media

Once firms have created an information package, management can choose the number of channels and whether a specific channel can be used to disseminate or distribute firm information. For example, firms can use their websites or initiate conference calls to distribute their information. The recent development of social media has increased the availability of information channels that firms can use to distribute their information. This development in communication technology enables and encourages investors to process firms' information on a timely and prolonged basis (Blankespoor, 2018). This channel has influenced the way that firms communicate with investors (Lee *et al.*, 2015a), and provides firms with more control over dissemination decisions (Jung *et al.*, 2018b).

Among social media platforms, Twitter provides unique features that support firms in further disseminating and promoting firm information. In particular, the design of short messages on

Twitter makes this channel suitable to be used for dissemination purposes, rather than for revealing new information (Jung *et al.*, 2018b). In fact, firm tweets often include quotes or hyperlinks to more informative reports (e.g. annual reports, corporate websites or conference calls). Moreover, firms are not mandated to repeat or broaden the information disclosed through other disclosure channels over Twitter, which allows them to disentangle dissemination from disclosure (Jung *et al.*, 2018b). In addition, firms can use Twitter to send multiple repeated messages to increase the emphasis of the information. These features suggest that the primary use for this channel is to disseminate information and supplement other disclosure channels, without providing comprehensive information (Blankespoor *et al.*, 2014). This channel allows firms to directly push messages to current and potential investors in a timely fashion, which decreases investors' search costs and, hence, potentially increases investor attention (Teoh, 2018).

Whilst firms may use RSS and email to send their information to investors, the historical data of these technology channels cannot be observed by researchers (Blankespoor *et al.*, 2014). Firms may also distribute their information through corporate websites or webcast conference calls. Firms usually use these channels as disclosure channels, whereas Twitter is used more for dissemination purposes (Blankespoor *et al.*, 2014). In addition, corporate websites require investors to search for or pull firm information. On the contrary, firms can use Twitter to push their information to investors, rather than waiting for investors to retrieve the information from the website. This mechanism allows firms to directly push their information to investors, which in turn reduces investors' cost of acquiring information. Furthermore, firms may also use Twitter to reach investors regularly and at any time. These features are unlike those of conference calls, which usually occur irregularly and over a limited period of time. Additionally, Twitter features such as redirection of messages (retweeting) are expected to increase the audience that can receive firm information. Twitter also allows firms to communicate with joint audiences such as customers and investors, unlike other traditional disclosure channels (e.g. conference calls, press releases). To increase the emphasis of the information disseminated, a firm may send frequent or multiple tweets regarding specific news or information. Overall, dissemination over Twitter results in reaching a diverse audience of potential investors.

Typically, firms depend on third party intermediaries, such as the press, to disseminate their information. This dependence tends to limit the amount of information disseminated to

investors, as the press are keen to deliver some subset of firm news and information (Miller, 2006; Blankespoor *et al.*, 2014). While press editors make the decision of which firm to cover, firms are unsure of when/whether the press will deliver their information to market participants and the public (Blankespoor *et al.*, 2014; Jung *et al.*, 2018b). In contrast, Twitter allows firm managers to have more control over the dissemination decision. This allows managers to choose the time and frequency of disseminated information. In addition, using Twitter to disseminate and spread information allows firms to directly reach investors and bypass other media channels. Furthermore, the press is keen to express their opinion and provide additional information, which makes the effect of dissemination ambiguous.

Chapter 3. The Effect of Twitter Dissemination on Cost of Equity[5]

3.1 Introduction

Revolutionary communication tools, such as social media applications, provide a massive amount of information ("*big data*"), which leads to a great deal of attention and action on the part of firms (de Camargo Fiorini *et al.*, 2018). These tools of *big data* bring profound changes in the way that firms manage their customers and business (see Raguseo, 2018), and have become important channels to diffuse information (Agarwal *et al.*, 2019), as part of firms' disclosure strategy to meet the increased demand for information by investors. A key objective is to reduce the uncertainty about current and future investment opportunities. Corporate disclosure can help to reduce the information asymmetry that exists between management and market participants, and between informed and uninformed investors (Diamond and Verrecchia, 1991; Kim and Verrecchia, 1994; Leuz and Verrecchia, 2000). In turn, this can have significant implications as to which companies attract the necessary financial resources to grow and become successful.

Although corporate information is assumed to be available to all market participants once firms disclose, "*most firms have difficulty ensuring their news reaches a broad set of investors*", which results in information asymmetry (Blankespoor *et al.*, 2014, p. 80) and this increases the need for a better dissemination strategy. This strategy is about a firm's decision to spread information about the firm to the public through specific channels or not. A firm's decision to disseminate is different from its voluntary disclosure decision, which focuses more on providing information, if the benefits of disclosure outweigh the associated processing and proprietary costs (Kothari *et al.*, 2009b). In contrast, the dissemination decision is related to firms' choice of communication channel to distribute already disclosed information. For instance, firms are required to report their quarterly results each quarter of the year with the SEC, however they are not required to use conference calls or social media channels to disseminate these quarterly reports. Therefore, the decision to disseminate could exceed disclosure decision and show how firms attempt to shape their information environment (Jung *et al.,* 2018b). Dissemination is also necessary for informing investors

[5] This chapter has been published in *International Journal of Information Management*:
Albarrak, M.S., Elnahass, M., Papagiannidis, S. and Salama, A. (2020) 'The effect of twitter dissemination on cost of equity: A big data approach', *International Journal of Information Management*, 50, pp.1-16..

about a firm, resulting in improving investor recognition of the stock and therefore a lower cost of equity (hereafter, COE) (Merton, 1987). The challenge is that investors can only spend limited time and pay little attention to news about firms, due to the acquisition cost that they bear through searching, retrieving and understanding the required information (Merton, 1987; Hong and Stein, 1999; Hirshleifer and Teoh, 2003; Hirshleifer *et al.*, 2011). As such, investors may rely on few information intermediaries, such as the press, to receive news about firms. Due to limitations in coverage, there is a high chance that investors will not receive the news about lower press coverage firms or start-ups that do not command the necessary recognition. Instead, managers may use social media as a complementary channel to address this challenge (Blankespoor *et al.*, 2014). This makes it possible for investors to obtain relevant information on a timely basis and in doing so to reduce the acquisition cost of information, by saving the time and energy needed to search for relevant news. Such dissemination activity is expected to lead to lower information asymmetry and improve investor recognition. Therefore, our study seeks to examine whether a firm's dissemination of financial information (*iDisc*) on Twitter has an impact on the firm's COE.

The effect of dissemination decisions has not been widely explored in the literature due to the difficulty of isolating dissemination from disclosure. Prior studies (Mayew, 2008; Kimbrough and Louis, 2011) have been either silent about the dissemination role or assume that dissemination exists once the disclosure is released. Although recent studies (Bushee *et al.,* 2010; Li *et al.,* 2011) have pointed out that dissemination can be isolated from disclosure through press coverage, firms have no control over the content and dissemination decisions of the press. The press is also likely to adjust the content of information by expressing opinions, including summaries, or providing additional information, which makes the effect of dissemination unclear. In addition, firms have no control over whether the press will cover firm news or the time that this is done. Conversely, firms may opt to use Twitter for dissemination as they can have full control over the volume, frequency and timing of the disseminated information and can reach investors undiluted. As such, using Twitter allows firms to directly reach a broad number of current and potential investors and bypass other media channels. Furthermore, Twitter messages are limited to 140 characters, which makes them short and ideal for dissemination. Twitter also allows firm to push their information to investors at a time of their choosing, unlike the firm's website which requires investors to search for the information. In addition, firm messages over Twitter usually include links to more informative reports such as press releases or the firm's website, which supports the use

of Twitter for dissemination purposes. In addition, Twitter allows firms to send multiple messages to increase the emphasis and reach of the information. Meanwhile, conference calls are usually used as a disclosure channel, and they are set at a specific time and date. This is different from Twitter, where firms can send as many messages as they want and at any time they choose.However, there is little empirical evidence on how firms' dissemination of financial information on Twitter can be valuable to firms. Hence, this study aims to shed light on whether *iDisc* affects their COE, also controlling for many relevant factors.

The study employs a sample of 1,737 observations which represent 584 non-financial firms with Twitter accounts that are listed on the NASDAQ stock exchange for the period 2009-2015. The findings show that firms can reduce the COE by improving their information environment through their dissemination activities on *big data* information technologies channels. This evidence suggests that the managerial choice of using *iDisc* and diffusing information through their social media accounts could be perceived as part of the firm's strategic voluntary disclosure policy. This finding also shows the importance of using Twitter as a communication channel to connect with market participants, to reduce investors' acquisition costs, reduce the gap between informed and uninformed investors and help investors to make better investment decisions. This paper contributes to the growing literature on the market consequences of firms' dissemination of information on Twitter (Blankespoor *et al.*, 2014; Lee *et al.*, 2015a; Prokofieva, 2015; Mazboudi and Khalil, 2017; Jung *et al.*, 2018b). These studies show how firms benefit from Twitter activity by improving market liquidity and attenuating negative market reaction. First, we show how *iDisc* affects the implied COE, based on an average of four measures of COE.[6] Our study adds to Al Guindy (2017), which examined firms' use of Twitter and the cost of capital. We have examined the dissemination effect, which is different from firms' decisions to use Twitter. We have also used dissimilar COE estimates, more control variables and a different estimation model. In addition, our study contributes to previous studies by focusing on firms that are traded on the

[6] The four estimates of COE are R_{CT}, R_{GLS}, R_{OJ} and R_{MPEG} which were introduced by Claus and Thomas's model (2001) Gebhardt, Lee, and Swaminathan (2001); Ohlson and Juettner-Nauroth's model (2005) and Easton (2004). These estimates are based on analysts' earnings forecast and firm's share prices. While both R_{CT} and R_{GLS} models assume clean surplus accounting, R_{CT} allows stock price to be expressed in terms of book value, abnormal earnings growth and forecasted abnormal earnings growth, whereas R_{GLS} expresses share price in terms of book value, forecasted return on equity and forecasted book value. Furthermore, R_{OJ} is generalised as an extension of Gordon's constant growth model. This model expresses stock price in terms of forecasted earnings per share and perpetual growth rate. R_{MPEG} expresses stock price in terms of forecasted earnings per share for one and two years ahead and future dividend payout.

NASDAQ stock exchange and by selecting a longer sample period. Second, while previous studies examined the effect of the level and quality of a variety of disclosure information and channels (Botosan, 1997; Orens *et al.*, 2010; Dhaliwal *et al.*, 2011; El Ghoul *et al.*, 2011; Mangena *et al.*, 2016), our empirical settings focus on firms' dissemination activity. Our results show that dissemination has a meaningful effect on COE, which is not in line with prior studies (Hughes *et al.*, 2007; Lambert *et al.*, 2007; Lambert *et al.*, 2011) that argue that the real effect is from the information precision. Although tweets are short messages which are expected to have a smaller amount of information than an annual report, our results show the influence of *iDisc* on COE. Third, we contribute to previous studies (Blankespoor *et al.*, 2014; Jung *et al.*, 2018b) that isolate the effect of dissemination from disclosure by examining the influence of dissemination on the COE. Fourth, the findings remain unchanged under varied news magnitudes and contents. Therefore, we extend the prior evidence of Kothari *et al.* (2009a) by examining the effect of dissemination and the tone of a new information intermediary, Twitter, and big data on the COE. Finally, we contribute to the literature on big data (e.g. Warren Jr *et al.*, 2015; Sivarajah *et al.*, 2017; Stieglitz *et al.*, 2018) by collecting over a million pieces of data for a longitudinal time period and constructing a measure of the amount of financial information that firms diffuse from the large set of firms' tweets data. While some studies focus on outside and within firm data (e.g. Gandomi and Haider, 2015), our study focuses on the firm's initiative data on Twitter. Overall, this study contributes to the literature by analyzing social media big data in the financial context.

The research provides important implications for firm managers, regulators, policymakers and investors. The research findings show that disseminating financial information (*iDisc*) reduces the COE. This reduction in COE should encourage firm managers to consider the benefit of disseminating firm information over Twitter. The finding of the study should also encourage firms that are less visible to use Twitter to communicate and reach a broader number of current and potential investors. This increase in visibility improves the investor base and thus reduces the investor required rate of return. In addition, Twitter provides a fast, inexpensive and acceptable platform for information processing. This platform accelerates the information delivery to a broad reach of current and potential investors at a lower cost. As such, this study encourages regulators to expand disclosure requirements to include using social media platforms for disseminating material information; this should contribute to a better information environment and capital market.

While COE reflects investors' expected return on their investment, there are many studies (Sprenger *et al.,* 2014; Jung *et al.,* 2018) investigating the association with price movement. However, this study extends previous literature by investigating the association with COE. Cost of equity is an essential element of managers' investment decisions (El Ghoul et al., 2018). Besides investors and market managers, COE also has important implications for the real economy as it plays a major role in capital budgeting and corporate finance decisions (Attig *et al.,* 2013). Regulators usually view the reduction of COE as a motivation and justification for improving firm reporting practices (Dutta and Nezlobin, 2017). For instance, the Financial Accounting Standard Board (FASB) chairman, Robert Herz, has stated that "It's about lowering the cost of capital, lowering the cost of preparation, and lowering the cost of using information" (see Wild, 2004; Lambert and Verrecchia, 2015). In addition, firm dissemination of financial information via Twitter should help investors to make better informed investment decisions

The next section reviews the relevant literature. The methodology section outlines the sample data and model tested. The paper then presents and discusses the empirical results, comparing and contrasting them with past literature. The paper concludes by considering the theoretical and managerial implications of the empirical evidence.

3.2 Literature Review and Hypothesis Development

3.2.1 Information asymmetry, information intermediaries and cost of equity

Cost of equity is the cost to a firm of using investors' funds that the company raises and uses. Previous studies have documented the important role of accounting information in reducing a firm's COE (Easley and O'hara, 2004; Beyer *et al.*, 2010). Some attention has been paid to the communication channel used for disseminating firm information and its implications for the COE. Francis *et al.* (2008) show that disclosing management forecasts and conference calls are associated with a higher COE, whereas this association is not significant for press releases. Kothari *et al.* (2009a) highlight the role of information intermediaries on the COE, finding that it is affected by business press coverage for both good and bad news. They find that information reported by management and analysts does not provide significant evidence. They also suggest that "*technological innovation […] and changes in disclosure channels and the number and type of information intermediaries that continue to reshape disclosure and financial reporting practices create new and exciting opportunities for research*" (p.

1667). Such intermediaries create value by being easier to manage, and being more efficient and specialised than other media channels (del Águila-Obra *et al.*, 2007).

As "*the cost of equity capital is increasing in the level of information asymmetry*" (Beyer *et al.,* 2010, p. 314), making dissemination decisions to spread information through different communication channels matters (Drake *et al.,* 2014; Twedt, 2016). In essence, firms' dependence on financial intermediaries, such as the press, could be subject to some limitation as the press may favour articles about firms that attract a wider audience (Miller, 2006), which may affect the effectiveness of the firm's disclosure. Therefore, improving the reach and spread of information through dissemination could play a role in enhancing the usefulness of corporate disclosure. That is, different degrees of dissemination, apart from voluntary disclosure, matter (Drake *et al.,* 2014). Previous studies have found that the dissemination level of the business press affects stock prices (Li *et al.,* 2011), price discovery (Twedt, 2016), information asymmetry (Bushee *et al.,* 2010) and the expected rate of return (Fang and Peress, 2009). Li et al. (2011) find that dissemination over Dow Jones alerts provides investors with value-relevant information. Francis et al. (2004) argue that the value relevance of information reduces the COE by improving the quality of reporting and lowering firms' information risk. However, improving a firm's information environment reduces potential investors' estimation risk, an element of risk arising from investors' uncertainty about the 'true' parameters of a security's return or pay-off distribution (Botosan, 2006; Easley & O'hara, 2004). Overall, these findings imply that dissemination has its own capital market consequences apart from disclosure.

3.2.2 Social media and financial dissemination

Social media employ mobile technologies and web-based to create highly interactive platforms by which various stakeholders, individuals and communities can create big data by sharing, discussing, co-creating, and modifying user-generated content (e.g. Kietzmann *et al.*, 2011; Ngai *et al.*, 2015; Shiau *et al.*, 2017). In addition to being user-driven communities, over the past years social media channels have provided an enormous amount of timely data that has served many business functions and purposes (Manika *et al.*, 2015). When it comes to financial dissemination, firms attempt to improve the information environment by initiating investor relations (IR) programmes (Agarwal *et al.*, 2016), providing information through various communication channels. Among these channels are channels supported by information technology, such as corporate websites and social media, which have become an essential part of IR programmes. For example, firms use their websites to provide

information (Ettredge *et al.*, 2002) and broadcast conference calls (Bushee *et al.*, 2003) and social media to disseminate corporate announcements (Jung *et al.*, 2018b).

Among the social media platforms, Twitter provides an accessible communication channel that enables customers, investors and firms to engage with each other in a two-way conversation by posting tweets and receiving comments. For example, from the investor perspective, Li *et al.* (2018) have proposed a framework for monitoring emerging technologies and by using patent analysis and Twitter data mining. Such monitoring can facilitate early investments and high return on these in due course. Social media data has also been used to make stock price predictions (Daniel *et al.*, 2017) or to detect corporate fraud (Xiong *et al.*, 2018). From the firms' perspective, unlike other communication channels, Twitter provides a unique mechanism that allows distinctions to be made about the effect of firms' dissemination decisions. Firstly, firms that seek to disseminate press releases would send investor-related information to newswire services or other information intermediaries (Bushee and Miller, 2012). It is difficult for firms to be certain about when or even whether the information would be broadcast to investors. Conversely, firms on Twitter have the option to choose the time to distribute investor information. Secondly, Twitter makes it possible for firms to know the size of their audience, which may motivate firms' dissemination decisions. Thirdly, the design of Twitter messages suggests that it is more likely to use tweets for dissemination rather than distributing comprehensive information. Tweets are limited to 140 characters, and often include hyperlinks to full press releases (Blankespoor *et al.*, 2014) or quotes from either press releases or conference calls (Jung *et al.*, 2018b). Even though Tweets could be stand-alone pieces of information, Blankespoor *et al.* (2014, p. 81) "*find evidence that they are more commonly used as a method of dissemination*". Fourth, prior literature has explored various aspects of voluntary disclosure channels (Ettredge *et al.*, 2002; Bushee *et al.*, 2003). Twitter provides different mechanisms that support the dissemination role. For instance, conference calls are infrequent and are limited to a short period, whereas firms can use Twitter more frequently. Also, corporate websites require investors to search through the whole website for the desired information, which takes time and effort. In contrast, Twitter does not wait for investors to look for information about the firm as it applies 'push' technology, which directly reaches investors and reduces the acquisition cost of information. Fifth, the spread of tweets can also reach more than the firm's followers as Twitter enables the followers to redirect and share tweets with their follower lists, through the 'retweet' feature. Finally, firms can repeatedly post

tweets over days or use hashtags (#earnings) or cashtags ($Ticker) that are ideally used to share opinion and spread news, which is expected to enhance investor recognition about a firm. All these features enable firms to expand the reach of firm disclosure on a timely basis, isolating the effect of dissemination from disclosure. Once investors receive and read this information, they can become less concerned about information asymmetry.

As this platform has become popular, researchers have paid more attention to studying the market consequences of disseminating information on Twitter. For a list of technology firms, Blankespoor *et al.* (2014) show that dissemination through links to press releases on Twitter reduces information asymmetry and improves market liquidity, especially for firms with a weaker information environment. In line with this, Prokofieva (2015) finds similar results for an Australian sample (100 ASK). Meanwhile, firms are most likely to use Twitter to strategically disseminate favourable news (Jung *et al.*, 2018b). Firms can also use Twitter to attenuate negative market reaction to unfavourable news such as product recall crises (Lee *et al.*, 2015a), acquisition announcements (Mazboudi and Khalil, 2017) and negative earnings surprises (Miller and Skinner, 2015). The attenuation effect suggests that firms that have better interaction, response and control to adjust investors' concerns mitigate the reputation damage of negative corporate announcements. As a firm loses control, other users' tweets may aggravate the adverse reaction (Lee *et al.*, 2015a). Overall, prior studies generally highlight how firms' dissemination decisions on Twitter in spite of other information intermediaries influence the capital market in many aspects (Blankespoor *et al.*, 2014; Jung *et al.*, 2018b). Also, using Twitter makes it possible to understand manager behaviour toward dissemination decisions. However, prior research (Botosan, 1997) has shown that managers strategically adjust disclosure decisions in a way to achieve their goals by increasing firm value and reducing the COE. We, therefore, attempt to fill such a gap in the research by studying the impact of the firm's dissemination of financial information on the COE.

3.2.3 iDisc and cost of equity (COE)

According to the "*market-liquidity hypothesis*", information asymmetry introduces adverse selection problem into transactions between market participants, and, therefore, should reduce market liquidity in firm shares (Glosten and Milgrom, 1985; Leuz and Verrecchia, 2000; Mangena *et al.*, 2016). Firms are hence issue shares at a discount as investors pay less for shares that have high transaction costs (Amihud and Mendelson, 1986). Firms alleviate the adverse selection problem between the firm and its investors (Verrecchia, 1983) and

reduce information asymmetries among informed and uninformed investors (Kim and Verrecchia, 1994) by voluntarily disclosing their information to decrease investors' incentives to acquire costly private information (Diamond and Verrecchia, 1991) and increase market participants' demand for the firm's stock, thus lowering the firm's cost of equity (Easley and O'hara, 2004; Beyer *et al.*, 2010). However, information about the firm may not reach the public effectively, and greater dissemination could play a role in improving the effectiveness of disclosure. As such, Twitter allows firms to make their own dissemination decisions and be less dependent on other information intermediaries such as the press. That is, *iDisc* is likely to improve the effectiveness of firm information (in turn reducing the COE) by pushing information more directly and immediately to a broader reach of market participants, including uninformed investors. As investors receive firm information on a timely basis, they become less concerned about information asymmetry and thus improve stock liquidity and reduce the cost of equity.

Recently, Blankespoor *et al.* (2014) and Jung *et al.* (2018b) have argued that firms may disseminate their information on Twitter to reach many potential investors. Accordingly, the '*investor recognition hypothesi*s' suggests that improving investor recognition of the firm will increase stock prices and reduce the cost of equity (Merton, 1987; Lehavy and Sloan, 2008). The key assumption here is that investors, among all firms, only buy the stocks of firms that they recognise. Therefore, stock prices increase when more investors know about the firm. If only a small number of investors are aware of the firm's stock, then these investors will take a larger portion of the stock. For this reason, stock with lower investor recognition needs to offer a higher rate of return for the risk that investors gain from the large undiversified position. One way to enhance investor recognition is to present information to market participants through more dissemination channels. Therefore, firms can use *iDisc* to improve the breadth of their information. As information is widely disseminated, investor awareness of the firm's news increases, which improves investors' risk sharing and reduces the cost of equity. In addition, the value of dissemination rises when investors become aware of the stock, by reducing the acquisition costs that investors gain from their limited time and attention to firm disclosure (Hong and Stein, 1999; Hirshleifer *et al.*, 2009). Such costs limit the information that investors process from corporate disclosure and make them mainly depend on a limited number of communication channels (Hirshleifer and Teoh, 2003). For this reason, firms attempt to improve the dissemination of corporate disclosure in many information intermediaries such as Twitter (Blankespoor *et al.*, 2014). Such an improvement

of dissemination is expected to provide investors with information about the firm at a lower acquisition cost, which reduces the information asymmetry and hence reduces the cost of equity.

Based on the above, we conjecture that a higher use of *iDisc* is predicted to enhance investors' reach with the firm information. This is likely to reduce the gap between informed and uninformed investors. As firms rely more on the use of *iDisc* to disseminate news, investors can receive the news at a low acquisition cost and with better investor recognition. Thereby, a higher level of *iDisc* use is expected to reduce COE.

H_1: There is a significant negative association between *iDisc* and the cost of equity (COE).

3.3 Methodology

3.3.1 Sample and data

Our initial sample includes non-financial firms listed on the US NASDAQ stock exchange that have official Twitter accounts. Our sample focuses on the US because foreign firms have different information environments, and the dissimilarities in transparency can influence the COE. The SEC, the regulator of the US stock markets, allows firms to use social media such as Twitter for disclosing financial information that complies with Regulation Fair Disclosure (Dorminey *et al.*, 2015). US firms have shown frequent adoption of Twitter and early use for corporate announcements (Zhou *et al.*, 2015; Jung *et al.*, 2018b), which ensured a potential coverage during our sample period. Consistent with Bushee *et al.* (2010), we mainly focus our sample on one stock exchange to remove any effect of exchange listing.

The study focuses specifically on NASDAQ-listed firms. Many technology-focused firms are traded in NASDAQ. Technology firms tend to be early adopters and users of Twitter, which increases the probability of using Twitter for disseminating financial information (Blankespoor et al., 2014; Lee et al., 2015a; Leuz and Wysocki, 2016). Firms that are traded in NASDAQ are relatively smaller in size and have a lower number of analysts following them than NYSE (Bushee et al., 2010; Dang et al., 2018; Meshcheryakov and Winters, 2019). They therefore face higher visibility concerns than firms in NYSE (Bushee and Miller, 2012). In fact, Dang et al. (2018) find that firms switch their listing from NYSE to NASDAQ to become more visible to investors among other NASDAQ-traded firms. This visibility concern

is relevant for the study because dissemination of firm information over Twitter can increase a firm's visibility and improve firms' information environment (Blankespoor et al., 2014).

We focus on 2009-2015, even though Twitter was founded in March 2006, because Twitter accounts' popularity grew among its users around 2009 (Marwick and Boyd, 2011). We also exclude tweets before 2009 to avoid the macroeconomic effects of the financial crisis (2007-2008), limited Twitter activity (approximately less than 10% of our sample had Twitter accounts before 2009), and limited use of cashtags in Twitter before 2009.

Our data collection strategy is based on identifying whether each firm in the sample has a Twitter account, using a number of checks (e.g. whether they had the Blue Verified Twitter Badge). After identifying Twitter adopter firms, we check whether these firms have positive median earnings forecasts for one and two years ahead to measure the implied COE. These consensus earnings forecasts are collected as of June to ensure that analysts had incorporated all the information from fiscal year reports in their forecasts. Firms with missing observations on the COE are excluded from the sample. These restrictions reduce the sample size to 584 firms (1,737 firm-year observations) from the initial sample of 745 non-financial firms with Twitter accounts that are traded on the NASDAQ stock exchange.

Corporate adoption of Twitter does not necessarily mean using their Twitter accounts for disseminating financial information (*iDisc*). We, therefore, use two sources to download the full texts of tweets to identify *iDisc*. We retrieve Twitter data from both Twitter's application programming interface (API) and Twitter's advanced search. Twitter API provides a maximum number of tweets (up to 3,200 tweets). Tweets beyond 3,200 are, therefore, manually collected through Twitter's advanced search function. Manual collection is performed to obtain tweets between the last collected tweets from Twitter API and the first tweet published by the firm's account. If the number of tweets is large, we use the advanced search option to search for financial keywords. We used keywords that related to financial capital, balance sheet items, equity and debt financing, financial ratio and financial reporting and announcement (discussed further in Measuring *iDisc*). The total number of tweets collected is 1,197,208 tweets, approximately 2/3 of which come from Twitter API. The mean (median) value of the number of tweets is 4,588 (944), which suggests that the total number

of collected tweets is not particularly large. We process these tweets through a matching classification scheme to quantify *iDisc* tweets.[7]

In addition to Twitter data, we collected all news articles that mentioned the firm's name from LexisNexis. This database includes major news media channels such as *Wall Street Journal*, *The New York Times*, *The Washington Post* and *USA Today*. We used company identifiers to allocate all firm news in the database. We define news coverage as the total number of news articles about the firm. In addition, we obtained accounting and market data to measure the dependent and control variables from Bloomberg and DataStream. To control for the outliers, we winsorize cost of equity (*COE)*, financial leverage (*LEV*), the dispersion of analysts forecast *(DISP*), systematic risk (*BETA*), long-term growth rate (*LTG*) and return on assets (*ROA*) at the 2.5th to 97.5th percentiles. Consistently with previous literature (Chen *et al.*, 2009; Botosan *et al.*, 2011), we winsorize the COE to lie between 0 and 0.6 as investors are not expected to require negative rates of return and high COE could be driven by outliers.

3.3.2 Variables

3.3.2.1 Cost of equity (COE)

The dependent variable in this model (*COE*) is the implied COE, which is estimated as the average of four equity premium estimates: (i) Claus and Thomas model, R_{CT} (2001); (ii) Gebhardt, Lee, and Swaminathan model, R_{GLS} (2001); (iii) Ohlson and Juettner-Nauroth model, R_{OJ} (2005); and (iv) Easton model, R_{MPEG} (2004). The COE estimates are measured based on current stock prices and analysts' future earnings forecast. In other words, COE equals the discount rate that is used to discount future cash flows to determine current stock value. However, each of these estimation models has different assumptions and implementations. For instance, R_{CT} assumes that the market expects abnormal earnings to grow at a constant rate, which equals the inflation rate, beyond the forecast horizon. R_{GLS} assumes that the market expects prices in terms of future return on equity (FROE) *"to linearly fade to an industry-based ROE 12 years hence, which GLS estimates based on*

[7] The classification process followed several steps: (1) we uploaded the data to the Python software programme; (2) we read all these data; (3) we applied "stop words", which is a process used to remove words that have no meaning in the text (e.g. "a", "the", "and"); (4) we divided tweets into words by applying a technique to split the text into separate words; (5) we matched the word in each tweet with our financial keyword list ; (6) we gave a value of 1 to every tweet that matched with our list of keywords; (7) we downloaded the data into an Excel file for tweets that matched our classifications.

historical industry ROE" (Botosan *et al.,* 2011, p. 1098). R_{OJ} is driven from an accounting-based evaluation model that use analysts' forecasts to calculate short- and long-term growth in earnings and to set an infinite growth that equals the 10-year treasury bond yield minus 3 percent. R_{MPEG} anticipates that the market expects abnormal earnings to grow at zero rate beyond the forecast horizon. Appendix C provides an explanation of the implementation of all COE measures. To calculate the four models (R_{CT}, R_{GLS}, R_{OJ} and R_{MPEG}), a numerical technique is employed**.**

After calculating these estimation model (R_{CT}, R_{GLS}, R_{OJ} and R_{MPEG}), risk-free return which is measured using ten-year Treasury bond yield is subtracted from each of these models. Then, the arithmetic mean of the four COE models is computed to measure the COE. The use of an average of these measures aimed to reduce the estimation errors (Dhaliwal *et al.*, 2006; Hail and Leuz, 2006; Hail and Leuz, 2009; Dhaliwal *et al.*, 2016). The implied COE is a good measure for comparing the COE to realised returns, because it attempts to differentiate the effect of growth and cash flow from the COE (Chen *et al.*, 2009; Chen *et al.*, 2011). Pástor *et al.* (2008) also indicate that the implied COE is a useful estimate for the time-series variation of expected returns. In essence, COE equals the average expected rate of return of R_{CT}, R_{GLS}, R_{OJ} and R_{MPEG} minus the risk-free rate

3.3.2.2 *iDisc*

We focus on financially related information (iDisc-related tweets), as financial information is important to investors and firms are mandated to disclose this information but are not required to disseminate it on Twitter. This makes it possible to distinguish the effect of dissemination from disclosure (Jung *et al.*, 2018b). To identify *iDisc* tweets from *big data* of firm tweets, we search for the existence of financial information by combining several sets of financial keywords or using single phrases. For instance, we use the following keywords and phrases to look for earnings-related tweets:

("earnings", "revenue*", "profit*", "income", "loss*", "sales", "dividend", "financial") AND ("disclos*", "report*", "record*", "perform*", "statement*" "release*", "announce", "declare*", "quarter", "annual", "result*")

We also use other financial keywords that relate to financial reporting, stock prices, balance sheet items and their variants such as:

(“annual report*”, “annual statement*”, “press release*”, “balance sheet”, “cash flow”, “cash inflow”, “total assets”, “current assets”, “total liabilit*”, “current liabilit*”, “long term assets”, “long term debt”, “net income*”, “net profit*”, “capital gain”, “net loss*”, “capital loss”, “capital expenditure*”, “market capital*”, “stock pric*”, “secur* pric*”, “share* pric*”, “merger”, “acquisition”, “earnings per share”, “stock* repurchase”, “share* repurchase”, “stock* offering”, “share* offering”)

The development of financial keyword lists starts with identifying words used in previous studies (Kothari *et al.*, 2009a; Matsumoto *et al.*, 2011; Kravet and Muslu, 2013; Campbell *et al.*, 2014). The strategy of developing word lists includes searching and adding other synonyms for financial words through WordNet and other dictionary software applications. Additional terms and synonyms have been added from Campbell Harvey’s financial glossary lists (Harvey, 1999). Terms or words that relate to firm activity, reporting, announcements and disclosure were included in the lists. To reduce the classification error, we look for the existence of multiple words in the same tweet.

In addition, Twitter provides features that firms can use to push information regarding any event or topic by using the hash key (#). These hashtags can be used for earnings announcements or quarter earnings events. Twitter also makes it possible for users and firms to discuss and disseminate a firm’s financial information through the cashtag key feature ($ticker). Thus, we also included hashtags that are used for firm announcements and cashtags in our keywords list, such as:

(“#earnings”, “#quarterearnings”, “#annualreport*”, “#financialresult*”, “#pressrelease”, #Q12014, e.g. $AAPL for Apple inc).

Tweets that match with our list of keywords are quantified as *iDisc* tweets. Our analysis examines the annual number of *iDisc* tweets for each firm in our sample period. Figure 3.1 provides two examples of *iDisc* tweets. In addition, further examples for *iDisc* tweets are provided in Appendix A. We count tweets that matched the criteria for measuring *iDisc* or zero otherwise.

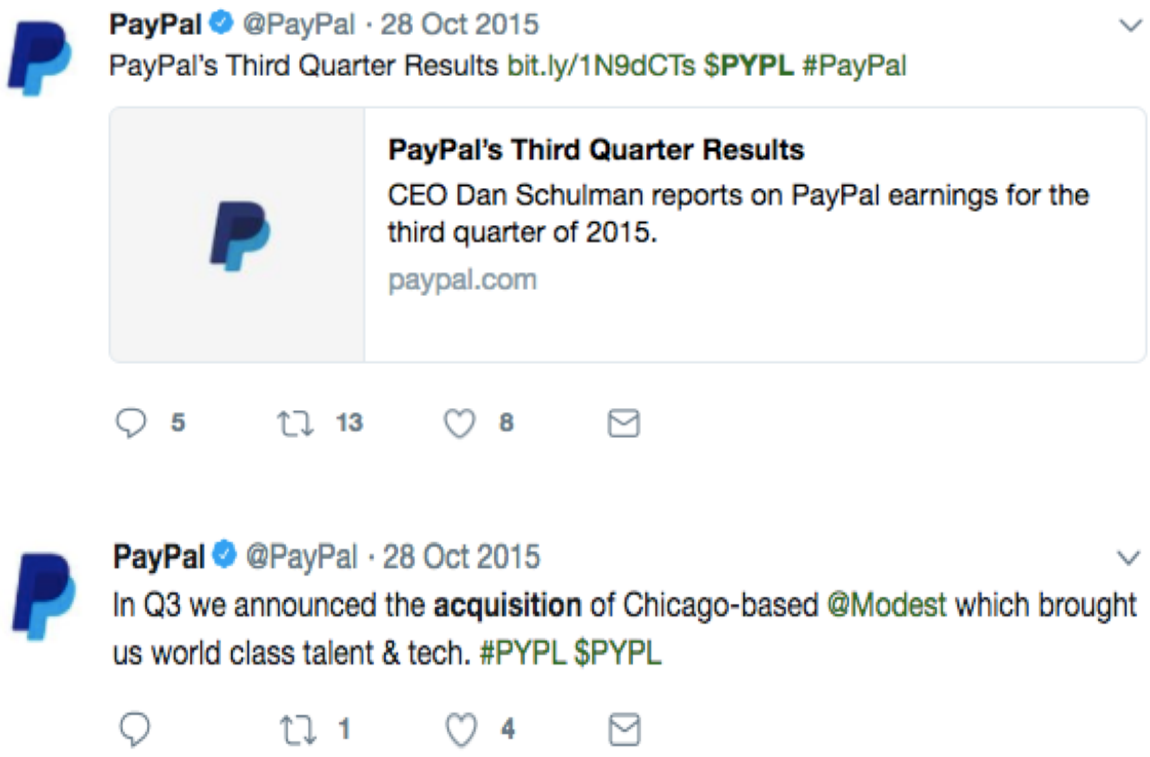

Figure 3.1 shows two examples of *iDisc* tweets

3.3.2.3 Control variables

While we argue that disseminating financial information (*iDisc*) on Twitter improves a firm's information environment to reduce the cost of equity by enhancing firm connection and information availability and accessibility to investors, we include many other control variables. These variables include firm size (*SIZE*), book-to-market ratio (*BTM*), financial leverage (*LEV*), the dispersion of analysts forecast (*DISP*), systematic risk (*BETA*), long-term growth rate (*LTG*), press coverage (*NEWS*), institutional holdings (*INSTOWN*), earnings surprise (*SURP*) and return on assets (*ROA*). These control variables are related to firm characteristics, analysts' forecast attribute, systematic risk, information intermediaries, content of information and firm performance.

To illustrate more, larger sized firms have a better information environment (Gebhardt *et al.*, 2001) and expect to have lower costs of equity (Botosan, 1997; Dhaliwal *et al.*, 2006; Mangena *et al.*, 2016), whereas smaller firms have a lower information environment, lower liquidity and hence expect to have a higher COE. Therefore, firm size (*SIZE*) is expected to have a negative association with COE.

In addition, the book to market ratio (*BTM*) reflects the difference in firm accounting conservatism and investment opportunities (Hail and Leuz, 2006). This variable is considered a risk factor (Easton, 2004; Mangena *et al.*, 2016). That is, firms with a higher *BTM* ratio are undervalued in price and should have a higher risk premium (Fama and French, 1992; Gode and Mohanram, 2003). In this sense, we expect the book-to-market ratio (*BTM*) to be positively associated with COE.

According to Modigliani and Miller (1958), firms that use more financial leverage face greater financial uncertainty and expect to have higher risk premiums. Firms with a high leverage ratio may face more liquidity risk that arise from limiting their ability to meet their obligations. Furthermore, those firms may also encounter more restrictions in their ability to access external funds, which in turn might affect the analyst evaluation from the credit rating perspective. Therefore, firms with higher debt on their capital structure may have a higher cost of equity (Fama and French, 1992; Dhaliwal *et al.*, 2006; Cao *et al.*, 2015). We, therefore, expect a positive association between *LEV* and COE.

The uncertainty surrounding the information environment due to wider dispersion of analysts' forecasts is expected to increase firm risk (Gode and Mohanram, 2003; Kothari *et al.*, 2009a). That is, wider dispersion or disagreement in analysts' forecasts implies greater uncertainty about earnings forecasts (Guedhami and Mishra, 2009; El Ghoul *et al.*, 2018), implying a greater risk for the firm information environment and hence a higher cost of equity. Therefore, we expect a positive relationship between dispersion analyst (*DISP*) and cost of equity (COE).

Under the capital asset market pricing model, investors expect a higher required rate of return as systematic risks become higher. Systematic risk or market beta (*BETA*) is an undiversifiable risk that increases the firm risk premium (Botosan, 1997; Botosan *et al.*, 2011; El Ghoul *et al.*, 2011; Cao *et al.*, 2015). As the risk increases, the certainty that investors expect to earn from their investment will become smaller, which, in-turn, increases their required return on their investment. Consequently, firms with high systematic risk (*BETA*) are expected to have a higher COE.

Prior literature (Guedhami and Mishra, 2009; Cao *et al.*, 2015) indicates that firms with a high long-term growth rate (*LTG*) are considered riskier and have more uncertainty than lower LTG firms. Thai is, high prospect about firm growth and earnings may result in the

inflation of stock prices and that any misestimating of growth rate can have a significant effect on the share price (Gode and Mohanram, 2003; Chen *et al.*, 2011). Therefore, the market perceives a firm with high LTG as a high-risk investment and hence they expect a higher cost of equity. Therefore, we predict a positive association between *LTG* and COE.

While media coverage may shape the firm information environment, which is expected to influence the expected rate of return, the press may contain additional information and favour a direction of news stories that could influence the firm valuation and cost of equity (Fang and Peress, 2009; Jung *et al.*, 2018b; Niessner and So, 2018). Kothari *et al.* (2009a) find that media coverage increases the firm's cost of equity when the news is negative, whereas positive news reduces the equity financing. Therefore, we do not provide any certain direction between media coverage (*NEWS*) and COE.

The existence of institutional investors enhances the monitoring role on firm management, exerting more pressure on them to provide better information quality, transparency and management practices (Elyasiani and Jia, 2010; Attig *et al.*, 2012). This enhancement of the monitoring and information role reduces the agency problem and information asymmetry between market participants and hence reduces the cost of equity (see Elyasiani *et al.*, 2010; Attig *et al.*, 2013). Therefore, we expect that high institutional holdings are likely to enrich the firm public information environment, reducing the uncertainty and thus reducing the cost of equity.

Firm managers may have an incentive not to miss earnings expectations. Previous studies (Mikhail *et al.*, 2004) have argued that earnings surprise can be costly to the firm as analysts would not prefer to follow firms with an earnings surprise. That is, an earnings surprise may cause an analyst's forecast to be inaccurate, which is not preferable for many analysts, resulting in lower analyst coverage and thus a lower information environment. In other words, an earnings surprise reflects the uncertainty surrounding the current earnings, which imposes a higher risk and is expected to increase the cost of equity (Rogers *et al.*, 2009; El Ghoul *et al.*, 2011; Kim and Shi, 2011). Therefore, we expect earning surprise (*SURP*) to be possibly associated with the cost of equity (COE).

Furthermore, we control for firm performance by including return on assets (ROA) that may determine firm decision to use communication channel for disseminating information (Ashbaugh *et al.*, 1999; Lee *et al.*, 2015a; Zhang, 2015; Jung *et al.*, 2018b). Firms that have

an increase in earnings, stable profitability and better performance are expected to have less exposure to default risk, lower uncertainty and hence lower COE (e.g. Francis, Khurana and Pereira, 2005; Gode and Mohanram, 2003). However, previous studies (e.g. Ferris et al. 2017) propose that the relationship between return on assets (ROA) and COE is inconclusive, which means that the direction of the relationship can be either positive or negative. Thus, the study expects no association between ROA and COE. In addition to these variables, we include both year and industry fixed effects in the regressions using the Fama-French 12-industry classification.

Where, these control variables are measured as follow. First, firm size (*SIZE*) is computed using the natural logarithm of market value of equity. Second, book to market (*BTM*) ratio is estimated as book value of common equity scaled by market value of equity. Third, financial leverage (*LEV*) is estimated as long term debt scaled by market value of equity. Fourth, analysts' forecast dispersion (*DISP*) equals the standard deviation of one year ahead earnings per share forecast. Fifth, *BETA* is estimated using the market model with 60 months stock return. Sixth, the consensus long term growth forecast (*LTG*) equals the average long-term growth forecast in June or two-year consensus EPS forecast minus one-year consensus EPS forecast divided by the mean of one-year consensus EPS forecast. Eighth, news coverage (*NEWS*) is measured by using the natural logarithm of number of news articles about the firm. Seventh, institutional ownership (*INSTOWN*) equals the proportion of the shares outstanding owned by institutions. Ninth, earnings surprise (*SURP*) is estimated using natural logarithm of the consensus earnings forecast for forthcoming fiscal year minus actual earning divided by stock price. Tenth, return on assets (*ROA*) is measured by scaling the income before extraordinary items to book value of total assets. Additionally, full descriptions of the variables and measurements are presented in Appendix B. Appendix C provides all the model measurements and descriptions for measuring the cost of equity (COE).

3.3.3 The empirical model

To examine the impact of *iDisc* and other control variables on the implied cost of equity premium we employ the following Model (1):

$$\begin{aligned} \mathrm{COE_{it}} = {} & \beta_0 + \beta_1 \mathrm{iDisc_{it}} + \beta_2\, \mathrm{SIZE_{it}} + \beta_3\, \mathrm{BTM_{it}} + \beta_4\, \mathrm{LEV} + \beta_5\, \mathrm{DISP_{it}} + \\ & \beta_6\, \mathrm{BETA_{it}} + \beta_7\, \mathrm{LTG_{it}} + \beta_8\, \mathrm{NEWS_{it}} + \beta_9\, \mathrm{INSTOWN_{it}} + \\ & \beta_{10}\, \mathrm{SURP_{it}} + \beta_{11}\, \mathrm{ROA_{it}} + \beta_{12} \textstyle\sum_{t=2015}^{2009} \mathrm{T_t} + \beta_{13}\, \mathrm{v_i} + \varepsilon_{it} \end{aligned} \quad (1)$$

The dependent variable in Model (1) is the cost of equity (*COE*). The independent variable is firm's dissemination of financial information on Twitter (*iDisc*). The control variables are firm size (*SIZE*), book to market (*BTM*), financial leverage (*LEV*), analysts' forecast dispersion (*DISP*), beta (*BETA*), long-term growth forecast (*LTG*), news coverage (*NEWS*), institutional ownership (*INSTOWN*), earnings surprise (*SURP*) and return on assets (*ROA*).

Our estimation procedures utilised pooled cross-sectional regressions with robust standard error clustered at the firm level to control for serial correlation and heteroscedasticity (Petersen, 2009; El Ghoul *et al.*, 2011; Cao *et al.*, 2015; Ferris *et al.*, 2017).[8] To mitigate potential endogeneity between *iDisc* and the COE (Nikolaev and Van Lent, 2005), we utilise a two-stage least square model (2SLS) with clustered standard error at the firm level.[9] We use *non-iDisc tweets in the previous year* (*LagOthertweet*) as the instrumental variable in line with prior social media and business press literature (Drake *et al.*, 2014; Lee *et al.*, 2015a). This instrumental variable is related to *iDisc* and is not directly related to the COE. In addition, *LagOthertweet* captured the prior tendency of firm activity and responsiveness in their Twitter account, which is likely to be correlated to *iDisc*. This measure also represents the amount that corporate firms added to their Twitter accounts. The results of the *F* statistic in the first stage is 34 which is greater than the critical value of 10 (Staiger and Stock, 1997). Also, the association between *LagOthertweet* and *iDisc* is positive and significant, which is consistent with our prediction and the previous literature (Lee *et al.*, 2015a).

3.4 Results and Discussion

3.4.1 Descriptive statistics

Table 3.1-Panel (A) reports the percentage of firms that have adopted Twitter and use *iDisc* in our sample. The results show that over 66% of firms used *iDisc* at least once in our sample period and 44% of the firms have disseminated financial information over Twitter for at least three years. This indicates that firms consider Twitter to be a suitable channel for disseminating financial information and many of these firms are persistent in their use of Twitter. This finding is comparable with Jung *et al.* (2018b), who found that more than 57% of firms that have a Twitter account disclose earnings-related tweets. Panel (B) shows that the

[8] The Breusch-Pagan test shows significant results (*p*-value = 0.000), indicating the presence of heteroscedasticity.
[9] To test for the endogeneity, we ran the Durbin Wu-Hausman test. The results show a *P*-value of 0.31, suggesting that endogeneity is prevalent.

percentage use of each *iDisc* class varies across the years and it also shows the average number of tweets per year. We find that the mean number of *iDisc* tweets of the full sample is, on average, seven tweets per year per firm. The results show that the number of such tweets grows substantially over time, which offers some primary insights into the role of Twitter in the dissemination of financial information by firms. This can be justified through the SEC guidance of April 2013, which motivates firms to use Twitter for dissemination purposes (Dorminey *et al.,* 2015). In addition, the results show that financial reporting tweets are the dominant type of *iDisc*, two-thirds of *iDisc* being related to financial reporting, which far exceeds other types. To illustrate more, the results indicate that on average 70% of firms' financial tweets are related to financial reporting. This finding is consistent with Jung *et al.* (2018b), who found a higher number of tweets related to the earnings releases. Our results also show that 7%, 21%, and 15% of *iDisc* tweets were related to financing, financial terms and financial ratio respectively. Nevertheless, the classification procedures allow multiple classification schemes where tweets may fall into more than one category. This means that the classification of tweet is not exclusive to a specific category and each tweet could be classified in more than one class. As such, the percentage sum of financial reporting, financing, financial terms and financial ratio may exceed hundred percent. However, *iDisc* calculation does not take into the account the classification of tweets; but it considers whether each tweet contain financial information, as explained in Section 3.3.2.2.

Panel A: Twitter and iDisc Adoption among Firms in the Sample

Type	% to Firms with Twitter Account
Firms use *iDisc* once	66%
Firms use *iDisc* for three years	44%

Notes: Panel (A) provides the percentage of firms in NASDAQ, with a Twitter account, which uses *iDisc* once and for three years.

Panel B: Average iDisc use among Firms

Years	Average *iDisc* Tweets	% of *iDisc*			
		Financial Reporting (FR)	Financing (Fin)	Financial Term (FT)	Financial Ratio (FR)
2009	1	70%	11%	22%	18%
2010	3	68%	10%	25%	18%
2011	6	68%	10%	27%	27%
2012	6	70%	8%	23%	16%
2013	8	69%	8%	23%	14%

2014	11	76%	6%	17%	11%
2015	13	77%	5%	18%	11%
Average	7	73%	7%	21%	15%

Notes: Panel (B) reports the average number of *iDisc* tweets per year and summary statistic of the percentage use of *iDisc* components across the sample period.

Table 3.1: Firm Twitter and iDisc Characteristics

Table 3.2 provides summary statistics of *iDisc* activity based on the Fama-French 12-industry classification. The distribution of *iDisc* tends to be heterogeneous across industries. The highest use during the whole sample period is prevalent in the business equipment industry. For this industry, at least half of the companies used *iDisc* once, which represents approximately 37% of the total number of firms that use *iDisc*. This result is expected given that firms in the business equipment industry are more likely to adopt this new communication channel (Blankespoor *et al.*, 2014). Although the oil and gas industry shows a high reliance on *iDisc*, consistent with Jung *et al.* (2018b), the percentage of *iDisc* tweets is rather low as compared to other sectors, with a low concentration for the number of firms. In contrast, firms in food, tobacco, textiles, apparel, leather and toys classifications tend to focus more on non-financial information.

Fama-French 12-Industry classification	Percentage of *iDisc* based on	
	Industry	Total *iDisc*
Food, Tobacco, Textiles, Apparel, Leather, Toys	15.3%	1.2%
Cars, TV's, Furniture, Household Appliances	16.5%	1.0%
Machinery, Trucks, Planes, Office Furniture, Paper, Com Printing	33.6%	4.1%
Oil, Gas, and Coal Extraction and Products	43.8%	0.3%
Chemicals and Allied Products	48.1%	1.2%
Software, Computers, and Electronic Equipment	54.0%	37.2%
Telephone and Television Transmission	39.4%	4.1%
Utilities	29.8%	0.7%
Shops Wholesale, Retail, and Laundries, Repair Shops Services	16.2%	4.1%
Healthcare, Drugs and Medical Equipment	36.4%	17.0%
Mines, Construction, Bldg Material, Transportation, Hotels, Business Service, Entertainment	36.0%	28.9%

Notes: The table provides summary statistics of firm use of *iDisc* across Fama-French 12-industry classification excluding financial industry for NASDAQ firms with Twitter accounts from 2009 to 2015.

Table 3.2: Industry Summary of iDisc

Table 3.3 provides descriptive statistics for the variables considered. The summary statistics of the dependent variables show that the mean estimate of *COE* is 5%, which is in line with the prior evidence (El Ghoul *et al.*, 2011; Attig *et al.*, 2013; Cao *et al.*, 2015). *COE* is based on four estimates: R_{OJ}, R_{MPEG}, R_{CT} and R_{GLS}. In comparison, R_{OJ}, R_{CT} and R_{GLS} show higher premiums than *COE* of 6.7%, 5.8% and 10.2% respectively, whereas a lower premium of 4.4% is associated with R_{MPEG}. The mean of firm size (*SIZE*) is 21.15, and the unreported mean (median) of firm size is $9144.4 million ($1277.7 million). The mean (median) of book-to-market (*BTM*) equals 0.42 (0.35). Sample firms have a mean financial leverage (*LEV*) of 15%. The median of dispersion (*DISP*), systemic risk (*BETA*) and the long consensus forecast of earnings estimates (*LTG*) are 8%, 1.03 and 15% respectively. Also, the mean and median of *BETA* are greater than one, which indicates that the sample consists of firms that have higher systematic risk than the market. These results are comparable to prior studies (Cao *et al.*, 2015). Additionally, the average news coverage (*NEWS*) is 5.87, and approximately 86% of firms are owned by institutional owners (*INSTOWN*). The mean average of earnings surprise (*SURP*) is equal to 0.2, which is in line with (Chen *et al.*, 2011). However, the mean of the profitability measure (*ROA*) is (4.9%), compared to a median of 5.4%.

Variables	N	Mean	Median	Min	Max	SD
COE	1737	0.05	0.04	0.00	0.17	0.03
iDisc	1737	1.10	0.00	0.00	5.59	1.37
SIZE	1732	21.15	20.97	17.01	27.16	1.71
BTM	1732	0.42	0.35	-0.01	1.75	0.31
LEV	1736	0.15	0.08	0.00	0.8	0.17
DISP	1588	0.13	0.08	0.02	0.93	0.16
BETA	1600	1.06	1.03	-2.08	3.88	0.56
LTG	1737	0.2	0.15	-1.2	0.847	0.13
NEWS	1729	5.87	5.65	1.61	8.94	1.13
INSTOWN	1490	0.86	0.92	0.00	1.71	0.26
SURP	1559	0.20	0.04	-3.70	3.77	0.69
ROA	1737	0.049	0.054	-1.21	0.22	0.11

Notes: The table summary statistics are presented for COE estimates, *iDisc* and other control variables for NASDAQ firms with Twitter accounts from 2009 to 2015. See Appendix (B and C) for definitions of the variables. The table presents the number of observations (N), mean (Mean), median (Median), minimum (Min) and maximum (Max) values and standard deviation (SD). To control for outliers, we use a winsorizing level of 2.5th to 97.5th percentiles for *COE*, *LEV*, *DISP*, *BETA*, *LTG* and *ROA*.

Table 3.3: Descriptive Statistics for all the Variables

The Spearman and Pearson correlation matrix is presented in Table 3.4 for all the variables at the 10% significance level. The correlation matrix shows a significant and negative

correlation between *COE* and *iDisc*. This finding provides a preliminary conclusion that firms which use *iDisc* have a lower COE. Results indicate that smaller (larger) sized firms have a higher (lower) COE. High risk, measured by *BTM*, *LEV*, *DISP*, *BETA*, *LTG* and *SURP*, is associated with high risk-premiums. Richer information environment variables (*NEWS* and *INSTOWN*) are negatively correlated with *COE*. The result also show that *ROA* is negatively correlated with COE. Overall, correlations between *COE* and the other independent variables are in line with expectations and previous studies (Orens *et al.*, 2010; Cao *et al.*, 2015; Dhaliwal *et al.*, 2016). Moreover, in Table 3.4 *iDisc* is negatively correlated with, *DISP* and *ROA,* and non-significantly negative correlated with *BTM, LTG* and *SURP*. These correlations suggest that enhanced *iDisc* alleviates the uncertainty and risk factors. The table also show that *iDisc* is positively correlated with *SIZE, BETA* and *NEWS*. The positive correlation between firm *SIZE* and *iDisc* indicates that larger firms publish more *iDisc* tweets. Furthermore, firms with a higher rate of news (*NEWS*) use *iDisc* more. The correlations also show that firms with higher *BETA* are more likely to release financial information on Twitter. In addition, the results show that lower return on asset (*ROA*) firms use *iDisc* more frequently. Considering both the Spearman and Pearson correlation matrix and unreported VIF tests indicates that multicollinearity is not dominant across our control variables.

Variables	*COE*	*iDisc*	*SIZE*	*BTM*	*LEV*	*DISP*	*BETA*	*LTG*	*NEWS*	*INSTOWN*	*SURP*	*ROA*
COE	1	-0.11***	-0.24***	0.37***	0.1***	0.06*	0.1***	-0.03	-0.04	-0.1***	0.09***	-0.08**
iDisc	-0.084***	1	0.13***	0.002	0.012	-0.06**	0.12***	-0.05	0.11***	-0.055	0.02	-0.08**
SIZE	-0.29***	0.18***	1	-0.38***	0.16***	0.2***	-0.01	-0.19***	0.64***	0.15***	-0.3***	0.38***
BTM	0.38***	-0.032	-0.44***	1	0.005	0.07**	0.1***	-0.2***	-0.12***	-0.06*	0.24***	-0.42***
LEV	0.09***	0.02	0.15***	-0.06**	1	0.1***	-0.03	-0.2***	0.17***	0.05	-0.05	-0.21***
DISP	0.05**	-0.05	0.29***	-0.05	0.06**	1	0.1**	-0.03	0.23***	0.1**	-0.07**	0.04
BETA	0.15***	0.09***	-0.03	0.09***	-0.04	0.06**	1	0.07**	0.09***	-0.02	0.12***	-0.1***
LTG	0.24***	-0.001	-0.18***	-0.05**	-0.08***	0.09***	0.05**	1	-0.12***	-0.03	0.1***	-0.11***
NEWS	-0.08***	0.11***	0.63***	-0.17***	0.092***	0.26***	0.05**	-0.08***	1	-0.06**	-0.07**	0.11***
INSTOWN	-0.17***	0.005	0.24***	-0.1***	0.07***	-0.005	-0.03	-0.13***	0.13***	1	-0.14***	0.04
SURP	0.177***	-0.001	-0.25***	0.15***	-0.032	-0.05**	0.079***	0.18***	-0.09***	-0.185***	1	-0.3***
ROA	-0.24***	0.015	0.32***	-0.204***	-0.07***	0.037	-0.05	-0.27***	0.12***	0.152***	-0.22***	1

Notes: The table presents the Pearson and Spearman correlation between COE, *iDisc* and control variables for NASDAQ firms with Twitter accounts from 2009 to 2015. See Appendix (B and C) for the descriptions of the variables. ***, **, * present the statistically significant level at 1%, 5% and <10% respectively.

Table 3.4: Pearson and Spearman Correlations for the Cost of Equity (COE), *iDisc* and other control Variables

3.4.2 Empirical results

Table 3.5 reports the results of the two estimation models (i.e., OLS in column 1 and 2SLS in column 2) for the association between *iDisc* and *COE*. Results show a negative and statistically significant association between *iDisc* and *COE* ($p < 0.05$) in OLS and ($p < 0.1$) in 2SLS.[10] Our results show that the economic significance of *iDisc* is -0.16%, which means that if *iDisc* tweeting increases by 50%, the COE is expected to change by -0.08%. However, the finding suggests that firms that disseminate more financial information (*iDisc*) have a lower COE. This implies that firms' decisions to engage in broader dissemination actions through *iDisc* promote financial benefits for both investors and managers. That is, investors can receive a firm's information at a lower acquisition cost and managers are able to alleviate the information asymmetry as well as enhance investor recognition. Although tweets are not expected to have comprehensive information, the results show that *iDisc* can still reduce *COE,* which supports our hypothesis. This finding is in line with our expectation that the effect of tweets should be small as it is less likely to have rich information. However, tweets provide an accessible (open) use for managers at lower costs, efficient timings and better control. This finding is consistent with other communication mechanisms such as corporate websites and open conference calls that firms can use to disseminate their information to the public openly (Zhao *et al.*, 2009; Orens *et al.*, 2010). Nevertheless, these channels are used as primary channels for disclosing corporate information whereas Twitter is used for dissemination of information.

[10] The reduction in sample size is due to the additional data requirements. To check whether our results are affected by missing data, we also ran the regression with the lagged *iDisc* as the instrumental variable. The Lagged *iDisc* can be an appropriate instrument as it is less likely to affect the cost of equity once year later. The Hausman test is 0.39, with first stage partial square equal to 0.59. In addition, a Generalized Method of Moments (GMM) models is applied and show a negative association between *iDisc* and COE. These results are presented in the appendix D. Overall, our main results remain unchanged using these estimation models.

	(1)	(2)
	(OLS)	(2SLS)
iDisc	-0.0016**	-0.0045*
	(0.0007)	(0.0026)
SIZE	-0.0028***	-0.0024*
	(0.0011)	(0.0013)
BTM	0.0404***	0.0400***
	(0.0041)	(0.0048)
LEV	0.0292***	0.0265***
	(0.0059)	(0.0081)
DISP	0.0041	0.0074
	(0.008)	(0.0106)
BETA	0.0056***	0.0062***
	(0.0018)	(0.0023)
LTG	0.0290***	0.0341***
	(0.0097)	(0.0116)
NEWS	0.0036***	0.0052***
	(0.0014)	(0.0016)
INSTOWN	-0.0043	-0.0053
	(0.0051)	(0.0064)
SURP	0.0034**	0.0033*
	(0.0016)	(0.0017)
ROA	0.0248	0.0377*
	(0.0176)	(0.0222)
Year Effect	Yes	Yes
Firm Effect	Yes	Yes
Wu-Hausman Test		0.31
Constant	0.0556***	0.0388
	(0.019)	(0.0249)
Observations	1,146	744
R^2	0.389	0.392

Notes: The table presents the regression results of the impact of *iDisc* on *COE*. The sample consists of nonfinancial firms in NASDAQ with Twitter accounts from 2009 to 2015. See Appendix (B and C) for definitions of the variables and measurements. Column (1) represents the results from pooled cross-sectional regression clustered at the firm level (OLS). Column (2) reports the results from the second stage of the 2SLS regression model. *, **, *** signify the significance level at 10%, 5% and 1% respectively. Robust standard errors are in parentheses.

Table 3.5: The Impact of *iDisc* on Cost of Equity (COE)

With respect to other variables, across the two columns, we find a negative coefficient on firm size (*SIZE*) and positive coefficients on the book-to-market ratio (*BTM*) and financial leverage (*LEV*), which is consistent our prediction. Additionally, *COE* tends to significantly increase systematic risk (*BETA*), with positive coefficients, which is consistent with our

prediction. These findings suggest that firms with higher uncertainty are associated with a higher required rate of return. The coefficient on *LTG* is positive and significant, which supports our expectation, indicating that the market perceives high growth firms as riskier. News coverage (*NEWS*) shows a positive association, which suggests that more news coverage, which is not under the firm's control, increases the COE. That is, firms with higher media coverage face more risk than lower coverage firms. These firms have higher stakeholder pressure as they are exposed to more stakeholder groups (Zyglidopoulos *et al.*, 2012). They also have higher levels of scrutiny from stakeholders, which makes them more vulnerable to campaign targets (Friedman, 1991; Rehbein *et al.*, 2004). In addition, previous literature (Niessner and So, 2018) found that media coverage may favour negative news. Therefore, firms with more news coverage could face higher risks of getting into difficulties when the media provide misshaping or negative news, which consequently increases the COE capital (Kothari *et al.*, 2009a). The coefficient on earnings surprise (*SURP*) is significantly positive, suggesting that firms that have higher optimism about analysts' earnings forecasts have a greater COE (El Ghoul *et al.*, 2011), which confirms our prediction. However, our results show no association for *DISP*, *INSTOWN* and *ROA* in Column (1) and positive association for *ROA* in column (2).

3.4.3 The firm visibility effect

Firms seek to attract investor attention, as well as reduce investor acquisition costs, by disseminating information through many information intermediaries (Hirshleifer and Teoh, 2003; Hirshleifer *et al.*, 2009). If firms with low press coverage rely on a small number of communication channels which are reasonably affordable, there is a high chance that investors will not receive news about the firm on a real-time basis. Therefore, low (high) visible firms are less (more) likely be frequently observed by market participants, and, hence, lower (higher) investor recognition and higher (lower) COE are likely (Merton, 1987). Accordingly, low visibility firms might have a higher need to disseminate firm news and, hence, rely more on *iDisc*. Under these scenarios, *iDisc* will help firms improve firm visibility and be less dependent on other information intermediaries, by voluntarily making dissemination decisions and directly approaching market participants promptly (Blankespoor *et al.*, 2014; Jung *et al.*, 2018b). As such, we predict that the impact of *iDisc* on the implied COE is more pronounced for less visible as compared to more visible firms.

To measure firm visibility, we have used firm size (*SIZE*), analyst following (*ANALYSTS*) and the number of investors (*LNOWN*) as proxies for a firm's visibility, where the upper quartile (lower three quartiles) is used to proxy for highly visible (low visible) firms.[11] These proxies are in line with Merton (1987), who argues that there is a stronger effect of investor recognition for firms with higher idiosyncratic risk. That is to say, firms with a smaller size, low analyst following, and a limited number of investors are less visible to market participants (Agarwal *et al.*, 2016). Although firms may issue voluntary disclosure to attract market participants, smaller sized firms are likely to be neglected and may not be able to benefit from such actions (Bushee and Miller, 2012). To overcome this concern, some firms attempt to initiate investor relation programmes to attract investor recognition and analyst followings (Bushee and Miller, 2012). This is likely to provide valuable communication sources to mid-size and/or small firms, given that large analyst following is associated with an increased demand for the firm's stock, which as a result improves the firm's value (Agarwal *et al.*, 2016). Also, previous research (Lehavy and Sloan, 2008) has argued that firm value is positively associated with the investor base.

We partitioned the full sample into high and low visibility firms under each variable, and the results are presented in Table 3.6 using OLS estimation with clustered standard errors at the firm level. The findings provide strong evidence that lower-visibility firms use *iDisc* to reduce their COE, with significant and negative coefficients reported under columns 2, 4 and 6 ($p < 0.01$, $p < 0.01$ and $p < 0.01$ respectively). These findings are also consistent with prior studies which show that the effect of investor recognition is more pronounced for small-sized firms (Merton, 1987; Blankespoor *et al.*, 2014; Agarwal *et al.*, 2016). Additional evidence suggests that corporate dissemination reduces the COE for firms with low information certainty, low analyst following and a limited number of investors (Botosan, 1997; Orens *et al.*, 2010). In contrast, we find that high-visibility firms with high investor awareness tend not to rely on *iDisc* to reduce the COE and consistently show insignificant associations with *COE*. This might be attributable to large firms having more analysts following them and a larger number of shareholders. Accordingly, these firms seem to benefit from other channels of dissemination and may be reached by more traditional information intermediaries. However, firm size (*SIZE*) is not included in the column 3 and 4 due to the high correlation

[11] Analyst following (*ANALYSTS)* is defined as natural logarithm of number of analysts making an earnings forecast. Whereas, number of investors (*LNOWN*) is estimated using the natural logarithm of number of shareholders.

between firm size (SIZE) and analysts following (*ANALYSTS*), which could cause a multicollinearity problem. That is, firms that are larger in size have a higher analysts following (Sun and Liu, 2016). Overall, these findings are consistent with the notion that broader dissemination to the public on Twitter improves firm visibility, which leads to better recognition and lower cost of equity, consistent with prior literature (Lehavy and Sloan, 2008; Blankespoor *et al.*, 2014; Cao *et al.*, 2015; Agarwal *et al.*, 2016).

	High SIZE (1) OLS	Low SIZE (2) OLS	High ANALYSTS (3) OLS	Low ANALYSTS (4) OLS	High LNOWN (5) OLS	High LNOWN (6) OLS
iDisc	0.00005	-0.003***	-0.0003	-0.0036***	0.0003	-0.003***
	(0.0013)	(0.0008)	(0.0009)	(0.0009)	(0.0013)	(0.0008)
SIZE	-0.0012	-0.0055***			-0.0001	-0.0076**
	(0.0031)	(0.0017)			(0.0043)	(0.0031)
BTM	0.0487***	0.0362***	0.0495***	0.0403***	0.0512***	0.0316***
	(0.0115)	(0.0042)	(0.0072)	(0.0046)	(0.0111)	(0.0078)
LEV	0.0341**	0.0289***	0.0308***	0.0311***	0.0259*	0.0305***
	(0.0131)	(0.0068)	(0.0085)	(0.0085)	(0.0141)	(0.0071)
DISP	-0.0017	0.0085	0.0029	-0.006	0.0008	-0.0018
	(0.0101)	(0.0097)	(0.0096)	(0.0110)	(0.0109)	(0.0097)
BETA	0.0068	0.0053***	0.0053**	0.0054**	0.0052	0.0062***
	(0.0042)	(0.0018)	(0.0022)	(0.0022)	(0.0046)	(0.0019)
LTG	0.0327***	0.0314**	0.0246	0.0313***	0.0041	0.0320***
	(0.011)	(0.0124)	(0.0246)	(0.0107)	(0.0263)	(0.0106)
NEWS	0.0031	0.00315*	0.0016	-0.0001	0.0052**	0.0023
	(0.0022)	(0.0018)	(0.0014)	(0.0022)	(0.0025)	(0.002)
INSTOWN	-0.0054	0.0001	0.0072	-0.006	0.0082	-0.0025
	(0.008)	(0.006)	(0.006)	(0.0068)	(0.0081)	(0.0061)
SURP	0.0033	0.0029*	0.0019	0.0033*	0.0037	0.0025
	(0.0052)	(0.0016)	(0.0027)	(0.0018)	(0.0045)	(0.0017)
ROA	0.110***	0.00343	0.0952***	-0.0333*	0.0950***	0.0109
	(0.0293)	(0.0180)	(0.0184)	(0.0183)	(0.0338)	(0.0186)
ANALYSTS			0.0041	-0.0036		
			(0.0048)	(0.004)		
LNOWN					-0.0047	0.0025
					(0.0065)	(0.0026)

Year Effect	Yes	Yes	Yes	Yes	Yes	Yes
Firm Effect	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.00872	0.114***	-0.0295*	0.0360**	0.0032	0.152***
	(0.0647)	(0.0320)	(0.0159)	(0.0169)	(0.0675)	(0.0514)
Observations	341	805	541	605	328	801
R^2	0.275	0.443	0.350	0.442	0.355	0.430

Notes: This table presents the regression results from estimating our base Model (1) of the impact of *iDisc* on *COE* based on firm visibility. The sample consists of nonfinancial firms in NASDAQ with Twitter accounts from 2009 to 2015. See Appendix (B and C) for definitions of the variables and measurements. The full sample is divided into subsamples based on firm size, analyst following and number of investors. Firm observation placed on the 4th (1s, 2d, 3d) quartile level is designated as high visible (low visible) firms. Columns (1-2) represent the relation based on firm size (*SIZE*). Analyst following (*ANALYSTS*) is added to columns (3-4) and number of investors (*LNOWN*) is added to columns (5-6). The coefficient estimates are based on pooled cross-sectional regression clustered at the firm level (OLS). *, **, *** represent the significance level at 10%, 5% and 1% respectively. Robust standard errors are in parentheses.

Table 3.6: The Effect of iDisc on Cost of Equity (COE) for High- and Low-Visible Firms

3.4.4 The effect of news magnitude and content

Firms are likely to have incentives to disclose good news rather than bad news to positively affect their stock value (Skinner, 1994). Therefore, firms are expected to increase their dissemination of good news on Twitter, rather than negative news. Nevertheless, firms could also use Twitter to attenuate the effect of unfavourable firm announcements such as negative earnings surprise (Miller and Skinner, 2015) or product recall (Lee *et al.*, 2015a). As such, we conjecture that firms that miss analysts' forecasts have less incentive to use *iDisc* as compared to those with a positive earnings surplus. We expect that voluntary disclosure could be used to match managers' and market expectations (Matsumoto, 2002).

To examine the effect of news magnitude (i.e. negative/positive earnings surprises) on the conditional use of *iDisc* to reduce the COE we utilize our base Model (1) to additionally control for the absolute earnings surprise (|*SURP*|) as an indicator variable for negative earnings surprise (*NegSURP*), which takes the value of one when *SURP* is negative and zero otherwise. We also include two interaction variables between absolute earnings surprise with *iDisc* (|*S*URP| * *iDisc*) and negative earnings surprise (|*S*URP| * *NegSURP*). Therefore, we specify Model (2) as follows:

$$\begin{aligned} \mathrm{COE}_{it} = {} & \beta_0 + \beta_1 \mathrm{iDisc}_{it} + \beta_2 \left|\mathrm{SURP}\right|_{it} + \beta_3 \mathrm{NegSURP}_{it} + \beta_4 \left|\mathrm{SURP}\right|_{it} * \\ & \mathrm{iDisc}_{it} + \beta_5 \left|\mathrm{SURP}\right|_{it} * \mathrm{NegSURP}_{it} + \beta_6 \mathrm{SIZE}_{it} + \beta_7 \mathrm{BTM}_{it} + \\ & \beta_8 \mathrm{LEV} + \beta_9 \mathrm{DISP}_{it} + \beta_{10} \mathrm{BETA}_{it} + \beta_{11} \mathrm{LTG}_{it} + \beta_{12} \mathrm{NEWS}_{it} + \\ & \beta_{13} \mathrm{INSTOWN}_{it} + \beta_{14} \mathrm{ROA}_{it} + \beta_{15} \sum_{t=2015}^{2009} \mathrm{T}_t + \beta_{16} \mathrm{v}_i + \varepsilon_{it} \end{aligned} \quad (2)$$

The definition of the variables in Model (2) are as follows: the dependent variable is the cost of equity (*COE*), the independent variable is firm's dissemination of financial information on Twitter (*iDisc*) and the control variables are absolute earnings surprise (|*SURP*|), negative earnings surprise (*NegSURP*), interaction variables between absolute earnings surprise with *iDisc* (|*S*URP| * *iDisc*), interaction variables between absolute earnings surprise with negative earnings surprise (|*S*URP| * *NegSURP*), firm size (*SIZE*), book to market (*BTM*), financial leverage (*LEV*), analysts' forecast dispersion (*DISP*), beta (*BETA*), long-term growth forecast (*LTG*), news coverage (*NEWS*), institutional ownership (*INSTOWN*), and return on assets (*ROA*).

Since firms have the option to use Twitter, firms may use *iDisc* to provide more positive than negative news (Jung *et al.*, 2018b). Therefore, we extend our analysis to identify the effect of news content on the conditional use of *iDisc* to reduce the COE. Previous literature (Kothari *et al.*, 2009a) has studied the effect of the disclosure's content by different information sources on the COE. They found different impacts on COE depending on the source (management, analysts and business press) and the content of the disclosure (favourable and unfavourable news). Johnstone (2016) also argues that the effect of financial reporting on the COE is subject to the direction of the report (what the report says). That is, bad information increases the uncertainty of future expected payoff and hence increases the COE. However, good news provides higher certainty of future cash flow and, thus, reduces the COE. To examine our predictions, using our base Model (1), we additionally include TONE as a proxy for *iDisc* contents and its interaction with *iDisc* (*TONE_ iDisc*). This measure aims to reflect whether *iDisc* tweets provide positive and negative meaning. We used Loughran and McDonald dictionary lists (2011) to identify the positive and negative words of iDisc tweets. We measured the TONE as the difference between positive and negative words divided by the sum of positive and negative words. Accordingly, our model (3) is specified as:

$$\begin{aligned} \mathrm{COE_{it}} = {} & \beta_0 + \beta_1 \mathrm{iDisc_{it}} + \beta_2\ \mathrm{TONE_{it}} + \beta_3\ \mathrm{TONE_{it}} * \mathrm{iDisc_{it}} + \beta_4\ \mathrm{SIZE_{it}} + \\ & \beta_5\ \mathrm{BTM_{it}} + \beta_6\ \mathrm{LEV} + \beta_7\ \mathrm{DISP_{it}} + \beta_8\ \mathrm{BETA_{it}} + \beta_9\ \mathrm{LTG_{it}} + \\ & \beta_{10}\ \mathrm{NEWS_{it}} + \beta_{11}\ \mathrm{INSTOWN_{it}} + \beta_{12}\ \mathrm{SURP_{it}} + \beta_{13}\ \mathrm{ROA_{it}} + \\ & \beta_{14} \sum_{t=2015}^{2009} \mathrm{T_t} + \beta_{15}\ \mathrm{v_i} + \varepsilon_{it} \end{aligned} \quad (3)$$

The definition of the variables in Model (3) are as follows: the dependent variable is the cost of equity (*COE*), the independent variable is firm's dissemination of financial information on Twitter (*iDisc*) and the control variables are tone (TONE), interaction variables between tone with *iDisc* (TONE * *iDisc*), firm size (*SIZE*), book to market (*BTM*), financial leverage (*LEV*), analysts' forecast dispersion (*DISP*), beta (*BETA*), long term growth forecast (*LTG*), news coverage (*NEWS*), institutional ownership (*INSTOWN*), earning surprise (*SURP*) and return on assets (*ROA*).

We estimated Models (2) and (3) using OLS and the results are reported in Table 3.7. The result from Model (2) shows that the dissemination of financial information on Twitter (*iDisc*) is significantly associated with a lower COE even after controlling for the magnitude of the news. The results show that the coefficient of *iDisc* is equal to negative 0.13%, which indicates that increasing *iDisc* tweets by 100% reduces the COE by 0.13%. Although this

may be a relatively small increase in % terms, this was a result of a very small number of posted messages. Increasing them can result in a high return of the time and effort put into systematically engaging investors. The coefficients of |SURP| is positive (statistically significant). However, NegSURP, |SURP| * iDisc and |SURP| * NegSURP are not statistically significant. These results are consistent with Jung et al. (2018), who found an insignificant result by using the total number of the firm's followers, and with the idea that the dissemination of firm initiated information may improve the information environment. The findings highlight the important role of *iDisc,* which extends beyond the type of news. Concerning the effect of news content, results for Model (3) provide evidence that the TONE of the news does not drive the negative association between *COE* and *iDisc*. Both the level and interaction variables for TONE show insignificant associations with *COE*. That is, firms' managers may benefit from *iDisc* even with unfavourable news. The overall findings provide limited support for the influence of news magnitude and news content on information dissemination through *iDisc*. These findings support our main findings and are in line with predictions.

	Model (2) News magnitude (OLS)	Model (3) News contents (OLS)
iDisc	-0.0013*	-0.0017**
	(0.0008)	(0.0008)
|SURP|	0.001***	
	(0.0003)	
NegSURP	0.0008	
	(0.0017)	
*|SURP| * iDisc*	-0.00007	
	(0.0001)	
*|SURP| * NegSURP*	-0.0004	
	(0.0003)	
TONE		0.00004
		(0.0002)
*TONE * iDisc*		-0.00001
		(0.00004)
SIZE	-0.0026**	-0.0028***
	(0.0011)	(0.0011)
BTM	0.0367***	0.0404***
	(0.004)	(0.0041)
LEV	0.0245***	0.0292***
	(0.0062)	(0.0059)
DISP	0.0075	0.0041
	(0.0085)	(0.008)

BETA	0.0051***	0.0056***
	(0.0018)	(0.0018)
LTG	0.0309***	0.0289***
	(0.0084)	(0.0098)
NEWS	0.0032**	0.0036***
	(0.0015)	(0.0014)
INSTOWN	-0.0045	-0.0043
	(0.0052)	(0.0051)
SURP		0.0249
		(0.0177)
ROA	-0.0001	-0.0028***
	(0.0160)	(0.0011)
Year Effect	Yes	Yes
Firm Effect	Yes	Yes
Constant	0.0600***	0.0559***
	(0.0191)	(0.0195)
Observations	1,229	1,146
R^2	0.401	0.389

Notes: The table reports the effect of *iDisc* on implied cost of equity capital after controlling for news magnitude and information content. The sample consists of nonfinancial firms in NASDAQ with Twitter accounts from 2009 to 2015. See Appendix (B and C) for definitions of variables and measurements. Model (2) presents the results after adding news magnitude based on earnings surprise variables. Model (3) includes the tone (*TONE*) of *iDisc* text, in which a tweet could convey the meaning of news reported and its interaction with *iDisc* (*TONE* * *iDisc*). *TONE* is measured based on positive and negative words from the Loughran and McDonald lists. The coefficient estimates are based on pooled cross-sectional regression clustered at the firm level (OLS) and *, **, *** represent the significance level at 10%, 5% and 1% respectively. Robust standard errors are in parentheses.

Table 3.7: News Magnitude of iDisc and Cost of Equity (COE)

3.4.5 The effect of providing additional information and the reach of iDisc

In this section, we examine the association between *iDisc* on COE by considering different measures of *iDisc* and COE. First, we count the *iDisc* tweets that include hyperlinks, as this allows users to acquire more information from websites by following the posted link (Blankespoor et al., 2014). Second, we examine the relationship studying the reach of *iDisc* tweets through counting the number of followers that receive *iDisc* tweets (size of the audience). The advantage of number of followers is that firm know the intended audience of their Twitter account which may be a factor that motivate firms to disseminate on Twitter and shape their information environment (Jung *et al.*, 2018b). Tweets that are disseminated to larger followers expect to reach larger number of audiences and hence have more effect on the equity financing. Finally, we employ an alternative COE measure, R_{PEG} (Easton, 2004), based on long-term horizon estimates. R_{PEG} is measured as the difference between the median of 5 years ahead earnings per share forecast ($FEPS_5$) and 4 years ahead earnings per share forecast ($FEPS_4$) scaled by share price at June next year. Across different measures of COE,

Botosan *et al.* (2011) find that R_{PEG}, which assumes no dividend payment, is a valid proxy for COE. They state that R_{PEG} is a reliable measure "associated with firm-specific risk characteristics in a theoretically predictable and stable manner" (p. 1085). Empirical studies on the relationship between corporate disclosure and the COE also use R_{PEG} as a proxy for COE (Kim and Shi, 2011; Mangena *et al.*, 2016). The findings are presented in Table 3.8 and show that iDisc_Hyperlink and iDisc_Followers in column (1) and (2) are negatively and significantly associated with COE. This implies that tweets which permit more access to information or are diffused to extend to potential investors considerably reduce the COE. The results also show that tweets that are spread larger firm audience have stronger negative association with COE. The results in column (3) show a significant and negative association between R_{PEG} (as an alternative measure of COE), which is consistent with our main findings. The use of the alternative estimation model to measure COE, which is based on on Easton's (2004) model, R_{PEG}, has increased the number of observations. That is, R_{PEG} has more data availability and is measured differently from COE, which is based on the existence of four COE estimates.

	(1)	(2)	(3)
	COE (OLS)	COE (OLS)	R_{PEG} (OLS)
iDisc_Hyperlink	-0.0015**		
	(0.0007)		
iDisc_Followers		-0.001***	
		(0.0002)	
iDisc			-0.0038**
			(0.0017)
SIZE	-0.00280***	-0.003**	-0.0113***
	(0.00107)	(0.0013)	(0.0026)
BTM	0.0404***	0.0388***	-0.0106
	(0.00412)	(0.0048)	(0.009)
LEV	0.0293***	0.0268***	-0.0359**
	(0.00591)	(0.0067)	(0.0153)
DISP	0.00414	0.0037	0.0406***
	(0.00805)	(0.0106)	(0.0146)
BETA	0.00563***	0.0063***	0.0101**
	(0.00177)	(0.0019)	(0.005)
LTG	0.0290***	0.0247*	0.0697
	(0.00974)	(0.0141)	(0.0447)
NEWS	0.00361***	0.0039**	0.0092***
	(0.00138)	(0.0015)	(0.0027)
INSTOWN	-0.00430	-0.0024	-0.037***
	(0.00511)	(0.0057)	(0.0139)

SURP	0.00341**	0.0033*	0.0119***
	(0.00159)	(0.0017)	(0.0042)
ROA	0.0248	0.0029	-0.134***
	(0.0177)	(0.0190)	(0.033)
Year Effect	Yes	Yes	Yes
Firm Effect	Yes	Yes	Yes
Constant	0.0563***	0.0589**	0.315***
	(0.0194)	(0.0249)	(0.0509)
Observations	1,146	822	2,399
R^2	0.388	0.404	0.222

Notes: This table represents the regression results from estimating our base Model (1) using different measures of *iDisc* and COE. The sample consists of nonfinancial firms in NASDAQ with Twitter accounts from 2009 to 2015. See Appendix (B and C) for definitions of variables and measurements. We use *iDisc* with hyperlink in column (1). In column (2), we use R_{PEG} as an alternative measure of the cost of equity. The coefficient estimates are based on pooled cross-sectional regression clustered at the firm level (OLS) and *, **, *** represent the significance level at 10%, 5% and 1% respectively. Robust standard errors are in parentheses.

Table 3.8: Applying Alternative Measures of iDisc and Cost of Equity (COE)

3.4.6 Controlling for information quality and other firm characteristics

In Table 3.9, we further check the robustness of our main results by controlling for a set of other variables in Model (1). First, we use discretionary accruals, based on Jones's model (Francis *et al.*, 2008; Demirkan *et al.*, 2012), as a proxy for information quality. Previous literature (Hughes *et al.*, 2007; Lambert *et al.*, 2011) has argued that information quality has both direct and indirect (through information asymmetry) effects on the COE. Francis *et al.* (2008) find that the impact of financial information on the COE becomes insignificant after controlling for information precision. Theoretical models (Lambert *et al.*, 2007) indicate that information asymmetry does not affect the COE after controlling for information quality. In column (1), we, therefore, incorporate discretionary accruals measured as the difference between discretionary accruals based on Jones model and firm's corresponding discretionary accruals. This measure is applied by estimating the following equation in each year and industry:

$$TACC_{it}/TA_{it-1} = \alpha 1\left(1/TA_{it-1}\right) + \alpha 2\ \Delta REV_{it}/TA_{it-1} + \alpha 3\ PPE_{it}/TA_{it-1} + \varepsilon$$

where TACC is total accrual, TA is total assets, ΔREV is change in revenue and PPE is gross property, plant and equipment. From the previous equation, α1 α2 and α3 are used to estimate the normal accrual (N_ACCRUAL).

$$N\_ACCRUAL_{it} = \alpha 1\left(1/TA_{it-1}\right) + \alpha 2\ \left(\Delta REV_{it} - \Delta REC_{it}\right)/TA_{it-1} + \alpha 3\ PPE_{it}/TA_{it-1}$$

Beside the variables that are defined, ΔREC is change in account receivables. However, ACCRUAL equal to [(TA_{it} / TA_{it-1}) – N_ACCRUAL].

Second, following previous research (Lee *et al.*, 2015a; Jung *et al.*, 2018b), we include an indication of the social media adoption of financial reporting, namely advertising intensity (ADVERTISING). This is calculated as total advertising expense divided by the total sales. Even though firms with high advertising expenses are more likely to have a Twitter account, firms that spend less on advertising tend to use Twitter for announcement purposes (Jung *et al.*, 2018b). We also control for whether a firm headquarters is located in Silicon Valley (SILICON) and whether the firm's manager is younger than the median age (CEOAGE). Firms that are located in Silicon Valley and have younger managers are more likely to adopt social media platforms (Lee *et al.*, 2015a). Furthermore, we also control for the growth in sales (GROWTH_SALES) which is measured as the percentage change in sales from previous year. Firms with high growth in sales are more likely to adopt other communication channels such conference call for corporate reporting (Frankel *et al.*, 1999). Previous literature (Lee *et al.*, 2015a; Jung *et al.*, 2018b) have also control for GROWTH_SALES.

Finally, the implied COE is measured by using earnings estimates of analysts' forecasts as a prediction of market expectations. Using these estimates might be subject to criticism as the poor market expectation by analysts may bias the implied COE estimates. Accordingly, previous studies suggest controlling for analysts' sluggishness forecasts by including price momentum (Chen *et al.*, 2011; El Ghoul *et al.*, 2011). We, therefore, include the price momentum (MMT), measured as the compounded rate of return of the previous 6 and 12 months.

	(1)	(2)	(3)	(4)
	COE (OLS)	COE (OLS)	COE (OLS)	COE (OLS)
iDisc	-0.0019**	-0.0021**	-0.0017**	-0.0016**
	(0.0007)	(0.001)	(0.0007)	(0.0007)
SIZE	-0.0022*	-0.003*	-0.0032***	-0.0031***
	(0.0012)	(0.0018)	(0.0011)	(0.0011)
BTM	0.0446***	0.0491***	0.0360***	0.0375***
	(0.0051)	(0.0069)	(0.0043)	(0.0042)
LEV	0.0290***	0.0319***	0.0292***	0.0282***
	(0.007)	(0.0083)	(0.006)	(0.006)
DISP	0.0053	0.0019	0.005	0.0046
	(0.0081)	(0.0101)	(0.0083)	(0.0082)
BETA	0.0049**	0.0045*	0.0066***	0.0064***
	(0.0019)	(0.0025)	(0.0018)	(0.0018)
LTG	0.0435***	0.0443***	0.0312***	0.0302***
	(0.0084)	(0.0138)	(0.01)	(0.0097)
NEWS	0.0022	0.0023	0.0038***	0.0039***
	(0.0017)	(0.0023)	(0.0015)	(0.0014)
INSTOWN	0.0006	-0.0037	-0.0041	-0.0035
	(0.0055)	(0.0078)	(0.0051)	(0.0051)
SURP	0.0053***	0.0025	0.0038**	0.0034**
	(0.0018)	(0.0029)	(0.0016)	(0.0016)
ROA	0.0392*	0.0715***	0.0289	0.0310*
	(0.0214)	(0.0199)	(0.0186)	(0.0181)
ACCRUAL	-0.0023			
	(0.0095)			
ADVERTISING		-0.009***		
		(0.0025)		
SILICON		0.0046		
		(0.0041)		
CEOAGE		0.0011		
		(0.0026)		
GROWTH_SALES		-0.0073		
		(0.0093)		
MMT6			-0.0103***	
			(0.0018)	
MMT12				-0.0128***
				(0.0021)
Year Effect	Yes	Yes	Yes	Yes
Firm Effect	Yes	Yes	Yes	Yes
Constant	0.0318	0.0575**	0.0705***	0.0660***
	(0.0210)	(0.0287)	(0.0197)	(0.0194)
Observations	675	549	1,100	1,115
R^2	0.445	0.423	0.411	0.415

Notes: This table presents the regression results from estimating our base Model (1) by including additional robustness tests for our selected sample. The sample consists of nonfinancial firms in NASDAQ with Twitter accounts from 2009 to 2015. See Appendix (B and C) for definitions of the variables and measurements. Column (1) controls for information quality by adding discretionary accrual (*ACCRUAL*) as a control variable. Column (2) reports the regression after adding variables that relate to social media adoption (*ADVERTISING*, *SILICON*, and *CEOAGE*). We have also added price momentum in the last 12 months and 6 months in columns (3&4) to control for the sluggishness of analysts' forecasts. The coefficient estimates are based on pooled cross-sectional regression clustered at the firm level (OLS) and *, **, *** represent the significance level at 10%, 5% and 1% respectively. Robust standard errors are in parentheses.

Table 3.9: Robustness Tests for Including Other Additional Variables

The results in column (1) suggest that the negative effects of *iDisc* on *COE* is not affected by information quality, whereas discretionary accruals (ACCRUAL) are insignificant. This finding supports the incremental role of dissemination for corporate disclosure (Fang and Peress, 2009; Blankespoor *et al.*, 2014), rather than the quality of information. When controlling for the effect of social media indicators, in column (2) we find a negatively significant association between *iDisc* and *COE*. While *ADVERTISING* is negative statistically significant, the other indicators of social media (*SILICON*, *CEOAGE* and *GROWTH_SALES*) report insignificant associations with *COE*.[12] These results alleviate any concern regarding the willingness to adopt social media and the implications of the use of *iDisc*. Finally, the results in columns (3 and 4) show that the two indicators of momentum are negatively and significantly associated with *COE*, which is consistent with prior research (Chen *et al.*, 2009). These findings suggest that the noise of analysts' forecasts does not drive our results. The negative and significant association between *iDisc* and *COE* is robust, which suggests that our main findings are not affected by analysts' noise.

3.5 Conclusion

The amount of real-time data, "*big data*", on social media has attracted various practices among many firms due to its application and involvement in people's daily life, resulting in a great deal of attention and business change (e.g. Raguseo, 2018). Social media such as Twitter has become a popular channel for many firms to disseminate financial information by directly reaching investors promptly. This study has examined the association between firms' dissemination decisions about financial information and the COE. Overall, the findings support the idea that firms can use Twitter to improve the communication with investors,

[12] The decrease in the number of observations is due to missing variables.

which reduces the time and energy of acquiring news about the firm, reduces information asymmetry and enhances investor recognition and firm visibility.

More specifically, the study has made a number of theoretical contributions. Firstly, using the implied COE as a proxy for COE, we find that *iDisc* is significantly and negatively associated with the COE. The results indicate that firms which rely more on *iDisc* to voluntarily disseminate financial information have significantly lower COE financing. This finding is robust for firm-specific risk, information intermediaries, analysts' forecast biases, earnings surprise and financial performance. Second, we have shown that the effect of *iDisc* is more pronounced for less-visible firms that are smaller in size, have a low analyst following and a limited number of investors. These findings are consistent with the investor recognition notion that highly visible firms are likely to have a lower impact on the COE since their information is already disseminated through other information intermediaries. Third, we have extended our analyses to examine whether the magnitude of the news, when missing earnings forecasts or conveying more negative or positive meanings, would affect our main findings. We find that *iDisc* is negatively associated with the COE even after considering the magnitude of the news. Finally, the results are robust to different *iDisc* and COE measures. As a sensitivity check, we have: (i) used *iDisc* with hyperlinks to reflect the diffusion and spread of information; (ii) used number of followers that receive *iDisc* to reflect the size of the audiences that firm information reaches; and (iii) applied the modified price-earnings growth (R_{PEG}) model, as an alternative measure of the COE. The findings from these sensitivity analyses support our main results, suggesting that extensive use of *iDisc* reduces the COE. These findings motivate firms' managers to use Twitter to disseminate financial information in order to enhance firms' information environment and transparency and also to reduce the uncertainty and agency problem between informed and uninformed investors, which limits the firm's accessibility to lower external financing costs. These findings also shed light on firm managers' concerns about firm visibility by showing that disseminating financial information on Twitter can benefit these firms and reach a wider number of investors. Managers should also consider engaging in *iDisc* activity to reduce the COE even when news about the firm is not favourable.

Future research could examine other markets and how decision investments are affected by local social media practices. Similarly, other social media and big data platforms that have different characteristics to those of Twitter (e.g. Facebook or LinkedIn) could be considered.

For example, the size of Twitter messages ("a tweet") is limited to 140 characters, which limits the information provided in each message. Other social media platforms do not have such limitations, which may mean that they have a different effect to Twitter. It would also be of interest to examine not just dissemination but also user engagement and whether the sectors in which firms operate and their business norms play a role in social media investor engagement. We also acknowledge some limitations regarding the variable measurements, such as using *SILICON* as a proxy for technology firms, which is subject to some limitations as not all technology firms' headquarters are located in Silicon Valley. In addition, the study is limited to firms that are traded on the NASDAQ stock exchange. Future studies can overcome this limitation by employing cross-country samples. Furthermore, the study focuses on COE and not cost of debt and hence does not reflect the total cost of capital. Thus, the study provides a venue for future studies to examine the effect of *iDisc* on cost of debt. However, our study provides comprehensive evidence that using social media as a dissemination channel can have a real effect on the capital market. Another limitation of the current study is the measures of cost of equity which are formulated on the forecasted values of different financial aspects, e.g. earnings, growth, and dividends. These forecasting figures are assessed and evaluated by different analysts which can be subjected to personal views of market expectation (Chen et al., 2009).

Chapter 4. The Effect of Carbon Dissemination on Cost of Equity[13]

4.1 Introduction

Undoubtedly, climate change-related events that receive high media coverage and increased attention from environmental groups, governments, and investors motivate firms to make strategic investments to improve their environmental performance (El Ghoul *et al.*, 2018) and to consider carbon impacts as part of their management strategy (Weinhofer and Hoffmann, 2010; Sprengel and Busch, 2011). Such interest has "created opportunities and challenges for firms in their risk-return relationships with shareholders and other stakeholders" (Ng and Rezaee, 2015, p. 128). This interest also puts growing pressure on managers to satisfy shareholders' carbon-related information demands to enable investors to assess potential risks, including regulatory, physical and business risks, and evaluate their investment strategy (e.g. Dobler *et al.*, 2014). Managers, therefore, have incentives to show their proactivity by strategically conveying messages about carbon-related information to reduce investors' uncertainty about future cash flows and to sustain a better competitive advantage and reputation (see Diamond and Verrecchia, 1991; Botosan, 1997). The value of carbon information, however, is expected to increase as more stakeholders become aware of it (Servaes and Tamayo, 2013). While firms may disclose carbon information, it is difficult to ensure that this information reaches a larger set of investors by relying on traditional or third-party communication channels, which results in information asymmetry (see Easley and O'hara, 2004; Blankespoor *et al.*, 2014) and thus a higher cost of equity (COE) (e.g. Dhaliwal *et al.*, 2011; Dhaliwal *et al.*, 2014). Consequently, firms acknowledge the importance of improving the dissemination of their information apart from disclosure (Bushee *et al.*, 2010; Bushee and Miller, 2012). Thus, a broader spread of carbon information allows potential investors to be aware of a firm's information and enlarges the investor base, which in turn can improve firm value and reduce the COE (Merton, 1987; Heinkel *et al.*, 2001; Byun and Oh, 2018).

This study employs legitimacy theory to examine whether a firm's dissemination of carbon-related information (*iCarbon*) on Twitter's social media network can influence a firm's

[13] This chapter has been published at Journal of *Business Strategy and the Environment*:
Albarrak, M.S., Elnahass, M. and Salama, A. (2019) 'The effect of carbon dissemination on cost of equity', *Business Strategy and the Environment*. Epub ahead of print.

COE.[14] Social media is an essential tool for connecting stakeholders with firms, for influencing corporate practice, and for controlling corporate pollution and irresponsible practices (Jia *et al.*, 2016). The Twitter platform, which enables the isolation of the effect of dissemination from that of disclosure (Blankespoor *et al.*, 2014; Jung *et al.*, 2018b), has "changed the disclosure landscape and the way firms communicate important information to stakeholders" (Lee *et al.*, 2015a, p. 368) and can provide positive signals to market participants about a firm's environmental responsibility to respond to the uncertainty of carbon risks and to improve the firm's reputation and image (Barnett and Salomon, 2012). Twitter provides open platform for firm and the public to engage about environmental issues which helps firms to gain legitimacy (Grimmelikhuijsen and Meijer, 2015; Castelló *et al.*, 2016; Lee *et al.,* 2018b). In addition, Twitter's design of short messages (tweets) may allow many firms to gain legitimacy among stakeholders and avoid scrutiny by demonstrating that they are environmentally responsible organisations (see Stanny, 2013). Twitter also allows firms to know the size of their audience and the number of their followers, which may motivate their decision to disseminate to a broader audience, in a much more timely and efficient manner than a corporate website can achieve. Firms can share their news and discuss their performance through the use of a hashtag (#CarbonEmissions or #ClimateChange) to spread their messages to stakeholders who are concerned about global warming issues and threats and to attract the attention of these stakeholders. By retweeting, the recipients of carbon-related tweets can share this information with their followers to expand the information reach to a more diverse audience and to more potential investors. In essence, using Twitter allows firms to reach potential investors directly and prolongedly in a timely manner that can reduce the time, effort, and energy that investors need to spend on finding, searching for and accessing information (Blankespoor *et al.*, 2014; Miller and Skinner, 2015). Twitter also mitigates information asymmetry by meeting the demand for information and ensuring its availability to investors (Hirshleifer and Teoh, 2003; Hirshleifer *et al.*, 2009; Blankespoor *et al.*, 2014).

[14] Legitimacy is defined as "a generalised perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions" (Suchman, 1995, p.574). Legitimacy theory argues that firms seek to alter public perception about the firm by legitimatising their activity though environmental reports (Cho and Patten, 2007). Firms' dissemination of carbon-related information (*iCarbon*) may boost stakeholder support and help to ensure that the firm's activities are perceived as legitimate.

Our paper makes several contributions to the extant literature. First, while the extant research (e.g. Sharfman and Fernando, 2008; Chen and Gao, 2011; Kim *et al.*, 2015; Lee *et al.*, 2015b; Peng *et al.*, 2015; Balvers *et al.*, 2017; Li *et al.*, 2017; Gupta, 2018; Jung *et al.*, 2018a; Zhou *et al.*, 2018; Fonseka *et al.*, 2019) focused on temperature shocks, managing climate/environmental risks and responding to the Carbon Disclosure Project (CDP) survey to examine market responses to firms' voluntary climate change information disclosure or their associations with the cost of debt financing/equity capital, this paper examines the dissemination effect of carbon-related information via Twitter (*iCarbon*) on the COE. This *broader* effect is unlike that of disclosure and has its own capital market consequences (Bushee *et al.*, 2010). Corporate disclosures also "often reach only a portion of investors, which results in information asymmetry among investors" (Blankespoor *et al.*, 2014, p. 79). Second, the prior research (Bushee *et al.*, 2010; Li *et al.*, 2011) has paid particular attention to press releases, as an information intermediary, to examine the effect of dissemination on information asymmetry. The press, however, is biased towards the coverage of highly visible firms and often modifies the information released by firms by adding a discussion, providing opinions, and/or summarising the news (Blankespoor *et al.*, 2014). In contrast, Tweets disseminated by firms are short and independent of media adjustments, which makes them most likely to be used for disseminating purposes rather than for providing comprehensive information. Finally, while previous studies (Chen *et al.*, 2014; Jame *et al.*, 2016; Bartov *et al.*, 2018) examine the effect of user-granted information over social media on capital market activity, we focus more on firm granted information. Prior work shows how firms' dissemination on Twitter improves market liquidity (Blankespoor *et al.*, 2014; Prokofieva, 2015) and attenuates negative market reaction to product recalls (Lee *et al.*, 2015a) and acquisition announcements (Mazboudi and Khalil, 2017), to the best of our knowledge, no study has examined the effect of the Twitter dissemination of carbon-specific information on the COE.

We employ a sample of 1,737 observations, representing 584 non-financial firms with Twitter accounts, listed on the NASDAQ stock exchange for the period 2009-2015. We use the implied cost of equity, which is based on the average of four estimates, as a proxy for the COE, and the number of tweets that relate to carbon information[15], as a proxy for *iCarbon*.

[15] We focus on carbon information because US firms that emit at least 25,000 metric tons of CO_2 are mandated to report their emissions, but not on Twitter, which allows us to differentiate the effect of dissemination from that of disclosure decisions.

Our findings show that the better dissemination of carbon information reduces a firm's equity financing costs. We also examine the effect of firms' environmental disclosure score on the association between *iCarbon* and the COE.[16] Our results report no effect of environmental reporting, whereas *iCarbon* is negatively related to the COE. Consistently, we find similar results by examining the effect of environmental, social and governance (ESG) disclosure. Overall, our findings support the legitimacy theory and indicate that firms that voluntarily disseminate more carbon-related information have a lower COE. The results are robust for the alternative specifications of the model.

The research provides several implications for firms' managers, regulators, policymakers and investors. The findings of the research show that firms' dissemination of financial information via Twitter (*iCarbon*) help managers to lower firms' equity financing. This finding should embrace firm managers to use social media as communication channel to meet investors demand of information. In addition, regulators have less established rules and more flexibility over what information is disseminated through social media in comparison to other traditional disclosure channels (Blankespoor, 2018). Therefore, the research encourages policymakers to implement more rules toward firm use of social media to address carbon emission and climate change issue and material information. Carbon related information attract great interest due its influence on the ecosystems and human health/life (Giannarakis *et al.*, 2017). As such, regulators should give more consideration to implement more rules to improve carbon related information and alleviating the harm to the ecosystem due to carbon emission. Beside managers and regulators, the findings of the study show that investors benefit from firm's dissemination of carbon related information by reducing investors' uncertainty over their required rate of return and making better decision making.

The research provides several implications for firm managers, regulators, policymakers and investors. The findings of the research show that firms' dissemination of financial information via Twitter (*iCarbon*) help managers to lower firms' equity financing. This finding should encourage firm managers to use social media as a communication channel to meet investors' demand for information. In addition, regulators have less established rules and more flexibility over what information is disseminated through social media, in comparison to other traditional disclosure channels (Blankespoor, 2018). Therefore, the

[16] The environmental disclosure score reflects the amount of environmental data that the firm reports and makes available to the public.

research encourages policymakers to implement more rules for firms' use of social media to address carbon emissions, climate change issues and material information. Carbon-related information attracts great interest due its influence on ecosystem and human health/life (Giannarakis *et al.,* 2017). As such, regulators should give more consideration to implementing additional rules to improve the reporting of carbon-related information and alleviate the harm to the ecosystem due to carbon emissions. Beside managers and regulators, the findings of the study show that investors benefit from firms' dissemination of carbon-related information by reducing investors' uncertainty over their required rate of return and making better decisions.

The organisation of the paper is as follows: the literature and hypothesis development are reviewed in section 2. The data and methodology are presented in section 3. Section 4 presents the results and discusses the key findings. Section 5 concludes.

4.2 Literature Review and Hypothesis Development

Organisations operate in a social, political and economic context (Buhr, 1998) and have obligations to society in general that go beyond their interests and legal responsibilities. As a part of the modern project of justice and progress, organisations establish their legitimacy based on society's perception of their contribution to the public good (Brunsson, 2006). The relationship between organisations and society, then, is viewed as a "*social contract*" in which their continuing existence relies upon adapting to the social norms, values, and expectations of organisations and their activities. Such a strategy is essential to obtain and preserve social approval or a licence to operate (Schepers, 2010), i.e., legitimacy[17], by changing the societal perceptions of social constituencies (Guthrie and Parker, 1989; Patten, 1992; Oliver, 1996; Buhr, 1998; Scherer *et al.*, 2013). As Dowling and Pfeffer (1975) state, "Organisations seek to establish congruence between the social values associated with or implied by their activities and the norms of acceptable behaviour in the larger social system of which they are a part" (p.122). Undoubtedly, "organisations that…lack acceptable

[17] The legitimacy concept is "rooted in neo-institutional social theory…and has branched out from sociology and is commonly used within legal scholarship that examines the connections among legal frameworks, social norms and decision making" (Bowen, 2014; p.59). Parsons (1960) viewed legitimacy in organisational institutionalism as the sharing of common values between the organisation and the social system in which it exists. Among other institutional theorists, Suchman (1995) provided an in-depth analysis of organisational legitimacy and referred to it as "a generalised perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions" (p.574).

legitimated accounts of their activities…are more vulnerable to claims that they are negligent, irrational or unnecessary" (Meyer and Rowan, 2004, p.50, cited in Suchman, 1995, p.575).

We use legitimacy theory (e.g. Guthrie and Parker, 1989; Suchman, 1995; Deegan and Gordon, 1996; Adams *et al.*, 1998; Campbell, 2000; Garriga and Melé, 2004; Zhao, 2012) as a positive theory that embraces a system-oriented perspective, which is derived from political economy theory[18] (e.g. Williams, 1999; Woodward *et al.*, 2001; Deegan, 2014), to explain why firms disseminate carbon-related information via Twitter. Much of the prior research drawing on legitimacy theory to explain or predict particular managerial activities claims that environmental disclosures to communicate with society, on whom an organisation depends for its viability, are necessary to gain legitimacy among stakeholders (Zeng *et al.*, 2012; Deegan, 2014), improve stakeholders' perceptions of a firm's environmental efforts (Cho and Patten, 2007; Plumlee *et al.*, 2015), mitigate stock market risk (Orlitzky and Benjamin, 2001; Bansal and Clelland, 2004; Salama *et al.*, 2011), reduce the cost of equity capital (Dhaliwal *et al.*, 2011; Dhaliwal *et al.*, 2014; Fonseka *et al.*, 2019; Lemma *et al.*, 2019), improve financial performance (Margolis and Walsh, 2003; Orlitzky *et al.*, 2003; Clarkson *et al.*, 2011), and lessen exposures to political and public pressures (Cho *et al.*, 2012)

Lindblom (1994) identifies four possible paths to legitimisation to respond to such public pressure. The first path is to inform the relevant public about actual changes in activities or intentions to improve performance. The second path is to attempt to alter stakeholders' perceptions of negative events without making any changes to those actions. The third path is to distract attention away from the threatening events by emphasising more positive actions that do not necessarily have to be related. The fourth path is to attempt to influence society's expectations with regard to performance.

It is also pertinent to note that legitimacy is "a multidimensional concept" (Álvarez-García *et al.*, 2018, p. 72), which, according to Suchman (1995), is composed of three dimensions that co-exist in most real-world settings: pragmatic, moral, and cognitive legitimacy. Pragmatic legitimacy (Suchman, 1995) emphasises the self-interested calculations of the particular interests of an organisation's most immediate social actors, through exchange, influence, or

[18] According to Gray *et al.,* (1996), stakeholder theory and legitimacy theory are both derived from a broader theory that has been called political economy theory. The political economy is "the social, political and economic framework within which human life takes place" (Gray *et al.,* 1996, p.47). The viewpoint included is that society, politics and economics are inseparable, and economic issues cannot be investigated without considerations of the political, social and institutional framework in which the economic activity takes place.

disposition. Pragmatic legitimacy occurs when the legitimacy granter fulfils his/her interests, achieving a value contribution, while acquiring specific commitments with the legitimacy seeker (Díez-de-Castro *et al.*, 2018). The second dimension of legitimacy is moral (ethical) legitimacy, which "becomes the decisive source of societal acceptance for corporations in an increasing number of situations" (Palazzo and Scherer, 2006, p. 74). Stakeholder pressure reflects moral legitimacy (Salmi, 2008), which rests on judgements about whether a given activity is the right thing to do to promote the social welfare of the actors that surround the organisation, rather than on judgements about whether the evaluated objective benefits a particular set of constituents (Suchman, 1995). Therefore, "moral legitimacy should be achievable by claiming to be ethical and acting accordingly" (Treviño *et al.*, 2014, p. 200). An organisation is evaluated as legitimate from a moral point of view when audiences perceive that it defends and pursues principles accepted and valued as socially positive, which are considered more important than private interests by such an organisation (Díez-de-Castro *et al.*, 2018; Miranda *et al.*, 2018). Maintaining this legitimacy notion leads to competitive advantages, such as enhanced reputation (Schepers, 2010), which emphasises the economic benefits to organisations of being different (Bowen, 2014). Moral legitimacy is usually analysed by evaluating the appropriateness or desirability of the outcomes (consequential legitimacy), procedures (procedural legitimacy), structures (structural legitimacy), and leaders (personal legitimacy) used to achieve the objectives. Unlike moral legitimacy, cognitive legitimacy is established when the techniques and procedures used to achieve an organisation's objectives are perceived to be adequate and accepted without question (Salmi, 2008; Iglesias-Pérez *et al.*, 2018). Cognitive legitimacy accentuates that an organisation is granted legitimacy when audiences see its activities as fitting into their beliefs and assumptions or when they cannot imagine that an organisation would not be corresponding to their interests (Treviño *et al.*, 2014). Cognitive legitimacy, therefore, represents a state of "comprehensibility" or a "taken-for-granted" (inevitability or permanence) (Palazzo and Scherer, 2006; Schepers, 2010) and operates at the subconscious level, making it difficult for the organisation to directly and strategically influence perceptions (Suchman, 1995).

Using legitimacy theory as an interpretive lens, Patten (1992) examined the change in the environmental disclosures of annual reports by 21 North American petroleum companies in response to the increased environmental concern resulting from the 1989 Alaskan Exxon Valdez oil spill incident. He argued that if the Alaskan oil spill resulted in a threat to the

legitimacy of petroleum firms and not just to Exxon, then legitimacy theory would suggest that companies operating within the petroleum industry would respond by increasing environmental disclosures in their annual reports. Patten's results show that there was a significant increase in the environmental disclosures made by the companies across the petroleum industry for the post-1989 period, even though the incident itself was directly related to one petroleum company. Patten suggested that threats to a firm's legitimacy entice it to include environmental information in its annual report. Deegan and Rankin (1996) also utilised legitimacy theory to explore how organisations altered their environmental reporting practices in their annual reports around the time of environmental prosecutions. The sample consisted of 20 Australian companies, which were subject to successful prosecution by the New South Wales and Victorian Environmental Protection Authorities, during the period 1990-1993. Of those firms that had been prosecuted, 18 provided positive and qualitative environmental news in their annual reports. Only two of the companies within the sample made any reference to the prosecutions. They found that prosecuted firms disclosed more environmental information (of a positive nature) in the annual report in the year of prosecution than any other year in the sample period. The prosecuted firms also disclosed more environmental information relative to non-prosecuted firms. The results of the study supported the view that management considered that the prosecutions negatively impacted the community's perception of the organisation, and as a result, management made other affirmative environmental disclosures in the annual report to limit the likely damage to the company's reputation as a result of the prosecutions.

More recently, Cho *et al.* (2012) examined two competing theories (voluntary disclosure theory[19] and legitimacy theory) to explain why some firms choose to disclose their environmental capital spending, while others do not. They found that disclosure does not appear to signal better future environmental performance relative to non-disclosure and that firms with worse environmental performance are more likely to disclose the amount they spend. They concluded that firms use environmental disclosure more as a strategic legitimising resource for reducing their exposures to political and regulatory concerns than as a mechanism for signalling superior environmental performance. Stanny (2013) examined voluntary disclosures concerning greenhouse gas (GHG) emissions by US S&P 500 firms to

[19] Voluntary disclosure theory explains the disclosure of both general and financial environmental information (Bewley and Li, 2000). Such theory suggests that companies use the information "to signal an unobservable pro-active strategy toward environmental concerns relative to poorer performing firms" (Cho *et al.,* 2012, p.487).

the Carbon Disclosure Project (CDP) from 2006-2008 and found that many firms only answer the CDP questionnaire but do not disclose their emission amounts or how they account for them. Consistent with legitimacy theory's predictions, she concluded that firms disclose the *minimum* necessary to reduce adverse public opinion, avoid scrutiny, and deter the possibility of being targeted by a shareholder resolution.

This paper contributes to empirical tests of legitimacy by examining a particular class of voluntary environmental information (*iCarbon*) and its dissemination impact on the COE. Climate change and its consequences present one of the most persistent threats to global economic stability (Peng *et al.*, 2015) and have the potential to affect firms' costs of equity capital, which is the required rate of return given the market's perception of a firm's riskiness (El Ghoul *et al.*, 2011; Lui *et al.*, 2016). The current emergence of investor interest in climate-related risks calls for a specific type of global data about such risks to support rational investment decisions (The Economist, 2017).

Managers have private information about firms' carbon profiles, including the carbon strategy, carbon emissions, and carbon reduction activities that is not directly accessible by outside stakeholders (Luo and Tang, 2014). Organisations seek to protect (or enhance) past legitimacy accomplishments that they have already acquired by developing "a defensive stockpile of supportive beliefs, attitudes and accounts" (Suchman, 1995, p. 595). Lee *et al.* (2015b) provided empirical evidence to support this theoretical supposition. They examined a sample of Korean firms from the CDP and concluded that firms could mitigate the adverse effects of carbon disclosure on shareholder value by communicating their carbon news periodically (i.e., carbon management efforts and performance through the media coverage of global warming in daily newspapers) in advance of its carbon disclosure. It can thus be implied that managers *strategically* release relevant information to maximise the value of the firm as perceived by capital providers (see Beyer *et al.*, 2010).

Accordingly, *iCarbon* can be considered a legitimate social contribution made by firms to enhance organisational credibility and legitimacy (see Lee *et al.*, 2013; Lee *et al.*, 2015b; Castelló *et al.*, 2016) and can be among the various aspects of transparency in environmental reporting to change societal perceptions and to respond to climate change-related political and public pressures. *iCarbon* is also expected to reduce investors' incentive to acquire private information by improving the broadness of information to a wider reach of investors, reducing information asymmetry, increasing share demand and thus reducing the COE

(Easley and O'hara, 2004; Blankespoor *et al.*, 2014). Correspondingly, using *iCarbon* enables a firm to transmit carbon-related information at lower acquisition costs, allowing potential investors to gain knowledge about a firm's environmental information and assess carbon-related risks. Such a strategy increases the willingness among those investors to take on a larger portion of a firm's shares, which improves risk diversification (risk-sharing) and hence reduces the COE (Merton, 1987; Heinkel *et al.*, 2001; Sharfman and Fernando, 2008).

Legitimacy, then, is a perception resource that organisations manipulate through various communication-related strategies (Aerts and Cormier, 2009; Deegan, 2014; Higgins and Larrinaga, 2014) to engage in dialogues with stakeholders, to portray an image that these organisations are trying to convey to the relevant public (Stanny, 2013), and to enhance their reputation (Ullmann, 1985; Hasseldine *et al.*, 2005; De Villiers and Van Staden, 2006; Beyer *et al.*, 2010; Busch and Hoffmann, 2011; Auger *et al.*, 2013). As an innovative source of information, *iCarbon* serves as one of the communication channels between a firm and its stakeholders. Legitimacy theory suggests that the need to legitimise business actions will motivate managers to voluntarily disseminate carbon-related information on Twitter.

Greater dissemination can increase investors' recognition of a firm, which enlarges its investor base and thus enhances risk sharing and reduces the COE (Merton, 1987). Consistently, Heinkel et al. (2001) demonstrate that investors who ethically care about a firm's green investment are willing to invest in 'green' firms and avoid 'non-green' firms, which puts greater pressure on polluting firms to improve their environmental performance. That is, 'green' firms can expect to have a larger investor base, which results in higher risk sharing and lower COE. In contrast, 'non-green' firms can expect to have fewer investors, lower risk sharing, lower stock prices and hence higher COE. As such, greater iCarbon can increase investors' awareness of firms' carbon-related information, making these firm more legitimate, which enlarges the investor base. In addition, using iCarbon allows a firm to transmit carbon-related information at lower acquisition costs, allowing many potential investors to know about a firm's environmental information. This increases the willingness among those investors to take a larger position in a firm's shares and hence reduce COE. The discussion above leads to the following hypothesis:

H_1: The dissemination of carbon-related information on Twitter (*iCarbon*) has a significant and negative association with the cost of equity (COE).

4.3 Research Design

4.3.1 Sample and data

Our sample comprises all non-financial firms with official Twitter accounts that are listed on the US NASDAQ stock exchange for the period from 2009 to 2015. We focus on US firms because foreign firms are exposed to different transparency levels, which influence their COE. Additionally, the US Securities and Exchange Commission (SEC) permits firms to use social media, especially an interactive platform such as Twitter, for disseminating corporate information. Many US firms also adopt Twitter and use it for multiple purposes, including corporate announcements (Blankespoor *et al.*, 2014; Jung *et al.*, 2018b), which induces an expected coverage during the sample period. We also focus on a single stock exchange to avoid any effect from exchange listing (Bushee *et al.*, 2010). NASDAQ is considered one of the main stock exchanges in the US after NYSE. Many technology firms are traded on the NASDAQ and they have a greater likelihood of adopting Twitter and have potential Twitter activity and coverage (Debreceny et al., 2002; Chen et al., 2010; Blankespoor et al., 2014; Lee et al., 2015a; Leuz and Wysocki, 2016). In addition, NASDAQ-traded firms face more visibility concerns than those traded on the NYSE in terms of firm size and analyst following (Bushee and Miller, 2012; Dang et al., 2018), which makes these firms more relevant for the study. Furthermore, our sample period allows us to mitigate any macroeconomic effects of the financial crisis.

Our data collection starts by identifying whether each firm in the sample has an official Twitter account. We first search firms' websites, including the Investor Relations pages, for any links or mentions of a firm's Twitter account. If a firm has not provided any Twitter account on its websites, we identify all profiles that match their names on Twitter by using the users' search engine. We ensure that only certified accounts, with a blue verified Twitter badge, are considered, assuring that the firms are the main source of carbon-related information. We also use Google's search engine to search for firms' adoption and presence on Twitter.

To measure the implied COE, we require all firms in our sample to have positive median earnings forecasts for one and two years ahead. These earnings forecasts are collected in June of each year to ensure that analysts have assimilated all the information from the fiscal year report in their forecasts. We also require firms to have available COE estimates. This procedure retains a full sample of 1,737 observations, representing 584 firms.

To download a firm's tweets, we use two main features that are usually used to aggregate Twitter data. We first use Twitter's application programming interface (API), which provides up to 3,200 tweets per user. If the number of tweets that the firm posts on Twitter exceeds 3,200, we then use keyword searches using Twitter's advanced search option. This procedure makes it easier to manually retrieve tweets. We refine our search criteria by using keywords that relate to carbon information (e.g., carbon, climate change, CO_2, emissions, GHG, global warming, greenhouse gas, and pollution). We then merge all firms' tweets from the Twitter API and advance search under one file.

We use two sources (*Bloomberg* and *DataStream*) to collect the data used to estimate the dependent and control variables. We also use *LexisNexis* to count the number of articles that are disseminated on other communication channels and that are related to carbon information. We allocate these articles by using company identifiers and keyword search features. We use our carbon keyword list, mentioned in section 4.3.2.2, to retrieve carbon-related news articles. This procedure allows us to retrieve articles from many sources, such as *The Wall Street Journal*, *USA Today, The Washington Post* and *The New York Times*. We also winsorise the amount of carbon news coverage (CD_NEWS), financial leverage (LEV), long-term growth forecast (LTG), beta coefficient (BETA), book-to-market ratio (BTM), earnings surplus (SURP) and the dispersion of analysts' forecasts (DISP) at the 2.5^{th} to 97.5^{th} percentiles to control for outliers. This Winsorising level is also used for the COE to eliminate negative values because we are not expecting investors to require a negative rate of return.

4.3.2 Variables

4.3.2.1 Cost of equity (COE)

Our dependent variable (COE) is based on the implied cost of equity (Hail and Leuz, 2006; Hail and Leuz, 2009; El Ghoul *et al.*, 2011), which is measured as the average of four COE estimates: (i) Claus and Thomas' model (2001), R_{CT}; (ii) Gebhardt, Lee, and Swaminathan's model (2001), R_{GLS}; (iii) Ohlson and Juettner-Nauroth's model (2005), R_{OJ}; and (iv) Easton's model (2004), R_{MPEG}. We use the average of these estimates to reduce any estimation error of the COE (Hail and Leuz, 2006). We also use this measure because it enables us to differentiate between the influence of both cash flow and growth from the COE (Chen *et al.*, 2009). This estimate is useful for time-series variations in the COE (Pástor *et al.*, 2008).

Overall, cost of equity is measured based on the average of four cost of equity estimates (R_{OJ}, R_{MPEG}, R_{CT} and R_{GLS}) minus risk-free return as discussed in Appendix C.

4.3.2.2 iCarbon

Our independent variable, *iCarbon*, reflects the number of carbon-related tweets that are disseminated to the public. We compute this measure by searching for keywords and phrases that relate to carbon-related information. In this regard, we use many keywords that were used in the prior literature and that align with carbon disclosure, reporting and information (e.g. Griffin and Sun, 2013; Hsu and Wang, 2013; Schmidt *et al.*, 2013; Hahn *et al.*, 2015; Lee *et al.*, 2015b). We also use the Twitter hashtag key (#), a feature that can be used to broaden climate information and trigger discussions among users about an event or specific topic. Thus, we include many hashtags that relate to carbon emissions, climate change and global warnings. In general, we define several keyword lists based on combinations of words and single phrases to identify *iCarbon* tweets.

To allocate *iCarbon* tweets, we process all collected tweets through a matching scheme program that we developed in Python. This program follows many steps: we ask the program to (1) read all firms' tweets, (2) divide these tweets into words, (3) remove the words that have no meanings ("stop words" such as "a" and "the") and (4) align these tweets with our keyword lists, which we define as follows:

("carbon*", "emission*", "gas", "climate", "GHG", "pollution", "CO_2") AND ("disclos*", "report*", "statement*" "release*", "announce", "declare*").

("carbon* emission*", "gas emission*", "climate emission*", "GHG emission*", "pollution emission*", "CO_2 emission*").

("greenhouse gas*", "carbon dioxide", "carbon neutral", "carbon footprint", "climate change", "greenhouse effect*", "carbon offset*", "carbon monoxide", "@CDP", "global warming*","fossil fuel*", "#globalwarming", "#global_warming", "#global-warming", "#climate-change", "#climatechange", "#climate_change", "#climate", "#carbonemission").

After matching firms' tweets with our keyword lists, we count the annual number of tweets that match our keyword lists for each firm or zero otherwise. Figure 4.1 provides some examples of *iCarbon* tweets. Further examples are also provided in Appendix E.

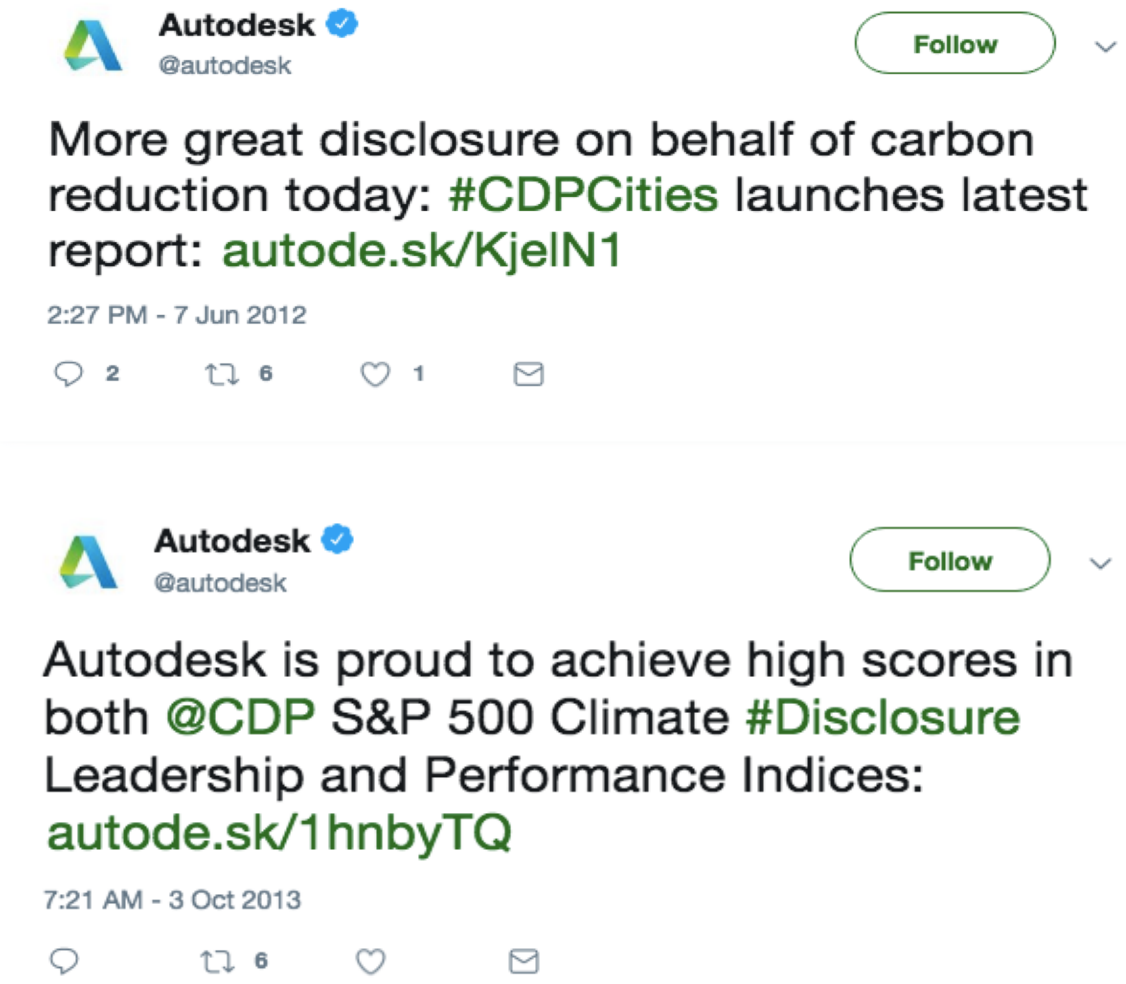

Figure 4.1 shows two examples of *iCarbon* tweets

4.3.2.3 Control variables

Our control variables include many variables associated with firm characteristics such as firm size (*SIZE*), book-to-market ratio (*BTM*) and financial leverage (*LEV*) (Fama and French, 1992; Botosan, 1997; Hail and Leuz, 2006; Hail and Leuz, 2009). Larger firms have a better information environment and thus a lower COE (Gebhardt *et al.*, 2001). The COE increases for undervalued firms that have a greater *BTM* ratio. Additionally, firms that have high *LEV* in their capital structure expect to have a higher COE (Cao *et al.*, 2015). We also expect a positive association with the dispersion of analysts' forecasts (*DISP*), beta coefficient (*BETA*) and long-term growth forecast (*LTG*). Firms that have a more uncertain information environment, systematic risk or market mispricing would be expected to have a higher COE (Gebhardt *et al.*, 2001; Gode and Mohanram, 2003; Botosan *et al.*, 2011; El Ghoul *et al.*, 2011; Cao *et al.*, 2015). We further control for the availability of information by other

intermediaries by including the amount of carbon news coverage (*CD_NEWS*) and the percentage of institutional holdings (*INSTOWN*) (Cao *et al.*, 2015; Zhou *et al.*, 2018). Prior literature shows inconclusive results carbon coverage (*CD_NEWS*) and cost of equity (Richardson and Welker, 2001; Li *et al.,* 2017). Hence, we do not expect a certain direction between *CD_NEWS* and COE. We expect higher institutional ownership (*INSTOWN*) to improve a firm's information environment and thus be associated with a lower COE (Griffin and Sun, 2013; Cao *et al.*, 2015; Li *et al.*, 2017). We also consider the content of firm news by controlling for earnings surplus (*SURP*). Due to the higher uncertainty of future earnings profitability, we expect that firms with negative earnings (*LOSS*) are difficult to analyse and thus have a higher COE (Orens *et al.*, 2010). Furthermore, we include many variables that determine climate change/carbon information. Additionally, we control for independent directors (*BOD_IND*), the environmental committee (ENV_COMMITTEE), CDP participation (CDP), firm age (AGE) and whether the firm is subject to the Environmental Protection Agency's (EPA) Mandatory Reporting Rule. Independent board directors play a monitoring role in managerial decisions and activities, which enhances disclosure policy and transparency. An environmental committee plays an advisory role in the better management of emissions and disclosure policy and a motivating role in reporting reliable information. We also include the CDP to control for firms' willingness to report carbon information. This measure represents the firm's ability to identify carbon-related issues and their potential consequences (Jung *et al.*, 2018b). Aged firms "tend not to choose to operate environmental information disclosure" (Zeng *et al.*, 2012, p. 317). Firms in industries that are more sensitive to carbon information are more inclined to choose greater transparency in the policy of disclosure to avoid the scrutiny of regulators (Deegan and Gordon, 1996). Therefore, we expect firms under EPA regulation to respond more to investor demand and to use *iCarbon* more. Technology firms are expected to be more inclined towards technology adoption, and thus, we expect them to be more active on Twitter (Blankespoor *et al.*, 2014). The full definition and measurement of the control variables is discussed in the next paragraph.

Firm size (*SIZE*) is measured as natural logarithm of firm's equity market value. *BTM* equals the ratio of book value to market value. Financial leverage (*LEV*) is estimated by dividing the long-term debt to equity market value. Analysts' forecast dispersion (*DISP*) equals to standard deviation of one-year consensus forecast of earnings per share. *BETA* is beta coefficient of market model using 60 with at least 24 months stock and market return. The consensus long term growth forecast (*LTG*) is measured as the mean of long-term growth rate

of earnings forecast or two minus one year ahead average EPS forecast scaled by one year ahead average EPS forecast. News coverage (*CD_NEWS*) equals the natural logarithm of number of carbon-related news articles. Institutional ownership (*INSTOWN*) is measured by the percentage of firm's shares owned by institutions. Earning surprise (*SURP*) equal the consensus earnings forecast minus firm's earnings scaled by share price. *LOSS* is an indicator variable that takes a value of 1 if a firm reports negative earnings and 0 otherwise. Board Independence (*BOD_IND*) is measured as the percentage of independent directors in the board. Environmental Committee (*ENV_COMMITTEE*) is dummy variable that takes a value of 1 if a firm has an environmental committee and 0 otherwise. Carbon Disclosure Project (*CDP*) participation is an indicator variable that takes a value of 1 if a firm participate and report to CDP and 0 otherwise. Firm age (*AGE*) is measured as the number of years since the firm is listed. Environment protection agency industry rules (*EPA*) is measured as a dummy variable that take a value of 1 if the firm belong to industry under GHG Mandatory Reporting Regulation and 0 otherwise. Technology firms (*TECH_FIRM*) is an indicator variable that takes a value of 1 if a firm belongs to technology industry (SIC 3570-3579, 3610-3699, 7370-7379, 3810-3849, 4800-4899, 4931, 4941) and 0 otherwise. The full definition and measurement of our dependent, independent and control variables are presented in Appendixes B and C.

4.3.3 Model

To examine the impact of *iCarbon* on COE, we employ the following Model 1:

$$\begin{aligned} COE_{it} = {} & \beta_0 + \beta_1 iCarbon_{it} + \beta_2 SIZE_{it} + \beta_3 BTM_{it} + \beta_4 LEV + \\ & \beta_5 DISP_{it} + \beta_6 BETA_{it} + \beta_7 LTG_{it} + \beta_8 CD\_NEWS_{it} + \\ & \beta_9 INSTOWN_{it} + \beta_{10} SURP_{it} + \beta_{11} LOSS_{it} + \beta_{12} BOD\_IND_{it} + \\ & \beta_{13} ENV\_COMMITTEE_{it} + + \beta_{14} CDP_{it} + \beta_{15} AGE_{it} + \beta_{16} EPA_{it} + \\ & \beta_{17} TECH\_FIRM_{it} + \beta_{18} \sum_{t=2015}^{2009} T_t + \varepsilon_{it} \end{aligned} \quad (1)$$

The dependent variable in model 1 is the implied cost of equity (COE). The independent variable is the amount of carbon-related information that firms disseminate on Twitter (*iCarbon*). The control variables are as follows: firm size (*SIZE*), book-to-market ratio (*BTM*), financial leverage (*LEV*), analysts' forecast dispersion (*DISP*), beta (*BETA*), consensus long-term growth forecast (*LTG*), carbon news coverage (*CD_NEWS*), percentage of institutional ownership (*INSTOWN*), earnings surplus (*SURP*), indicator for loss-making firms (*LOSS*), the proportion of independent directors on the board (*BOD_IND*), whether the

firm has an environmental committee (*ENV_COMMITTEE*), CDP participation (*CDP*), firm age (*AGE*), whether the firm is subject to the Environmental Protection Agency (*EPA*) and whether the firm is a technology firm (*TECH_FIRM*).

Our estimation procedures employ pooled OLS regressions with robust standard error clustered at the firm level to control for serial correlation and heteroscedasticity (Petersen, 2009; El Ghoul *et al.*, 2011; Cao *et al.*, 2015; Ferris *et al.*, 2017).[20] We also utilise a two-stage least squares (2SLS) model as an alternative estimation, clustered at the firm level, to control for any potential endogeneity between *iCarbon* and the COE (Nikolaev and Van Lent, 2005). In this model, we use both the lagged value of *iCarbon* and the industry-year *iCarbon* mean as our instrumental variables. These instruments are more related to a firm's engagement in *iCarbon* but do not necessarily affect the firm's value or COE (Schreck, 2011; Cheng *et al.*, 2014). Firms' performance environmental and social issues is influenced by other firms' performance in the same year, country and industry, whereas *iCarbon* in the prior year is expected to reflect firms' persistence and the stability of using *iCarbon* over time. To capture the validity of these instruments, our tests show that both LAG_iCarbon and IND_iCarbon are significantly correlated with *iCarbon*. We perform two diagnostic tests to identify the validity of both the IVs and the specification of our system equations, the Sargan test (mis-specification test with the null hypothesis of no mis-specification) and the Breusch and Pagan LM test (to examine whether cross-equation disturbances are truly associated with each other and if the equations need to be tested simultaneously).[21] Both IVs theoretically and statistically satisfy the necessary conditions for validity and relevance, and hence, the 2SLS results tend to be consistent and more efficient than those obtained using the OLS method.

4.4 Results and Analysis

4.4.1 Descriptive statistics

The descriptive statistics, provided in Table 4.1, for all our variables in Model 1 show that the mean of COE is equal to 5%, which is consistent with the prior literature (El Ghoul *et al.*, 2011; Ferris *et al.*, 2017). The mean value of *iCarbon* is 0.51, which indicates that firms' use of *iCarbon* is not high. The natural logarithm of firm size (SIZE) has a mean equal to 21.147,

[20] Our results show the existence of a heteroscedasticity problem; the Breusch-Pagan test is significant with *p*-value = 0.000.
[21] The partial-R^2 is equal to 0.844, with an *F*-statistic higher than the critical value (Staiger and Stock, 1997). The Durbin Wu-Hausman test shows a *P*-value of 0.87, suggesting that endogeneity is not an issue. The Sargan test for over-identification is insignificant with a *P*-value equal to 0.4736.

which is equivalent to an unreported mean of firm value equal to 9144.414 million dollars. The mean and median values of BTM are equal to 0.424 and 0.347, respectively. On average, firms in our sample have leverage equivalent to 15%. The medians of DISP, BETA and LTG are 0.081, 1.029 and 0.15, respectively.

Variables	N	Mean	Med	Min	Max	SD
COE	1737	0.052	0.045	0.00	0.172	0.035
iCarbon	1737	0.509	0	0	111	3.522
SIZE	1732	21.147	20.968	17.009	27.163	1.715
BTM	1732	0.424	0.347	-0.006	1.755	0.314
LEV	1736	0.15	0.082	0	0.8	0.172
DISP	1588	0.131	0.081	0.017	0.926	0.157
BETA	1600	1.055	1.029	-2.075	3.879	0.563
LTG	1737	0.2	0.15	-1.162	0.847	0.134
CD_NEWS	1737	0.770	0	0	3.367	1.061
INSTOWN	1490	0.863	0.920	0.00	1.707	0.260
SURP	1703	-0.334	0.031	-85.714	42.446	7.962
LOSS	1737	0.176	0	0	1	0.381
INDEPENT	1625	0.781	0.818	0.143	1	0.122
ENV_COMMITEE	1400	0.014	0	0	1	0.119
CDP	1737	0.22	0	0	1	0.417
AGE	1737	21.33	18	0	78	16.66
EPA	1737	0.324	0	0	1	0.468
TECH_FIRMS	1737	0.482	0	0	1	0.500

Notes: The Table presents summary statistics for *COE*, *iCarbon* and control variables for nonfinancial NASDAQ firms with Twitter accounts for a period from 2009 to 2015. See Appendix (B and C) for variables descriptions and measurements. This table shows variables' observations number (N), values of mean (Mean), median (Med), minimum (Min) and maximum (Max) and standard deviation (SD). We use winsorizing percentiles level of 2.5^{th} to 97.5^{th} to control for outliers.

Table 4.1: Descriptive statistics for COE, iCarbon and control variables

Regarding news coverage of carbon information, on average, a natural logarithm of 0.77 news articles is issued regarding firms. Furthermore, the table shows that institutional investors own a high proportion in terms of the mean and median of the sample. It also appears that the mean of earnings surprise is negative (-0.334), whereas the median is positive (0.031). Accordingly, approximately 18% of our sample report negative earnings. Our sample also shows that 78% of firms' board directors are independent and that a small number of firms have an environmental committee and participate in the CDP, with a mean

value of 0.014 and 0.22, respectively. The mean (median) of firm age (AGE) is 21.33 (18) years.

The Spearman and Pearson correlation matrix between the dependent, independent and control variables at the 10% significance level are presented in Table 4.2. The correlation matrix shows a negative correlation between the COE and *iCarbon*. This finding provides initial evidence that higher *iCarbon* use reduces the COE, which is consistent with our hypothesis. Larger firms tend to have a lower COE. The results also show that higher BTM, LEV, DISP, BETA LTG and LOSS increase the COE, while INSTOWN, SURP and BOD_IND reduce the COE. Additionally, our results show that loss-making firms have higher equity financing. In short, these results are consistent with the view that the COE is lower for firms with less uncertainty and a richer information environment. Consistently, participation in the CDP reduces the COE. However, the positive association between *iCarbon* and SIZE indicates that larger firms use *iCarbon* more, which is consistent with prior findings (Weinhofer and Hoffmann, 2010; Lee, 2012). Our results show that *iCarbon* is positively correlated with DISP and CD_NEWS. Firms that have negative earnings are less likely to use *iCarbon*. Conversely, higher BOD_INDP leads to increased use of *iCarbon*. Consistently, firms that participate in the CDP disseminate more carbon-related information on Twitter. Overall, the correlation matrix and unreported variance inflation factor (VIF) tests indicate that multicollinearity is not an issue across our empirical models.

	COE	*iCarbon*	SIZE	BTM	LEV	DISP	BETA	LTG	CD_NEWS	INSTOWN	SURP	LOSS	INDEPENT	ENV_COMMITEE	CDP	AGE	EPA	TECH_FIRMS
COE	1	-0.06**	-0.24***	0.37***	0.1***	0.06*	0.11***	-0.03	0.03	-0.1***	0.02	0.06*	0.00	-0.004	0.013	0.03	0.026	-0.2***
iCarbon	-0.01	1	0.24***	-0.02	0.05	0.05	0.01	-0.07**	0.28***	-0.02	-0.05	-0.07**	0.11***	0.02	0.16***	0.004	0.030	0.01
SIZE	-0.29***	0.14***	1	-0.38***	0.16***	0.2***	-0.01	-0.19***	0.47***	0.15***	-0.15***	-0.2***	0.08**	-0.1***	0.30***	0.24***	-0.06**	0.08***
BTM	0.38***	-0.02	-0.44***	1	0.00	0.07**	0.1***	-0.2***	-0.01	-0.06*	0.15***	0.11***	-0.06*	0.08***	0.012	0.01	0.14***	0.05*
LEV	0.09***	0.03	0.15***	-0.06**	1	0.11***	-0.03	-0.2***	0.10***	0.05	-0.06**	0.02	0.10***	-0.08**	0.11***	0.02	-0.03	-0.04
DISP	0.05**	0.1***	0.29***	-0.05*	0.06**	1	0.11***	-0.03	0.21***	0.10***	0.01	0.02	0.02	0.006	0.046	0.04	0.18***	-0.01
BETA	0.15***	0.02	-0.03	0.09***	-0.04	0.06**	1	0.07**	0.15***	-0.02	0.08**	0.08**	0.01	0.00	0.00	-0.04	0.08**	0.18***
LTG	0.24***	0.002	-0.18***	-0.05**	-0.08***	0.09***	0.05**	1	-0.08**	-0.03	0.07**	0.15***	-0.04	-0.04	-0.19***	-0.3***	0.03	0.03
CD_NEWS	0.01	0.22***	0.47***	-0.04*	0.06***	0.23***	0.08***	-0.09***	1	-0.06**	-0.05	-0.01	0.11***	-0.05*	0.31***	0.1***	0.05	0.06**
INSTOWN	-0.17***	-0.06**	0.24***	-0.1***	0.07***	-0.00	-0.03	-0.13***	0.01	1	-0.1***	-0.06**	0.18***	-0.01	0.002	-0.02	0.00	0.01
SURP	-0.11***	0.000	0.09***	-0.04*	-0.01	-0.00	-0.02	-0.06**	-0.00	0.09***	1	0.08**	-0.05	-0.01	-0.07**	-0.1***	-0.01	0.11***
LOSS	0.17***	-0.04*	-0.27***	0.16***	0.01	0.01	0.08***	0.21***	-0.03	-0.1***	-0.2***	1	-0.01	-0.00	-0.02	-0.2***	0.03	0.12***
INDEPENT	-0.06**	0.08***	0.09***	-0.08***	-0.07***	0.01	-0.01	-0.04*	0.04*	0.18***	0.03	-0.03	1	-0.03	0.11***	0.12***	0.03	0.00
ENV_COMMITEE	-0.01	0.00	-0.04*	0.05*	-0.06**	-0.03	0.02	-0.03	-0.03	-0.01	-0.01	0.01	-0.04	1	-0.01	-0.02	0.09***	0.06**
CDP	-0.04*	0.06***	0.38***	-0.07***	0.02	0.06**	-0.01	-0.13***	0.3***	0.07***	0.01	-0.06***	0.1***	0.02	1	0.2***	-0.02	0.08***
AGE	-0.02	0.002	0.2***	0.05*	-0.03	0.02	-0.1***	-0.2***	0.1***	-0.01	-0.007	-0.15***	0.1***	-0.02	0.14***	1	-0.06*	-0.1***
EPA	-0.01	-0.00	0.01	0.05**	-0.07***	0.15***	0.06**	0.03	0.04*	0.05*	0.01	0.010	0.06**	0.1***	0.00	-0.04*	1	-0.01
TECH_FIRMS	-0.15***	-0.02	0.03	0.01	-0.10***	-0.05*	0.14***	0.04*	0.01	-0.02	0.03	0.11***	0.07***	0.03	0.06**	-0.2***	-0.05**	1

Notes: The table shows the Pearson and Spearman correlation matrix between *COE*, *iCarbon* and control variables for nonfinancial NASDAQ firms with Twitter accounts for a period from 2009 to 2015. See Appendix (B and C) for variables descriptions and measurements. ***, **, * signify the significant of 1%, 5% and 10% levels respectively.

Table 4.2: Pearson and Spearman correlations for the COE, iCarbon and control variables

4.4.2 Empirical results

Table 4.3 reports the results of both the OLS and 2SLS estimation models for testing our hypothesis, identifying the possible negative significant impact of *iCarbon* on the COE. The results show significant negative coefficients between *iCarbon* and the COE for both models ($p < 0.05$) in columns 1 and 2. These findings imply that a managerial decision to disseminate carbon-related information (*iCarbon*) on Twitter reduces the COE. Such an improvement in information dissemination allows many investors to receive information in a timely and efficient manner, resulting in lower uncertainty in evaluating a firm's future cash flows and a better assessment of a firm's risks. Therefore, firms' decision to disseminate and broaden carbon information provides benefits for both firm management and investors. First, this dissemination and broadening allow managers to mitigate information asymmetry and improve legitimacy and investor recognition. Second, this dissemination and broadening enables investors to acquire firm information at a lower acquisition cost and estimate firms' potential risks. Even though these tweets are short, providing less comprehensive information, the dissemination role of carbon information on Twitter, apart from disclosure, has a negative impact on the COE.

The findings also indicate a significant negative association for SIZE and positive associations for BTM, LEV, BETA and LTG. These results suggest that the market perceives firms that are small in size or have a high growth rate, financial leverage or systematic risk to be high-risk firms and thus should offer a higher required rate of return (COE). The negative coefficient of INSTOWN suggests that greater institutional ownership enhances a firm's information environment, which reduces uncertainty and thus also reduces the COE. Furthermore, the nature of the industry may have a differing effect on the COE (Fama and French, 1997). Our results show that technology firms (TECH_FIRM) tend to have a lower COE. These firms face greater demand for information, which motivates them to provide more information through disclosure (Kothari, 2000). Previous studies have found that firms that belong to this industry and use Twitter to disseminate corporate information reduce information asymmetry and improve market liquidity (Blankespoor *et al.*, 2014), which, in turn, reduces the COE. The regression models have R^2 equal to 0.37, indicating that our models explain 37% of the variance in the COE. This result is consistent with the previous literature (e.g. El Ghoul *et al.*, 2011; Cao *et al.*, 2015; Breuer *et al.*, 2018), although smaller R^2 is not uncommon in the field of social sciences (Wooldridge, 2015). Overall, the results

indicate that *iCarbon* helps to reduce equity financing. This finding may help managers to consider using *iCarbon* strategically as part of their voluntary disclosure policy to gain legitimacy among stakeholders. This evidence also provides insight into the importance of social media, particularly Twitter, as a communication channel to connect with various investors. This mechanism is expected to reduce information asymmetry, improve recognition, reduce acquisition costs and enhance investors' estimation of risk.

	(1) COE (OLS)	(2) COE (2SLS)
iCarbon	-0.0003**	-0.0003**
	(0.0001)	(0.0001)
SIZE	-0.0028***	-0.0028***
	(0.0011)	(0.0011)
BTM	0.0395***	0.0401***
	(0.0047)	(0.0052)
LEV	0.0253***	0.0204***
	(0.0064)	(0.0065)
DISP	0.014	0.0156
	(0.0107)	(0.0113)
BETA	0.0062***	0.0054***
	(0.002)	(0.0021)
LTG	0.0572***	0.05***
	(0.0175)	(0.0176)
CD_NEWS	0.0024	0.003*
	(0.0015)	(0.0016)
INSTOWN	-0.0115*	-0.0082
	(0.0059)	(0.0061)
SURP	-0.0003	-0.0002
	(0.0002)	(0.0002)
LOSS	0.0028	0.0025
	(0.0037)	(0.0039)
INDEPENT	0.0132	0.0116
	(0.0115)	(0.0124)
ENV_COMMITEE	-0.0033	-0.0049
	(0.0078)	(0.008)
CDP	0.0044	0.0054*
	(0.0028)	(0.0029)
AGE	0.00001	0.00001
	(0.00006)	(0.00006)
EPA	0.001	0.0009
	(0.0024)	(0.0025)
TECH_FIRM	-0.0127***	-0.0111***
	(0.0024)	(0.0025)
Year Effect	Yes	Yes
Firm Effect	Yes	Yes

Constant	0.0722***	0.0822***
	(0.0244)	(0.0250)
Observations	936	839
R^2	0.372	0.369

Notes: The table presents the results of the impact of *iCarbon* on *COE*. The sample comprises of nonfin NASDAQ firms with Twitter accounts for a period from 2009 to 2015. See Appendix (B and C) for var descriptions and measurements. Column (1) presents the regression findings from pooled regression (OLS) clu at the firm level. Column (2) presents the regression findings from the second stage of two stage least square (2 model clustered at firm level. ***, **, * present the statistical significance of 1%, 5% and 10% levels respectiv parentheses, robust standard errors are presented.

Table 4.3: The impact of iCarbon on cost of equity (COE)

4.4.3 Additional Analyses

4.4.3.1 The effect of Bloomberg's environmental (ENV) and environmental-social-governance (ESG) disclosure

We further address whether a firm's level of environmental disclosure would affect the association between *iCarbon* and the COE. Firms that are more socially responsible have more incentives to disclose and engage in environmental activities and practices (Harjoto and Jo, 2015). These firms are motivated to maintain and improve their public images by generating positive media coverage, which, in turn, improves firm value and decreases the COE (Cahan *et al.*, 2015; Fatemi *et al.*, 2018). That is, investor preference for environmentally friendly firms can lead to a lower investor base that is willing to buy and hold shares in polluting firms. This preference reduces risk sharing and thus increases firms' equity financing, creating environmental costs for firm managers (Merton, 1987; Heinkel *et al.*, 2001; Chava, 2014). Accordingly, poor environmental performance induces lower demand by institutional investors and less 'loan syndicate' participation by banks (Hsu and Wang, 2013; Chava, 2014). These studies show that firms should consider the benefits of environmental information to reduce their equity financing. Accordingly, firms with different levels of environmental performance induce different behaviours towards using communication channels to respond to environmental issues and concerns (de Villiers and Van Staden, 2011). As such, firms with better environmental performance promote more voluntary climate change disclosure (Dawkins and Fraas, 2011). We therefore expect firms with a higher environmental disclosure score to use *iCarbon*. Hence, we address whether a firm's disclosure score of environmental reporting would affect our main findings.

We use *Bloomberg* for firm environmental disclosure score (ENV_SCORE). ENV_SCORE reflect the amount of environmental reports that available to the public. This variable incorporates data from many sources, including annual reports, the CDP, firms' websites and

CSR reports, generating a comprehensive score for firm disclosure. This score is estimated in terms of both industry relevance and data availability, starting from 0.1 for low-disclosing firms and continuing up to 100 for high-disclosing firms. The weighting system takes into account the importance of each category, making a category such as greenhouse gas emissions carry greater weight than other disclosure items. Weighting each data point in terms of its importance makes the disclosure score reflect both the quality and quantity of disclosure (Qiu *et al.*, 2016; Bernardi and Stark, 2018). We address this issue by including the environmental score (ENV_SCORE) and the interaction between *iCarbon* and the environmental score (*iCarbon* * ENV_SCORE) in Model 2. In the 2nd equation, the interaction term between iCarbon and ENV is added to examine whether the effect of disseminating information through Twitter on the firm's COE is independent of the ENV score of the firm. Since firms have already exhibited a good reputation in their environmental performances, this effect may have been well-reflected and acknowledged by the investors, i.e. through a lower COE. Therefore, the dissemination of carbon-related information through Twitter may lose its impact on COE to a certain extent. Therefore, the 2nd equation addresses whether the ENV score may impact the influence of iCarbon on COE.

We also examine a broader aspect of a firm's disclosure than simply environmental reporting by taking into account two components of sustainability reporting in addition to environmental disclosure: social and governance disclosures. In this section, we address whether a firm's disclosure score of ESG disclosure would also influence the association between *iCarbon* and the COE. The combination of all ESG dimensions enables many investors to evaluate a firm's risks, opportunities and transparency, which in turn improves firm value and reduces the COE (Ng and Rezaee, 2015; Yu *et al.*, 2018). Such an effect is more pronounced for lower-ESG-disclosure-performing firms than for higher-ESG-disclosure-performing firms (Crifo *et al.*, 2015). However, firms with better ESG disclosure have better interaction and communication with stakeholders (Eccles *et al.*, 2014). These firms are likely to disclose their ESG activities and initiatives to signal and differentiate themselves in the capital market from those with lower ESG disclosure ratings (Crifo *et al.*, 2015). We therefore expect firms with better ESG disclosure scores to strategically use *iCarbon* more than those with lower ESG disclosure scores. ESG score reflect the amount of environmental, social and governance reports that available to the public.[22] Therefore, we

[22] We use the Bloomberg database to obtain the ESG disclosure score, which reflects a firm's social, environmental and governance data that are available to the public from corporate websites, press releases,

investigate whether the ESG disclosure score (ESG_SCORE) would moderate the association between *iCarbon* and the COE. To examine this influence, we include ESG_SCORE and its interaction with *iCarbon* (*iCarbon* * ESG_SCORE) in Model 3. In the 3rd equation, the interaction term between *iCarbon* and ESG is included in the additional analysis to further examine whether the effect of dissemination information through Twitter on the firm's COE is independent of the ESG score of firm. It has been documented that firms with good ESG score are more inclined to disseminate more information and hence, contribute to lowering the firm's COE. Therefore, *iCarbon* may lose its influence on COE. As such, additional analysis overall can provide further insights into the effects of Twitter dissemination on COE, taking into account firm's ESG score.

Model 2 and 3 are presented as follow:

$$\begin{aligned} COE_{it} = {} & \beta_0 + \beta_1 iCarbon_{it} + \beta_2 ENV\_SCORE_{it} + \beta_3 iCarbon_{it} * \\ & ENV\_SCORE_{it} + \beta_4 SIZE_{it} + \beta_5 BTM_{it} + \beta_6 LEV + \beta_7 DISP_{it} + \\ & \beta_8 BETA_{it} + \beta_9 LTG_{it} + \beta_{10} CD\_NEWS_{it} + \beta_{11} INSTOWN_{it} + \\ & \beta_{12} SURP_{it} + \beta_{13} LOSS_{it} + \beta_{14} BOD_{IND\,it} + \beta_{15} ENV_{COMMITTEE\,it} + \\ & \beta_{16} CDP_{it} + \beta_{17} AGE_{it} + \beta_{18} EPA_{it} + \beta_{19} TECH\_FIRM_{it} + \\ & \beta_{20} \sum_{t=2015}^{2009} T_t + \varepsilon_{it} \end{aligned} \quad (2)$$

$$\begin{aligned} COE_{it} = {} & \beta_0 + \beta_1 iCarbon_{it} + \beta_2 ESG\_SCORE_{it} + \beta_3 iCarbon_{it} * ESG_{SCORE} + \\ & \beta_4 SIZE_{it} + \beta_5 BTM_{it} + \beta_6 LEV + \beta_7 DISP_{it} + \beta_8 BETA_{it} + \\ & \beta_9 LTG_{it} + \beta_{10} CD\_NEWS_{it} + \beta_{11} INSTOWN_{it} + \beta_{12} SURP_{it} + \\ & \beta_{13} LOSS_{it} + \beta_{14} BOD_{IND\,it} + \beta_{15} ENV_{COMMITTEE\,it} + \beta_{16} CDP_{it} + \\ & \beta_{17} AGE_{it} + \beta_{18} EPA_{it} + \beta_{19} TECH\_FIRM_{it} + \beta_{20} \sum_{t=2015}^{2009} T_t + \varepsilon_{it} \end{aligned} \quad (3)$$

The definition of the variables in Models 2 and 3 is as follows: COE is the implied COE. *iCarbon* is the amount of carbon-related information that firms disseminate over Twitter. Model 2 includes *ENV_SCORE*, which represents firms' environmental reporting score and the interaction between *iCarbon* and *ENV_SCORE* (*iCarbon* * *ENV_SCORE*). However, Model 3 includes *ESG_SCORE*, which represents firms' environmental, social and governance reporting score and the interaction between *iCarbon* and ENV_ESG (*iCarbon* *

annual reports, sustainability reports and corporate governance reports. The score covers many topics such as board structure and independence, human capital, shareholders' rights and GHG emissions. Such information is reflected in the ESG index score to reflect both the amount and importance of information. The score ranges from 0.1 to 100, where each data point is weighted in term of its importance and relevance to industry peers.

ESG_SCORE). Nevertheless, Model 2 and Model 3 also include other control variables that are in Model 1, such as firm size (*SIZE*), book-to-market ratio (*BTM*), financial leverage (*LEV*), analysts forecast dispersion (*DISP*), beta (*BETA*), the consensus of long-term growth forecast (*LTG*), carbon related news coverage (*CD_NEWS*), the proportion of institutional ownership (*INSTOWN*), earning surprise (*SURP*), dummy variable for loss-making firms (*LOSS*), the percentage of independent directors on the board of directors (*BOD_IND*), indicator for the existence of an environmental committee (*ENV_COMMITTEE*), CDP participation (*CDP*), firm age (*AGE*), whether the firm is subject to the Environmental Protection Agency (*EPA*) and whether the firm is a technology firm (*TECH_FIRM*).

We employ OLS regression with a robust standard error cluster at the firm level to estimate both Models 2 and 3 and present the results in Table 4.4. In these models, we have centralised our explanatory variables (i.e., *iCarbon*, ENV_SCORE, and ESG_SCORE) and their interactions (i.e., iCarbon*ENV_SCORE and iCarbon*ESG_SCORE). The finding from Model 2 shows that ENV_SCORE does not affect the association between *iCarbon* and the COE, as the interaction between *iCarbon* and ENV_SCORE has no significant coefficient with the COE. This result means that the number of *iCarbon* tweets has a direct association with the COE, which is not affected by the environmental disclosure score. The result from Model 3 shows a similar finding of a negative association for *iCarbon* on the COE, which is consistent with our main findings. The results also show no significant association for the interaction *iCarbon**ESG_SCORE.

Similarly, we found no significant association between ESG disclosure and the COE. Overall, the findings provide evidence that the association between *iCarbon* and the COE is not affected by either ENV_SCORE or ESG_SCORE. The results support our argument that investors appreciate carbon messages and dissemination, which is different from the reporting score, and *iCarbon* has its own equity market consequences, apart from disclosure score.

	Model (2) COE	Model (3) COE
iCarbon	-0.0005*	-0.0013**
	(0.0003)	(0.0006)
ENV_SCORE	0.00006	
	(0.0002)	
iCarbon * ENV_SCORE	0.00002	
	(0.00002)	

ESG_SCORE		0.0002
		(0.0002)
iCarbon * ESG_SCORE		0.00003
		(0.00002)
SIZE	0.0003	-0.0035***
	(0.0021)	(0.0011)
BTM	0.0448***	0.0385***
	(0.012)	(0.0046)
LEV	0.0161	0.0249***
	(0.0176)	(0.0064)
DISP	0.0195	0.0145
	(0.0164)	(0.0107)
BETA	0.0032	0.0065***
	(0.0047)	(0.002)
LTG	0.0291	0.0594***
	(0.0368)	(0.0176)
CD_NEWS	-0.0033*	0.0019
	(0.0018)	(0.0015)
INSTOWN	0.0073	-0.0096
	(0.0124)	(0.0059)
SURP	0.0003	-0.0003
	(0.0033)	(0.0002)
LOSS	-0.0052	0.0031
	(0.0077)	(0.0037)
INDEPENT	0.0101	0.0107
	(0.0193)	(0.0123)
ENV_COMMITEE		-0.0026
		(0.0082)
CDP	0.0005	0.0028
	(0.0057)	(0.0028)
AGE	0.000006	0.00001
	(0.0001)	(0.00006)
EPA	0.0009	0.0005
	(0.0045)	(0.0024)
TECH_FIRM	-0.0124***	-0.0128***
	(0.0044)	(0.0024)
Year Effect	Yes	Yes
Firm Effect	Yes	Yes
Constant	0.0229	0.0875***
	(0.0568)	(0.0261)
Observations	212	927
R^2	0.335	0.377

Notes: The table presents the effects of environmental and ESG reporting on the association between *iCarbon* and COE. The sample comprises of nonfinancial NASDAQ firms with Twitter accounts for a period for a period from 2009 to 2015.See Appendix (B and C) for variables descriptions and measurements. Model (2) presents the results after adding environmental reporting (*ENV*) score and its interaction with *iCarbon*. Model (3) includes environmental, social and governance (*ESG*) score and its interaction with *iCarbon*. The coefficient estimates are results from pooled regression (OLS) clustered at the firm level. ***, **, * present the statistical significance of 1%, 5% and 10% levels respectively. In parentheses, robust standard errors are presented.

Table 4.4: The effect of ENV and ESG score

4.4.3.2 Robustness checks

As a robustness check, we use different measures for the COE and *iCarbon* and add different sets of control variables to our main Model 1. The results are reported in Table 4.5. We use R_{PEG} (Easton, 2004) as an alternative measure of the COE. This measure (R_{PEG}) is estimated as the difference between five years median forecast of earnings per share ($FEPS_5$) minus four years ahead median forecast of earnings per share ($FEPS_4$) divided by share price at June next year. R_{PEG} is considered a reliable measure for the COE and is widely used in the literature (Mangena *et al.*, 2016). This measure assumes no dividend pay-out and is associated "with firm-specific risk characteristics in a theoretically predictable and stable manner" (Botosan *et al.*, 2011, p. 1085). We employ the analysis in our main Model 1 by alternatively using R_{PEG} instead of the COE in column 1. The results show consistent evidence that *iCarbon* is negatively associated with the COE, as measured by R_{PEG}. However, the increase in the number of observations in Column 1 is due to the use of a different dependent variable that is based on Easton's (2004) model, R_{PEG}, and measured differently from COE, which is based on the average of four proxies of COE (R_{CT}, R_{GLS}, R_{OJ} and R_{MPEG}). As such, R_{PEG} has more observations (1941) than COE (1737).

We also use two alternative measures of *iCarbon*. First, we use the number of *iCarbon* tweets that have a hyperlink. Including a hyperlink allows users to acquire more information by following the link (Blankespoor *et al.*, 2014). Second, we use the number of *iCarbon* tweets that have been retweeted. This measure enhances the size of the audience as users share a firm's *iCarbon* tweets with their followers through the retweet button (Jung *et al.*, 2018b). Cade (2018) claim that retweeted messages are considered more valid by investors. These features expect to enrich corporate communication with stakeholders through social media (Brennan and Merkl-Davies, 2018). We present the results in columns 2 and 3 in Table 4.5. The results indicate that tweets with a hyperlink to the full information (*iCarbon_Hyperlink*) or news articles that are diffused to a larger number of users through the retweet feature (*iCarbon_Retweet*) on Twitter are negatively associated with the COE. This finding is consistent with our main findings.

In column 4, we control for multiple variables used in the prior literature (El Ghoul *et al.*, 2011; Harjoto and Jo, 2015; Lee *et al.*, 2015a; Jung *et al.*, 2018b). We control for the ratio of total advertising expenses to total assets (ADVERTISING) and a dummy variable for whether a firm's CEO is younger than the median value of other CEO age (CEOAGE) and

the percentage change in sales growth (SALES_GRWOTH). Firms that spend more on advertisements and have younger CEOs and high growth rates in sales are expected to adopt social media, have Twitter accounts and disclose more announcements on communication channels (Lee *et al.*, 2015a; Jung *et al.*, 2018b). We also expect a firm's valuation to increase by generating high sales growth. Additionally, some industries are subject to different litigation risks and more potential lawsuits. Hence, we include dummy variables (LITI) for firms that operate in high-litigation industries (Dhaliwal *et al.*, 2011). LITI take 1 if the firm belong to high litigation industry (SIC 2833-2836, 3570-3577, 5200-5961, 3600-3674, 7370) and 0 otherwise. We also control for research and development (R&D) and capital expenditure (CAPX). *CAPX* is measured as the total capital expenditure divided by total revenue and *R&D* equals research and development expenditure divided by total assets. Although R&D is an expense that a firm pays, this expense might generate value (Servaes and Tamayo, 2013). Furthermore, firms with high growth in sales (SALES_GROWTH, R&D and CAPX) are expected to disclose more environmental information (Dhaliwal *et al.*, 2011; Harjoto and Jo, 2015). The results in Column 4 show negative associations for ADVERTISING and CAPX with the COE. In contrast, DUM_CEO, GROWTH_SALES, R&D and LITI have no association with the COE. These findings mitigate any concern towards a firm's willingness to adopt Twitter and disseminating carbon information.

Finally, we further re-estimate our regression model by using the generalised method of moments (GMM).[23] We use the GMM model to address the endogeneity problem that may affect the interpretation of our association between *iCarbon* and the COE. Our results in column 5 show that *iCarbon* is significant and negatively associated with the COE. This finding is consistent with our main finding. The results for the GMM estimation model show that first-order serial correlation (AR(1)) is significant ($p = 0.031$), rejecting the null hypothesis of correlated differences in the residual, whereas the second-order serial correlation (AR(2)) is insignificant ($p = 0.391$), indicating no correlation difference in the residual. The results also show that the result of the Hansen test ($p = 0.231$) is insignificant, which validates our instruments to address the over-identification problem.

[23] This regression model addresses the endogeneity and unobservable variable effects by using a lagged value as an instrumental variable.

	Alternative measure of COE	Alternative measure of iCarbon		Additional control variables	GMM
	(1) R_{PEG}	(2) COE	(3) COE	(4) COE	(5) COE
iCarbon	-0.0005**			-0.0003*	-0.0017*
	(0.0002)			(0.0002)	(0.001)
iCarbon_Http		-0.0005**			
		(0.0002)			
iCarbon_Retweet			-0.0004**		
			(0.0002)		
SIZE	-0.0111***	-0.0034**	-0.0034**	-0.0015	0.004
	(0.0025)	(0.0014)	(0.0014)	(0.0013)	(0.0061)
BTM	-0.005	0.0407***	0.0406***	0.0501***	0.0501***
	(0.0125)	(0.0061)	(0.0061)	(0.0064)	(0.019)
LEV	-0.0381**	0.0226**	0.0225**	0.0286***	0.0117
	(0.0186)	(0.0089)	(0.0089)	(0.0087)	(0.0176)
DISP	0.0628***	0.0214	0.0218	-0.0004	0.0006
	(0.0170)	(0.0132)	(0.0133)	(0.0136)	(0.0238)
BETA	0.0164**	0.0059**	0.0059**	0.0048*	-0.0073
	(0.0075)	(0.0026)	(0.0026)	(0.0025)	(0.0091)
LTG	0.0536	0.0495**	0.0495**	0.0684***	0.0720***
	(0.0457)	(0.0207)	(0.0207)	(0.0158)	(0.0227)
CD_NEWS	0.0074**	0.0043**	0.0041**	-0.0002	0.0036
	(0.0033)	(0.0019)	(0.002)	(0.0016)	(0.0026)
INSTOWN	-0.0575***	-0.0170**	-0.0170**	-0.0108	-0.0085
	(0.0149)	(0.0077)	(0.0078)	(0.0081)	(0.0113)
SURP	-0.0001	-0.0002	-0.0002	-0.00003	-0.0002
	(0.0007)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
LOSS	0.0439***	0.0068	0.0068	-0.0036	0.0007
	(0.0093)	(0.0046)	(0.0046)	(0.0046)	(0.0058)
INDEPENT	0.0106	0.0104	0.0100	0.0277*	0.0010
	(0.0255)	(0.0145)	(0.0145)	(0.0156)	(0.0152)
ENV_COMMITEE	0.0209	-0.0031	-0.0031	-0.0011	0.0105
	(0.0330)	(0.011)	(0.0108)	(0.0121)	(0.0098)
CDP	-0.0033	0.0038	0.0037	0.0038	-0.0065
	(0.0062)	(0.0036)	(0.0036)	(0.0038)	(0.0075)
AGE	-0.00025*	-0.00004	-0.00003	0.00005	-0.0001
	(0.0001)	(0.0001)	(0.0001)	(0.00006)	(0.0003)
EPA	0.0038	0.0008	0.0008	0.0066*	0.0008
	(0.0061)	(0.0033)	(0.0033)	(0.0034)	(0.0032)
TECH_FIRM	-0.0181***	-0.014***	-0.014***	-0.0116***	-0.0081
	(0.0058)	(0.0031)	(0.0031)	(0.0036)	(0.0052)
DUM_CEO				-0.0026	
				(0.0028)	
GROWTH_SALES				-0.0042	
				(0.0082)	
R&D				0.0017	

				(0.0277)	
CAPX				-0.0613*	
				(0.0351)	
ADVERTISING				-0.0054***	
				(0.0017)	
LITI				0.0032	
				(0.0031)	
COE_{t-1}					0.410***
					(0.137)
Year Effect	Yes	Yes	Yes	Yes	Yes
Firm Effect	Yes	Yes	Yes	Yes	No
Constant	0.378***	0.0915***	0.0916***	0.0218	-0.0686
	(0.0636)	(0.0307)	(0.0310)	(0.0318)	(0.127)
Observations	1,941	561	561	480	461
R^2	0.174	0.414	0.413	0.456	

Notes: The table presents the regression findings from our main Model (1) using alternative measures of *COE*, *iCarbon*, including additional control variables and using alternative estimation model. The sample comprises of nonfinancial NASDAQ firms with Twitter accounts for a period from 2009 to 2015. See Appendix (B and C) for variables descriptions and measurements. In column (1) we use R_{PEG} on Model (1) instead of COE. Alternative: we use *iCarbon* with hyperlink in column (2) and *iCarbon* tweets that are retweeted in column (3) instead of *iCarbon* in Model (1). Column (4) reports the regression after adding many control variables (*ADVERTISING, CEOAGE*, *SALES_GROWTH*, *LITI*, *R&D* and *CAPX*). Column (5) estimate Model (1) by using GMM regression technique and including lagged value of COE (COE_{t-1}). The coefficient estimates are results from pooled regression (OLS) clustered at the firm level except for Column (5). ***, **, * present the statistical significance of 1%, 5% and 10% levels respectively. In parentheses, robust standard errors are presented.

Table 4.5: Robustness tests for other measurements and additional Variables

4.5 Conclusion

This study examined whether a firm's voluntary dissemination of carbon-related information on Twitter influences the COE. Using a sample of non-financial firms with Twitter accounts that were listed on NASDAQ throughout the period 2009-2015, we developed a measure of carbon information reported via Twitter to reflect the number of firms that decide to disseminate carbon-related information in this way and broaden their reach to investors and gain legitimacy among stakeholders. The results show that firms disseminating carbon-related information tend to have a lower COE. This association holds consistently throughout alternative estimations and is not affected by either ENV or ESG disclosure score. Overall, our results suggest that the increase in a firm's dissemination of carbon information improves investor recognition among many potential investors and environmentally concerned groups, reduces information asymmetry between market participants, enables investors to evaluate

firms' potential risk and acquire firm information at lower acquisition costs and allow firms to obtain legitimacy for their activity, which in turn reduces the COE.

This paper provides several implications for market participants, managers and policymakers about integrating information technology into their strategic voluntary disclosure policy. Our results show the importance of firm managers considering the dissemination of carbon-related information seriously and the benefit to the COE. As Twitter allows market participants to receive firm information in a timely and efficient manner, *iCarbon* enables many market participants to assess a firm's potential risk and make better investment decisions. Additionally, firms should consider using *iCarbon* to address investors' concerns and information demands and to obtain legitimacy. Our findings suggest that market participants incorporate carbon information, in addition to disclosure, that is disseminated on Twitter. This evidence prepares regulators to take steps towards encouraging firms to disseminate carbon information and providing more guidance on carbon emissions. While firms are mandated to report their emissions under EPA regulations, further regulations under the Clean Power Plan are under review, and they are expected to be dismantled by President Trump, who led the US's exit from the Paris Agreement on climate change (Davenport and Rubin, 2018). The initial plan under Obama's administration aimed to reduce greenhouse gas emissions by 32% by 2030. The Trump administration proposes an easier plan that would cut emissions by approximately 0.7% to 1.5%. Our evidence suggests that market participants have an interest in climate change reporting, which should encourage regulators to implement a more solid plan for climate change. Furthermore, these results show the importance of using Twitter as a disclosure channel to communicate with market participants, to attract potential investors and to improve information sharing. These benefits are expected to improve firms' information environment and transparency and to reduce the COE.

It is important to acknowledge the limitations of the study, which could open a new avenue for future studies. One of the challenges in the study is related to data collection. For example, firms' Twitter accounts and messages are not available on a database and thus they have to be collected manually. In addition, tweets are limited to 140 characters, which may limit the information provided by firms over Twitter. While the study focuses on firms' Twitter activity, little is known about managers' Twitter activity with regard to carbon-related information and its influence on the capital market. In addition, future research also can extend the literature by focusing on other social media platforms. Nevertheless, many

social media platforms have restricted access to their data, which makes data availability an obstacle. While the study does not control for the intensity of carbon emissions due to data limitations, future research can give more consideration to explaining the association between carbon intensity and firms' dissemination of carbon- related information over social media. While the research focuses on COE capital, future studies can examine the association between *iCarbon* and cost of debt. As the PhD study has time constraints, the research focuses on carbon-related information and does not examine other firm news and events.

Chapter 5. Conclusions

5.1 Introduction

The traditional disclosure and dissemination channels of information are exposed to limitations in providing good coverage of different types of investors, whilst investor demand for information continues to increase and become stronger than ever. This triggers the importance of exploring a more effective communication channel, which can extend the reach of information dissemination to a larger pool of both existing and potential investors. The recent development of information technology has introduced Twitter as an information medium with which firms can communicate with a wider number of investors. This channel has transformed the firm information communication landscape, allowing firms to disseminate information directly to investors at lower cost and on a timely basis (Blankespoor *et al.*, 2014; Lee *et al.*, 2015a). Twitter has become an essential tool for investors to receive firm news and advice about potential investments (Cade, 2018). More specifically, firms have adopted Twitter and used this channel to communicate with investors and disseminate information about the firm (Bartov *et al.,* 2018). This includes using Twitter to disseminate financial information (Blankespoor *et al.,* 2014; Bartov *et al.,* 2018; Elliott *et al.,* 2018; Jung *et al.,* 2018b).

Prior literature (Bellucci and Manetti, 2017; Deegan, 2019) suggests that Twitter is an effective channel for communicating and engaging with stakeholders and that it can be used as a tool for legitimation. Furthermore, Gómez-Carrasco *et al.* (2020) imply that Twitter provides a suitable channel for environmental information. With the increasing use of Twitter as an information channel, practitioners and academics have been increasingly interested in the value added by corporate social media (Blankespoor *et al.,* 2014; Miller and Skinner, 2015; Cade, 2018). However, it is still unclear whether firms' use of Twitter to disseminate information has an impact on their equity financing. Therefore, the main aim of this thesis is to examine the association between Twitter as a dissemination channel and a firm's COE.

Specifically, this thesis focuses on two essential types of information: financial and carbon-related information. Both financial and carbon-related information attract great interest from investors, who assess them in order to evaluate firm risk, firm value and expected return (Dhaliwal *et al.,* 2014). The thesis objectives are two-fold: investigating whether a firm's dissemination of (1) financial and (2) carbon-related information through Twitter influences

the firm's COE. At the heart of the investigation is providing a better understanding of the benefits of a firm's dissemination of information through Twitter, and its capital market consequences.

This chapter is structured as follows. First, the chapter provides a summary of the main findings of this thesis. Second, the chapter discusses the implications of the studies. Finally, the chapter provides avenues for future research.

5.2 Findings of the Research

This section provides a summary of the main findings of the two empirical studies examined in this thesis.

5.2.1 Chapter 3: The effect of Twitter dissemination on cost of equity

In the recent years, an increase number of firms has begun to use this channel to disseminate financial information and reach investors directly and on real time basis (Jung *et al.*, 2018b). Accordingly, this study examines the association between firm's dissemination of financial information (*iDisc*) on Twitter and firm's COE.

By using a sample (1,737 firm-year observations) of 584 non-financial firms with Twitter accounts that are listed on the NASDAQ stock exchange over the period 2009-2015, the study finds significant negative relationship between firm's dissemination of financial information on Twitter (*iDisc*) and COE. This finding indicates that *iDisc* help firm to reach broad reach of existence and potential investors and lower their COE. The study also finds that the association between *iDisc* and COE is more pronounced for less visible firms that are smaller size, have lower analysts following, and have smaller number of shareholders. This evidence shows that the benefit of *iDisc* is greater for firms that face greater need for dissemination by gaining larger investor base and hence reducing the COE. The findings also show that the negative association between *iDisc* and COE is presence even after considering news magnitude (in term of missing earnings forecast) and tweets content (tone). The study also finds consistence results by using alternative measure of *iDisc*: (i) tweet with hyperlink (*iDisc_Hyperlink*) which allows investors to access more information and (ii) tweets that disseminate to larger size of audience (*iDisc_Followers*). The additional tests also show consistence results after using alternative measure for COE and adding more control variables. In essence, the finding supports the argument that disseminating financial

information over Twitter allow a broader reach of firm information, which, as a result, lower the COE.

5.2.2 Chapter 4: The Effect of carbon dissemination on cost of equity

The increase demand of climate change and carbon emission information by individuals, environmental concerned groups and regulators has leads firms to allocate resources towards communicating about carbon related information (Griffin and Sun, 2013). In this regard, Twitter provide firms with opportunity to broaden the reach of their information to diverse set of audience and investors (Blankespoor, 2018). This channel allows firm to broaden their information directly and on timely manner (Jung *et al.*, 2018b). As such, this study examines whether firm's dissemination of carbon related information (*iCarbon*) over Twitter affect firm's COE.

Using a sample (1,737 firm-year observations) of 584 non-financial firms with Twitter accounts that are listed on the NASDAQ stock exchange over the period 2009-2015, the findings of the study show a significant negative association between firm's dissemination of carbon-related information (iCarbon) and firm COE. This finding indicates that disseminating of carbon related information through Twitter compensate firms' managers by reducing the COE. The study also confirms that the negative association between iCarbon and COE is not affected by firms environmental (ENV) and/or social and governance (ESG) reporting scores. That is, firms with higher ENV or ESG may be motivated to use *iCarbon* more. These results imply that dissemination has its own influence on COE, which is not affected by either firm ENV or ESG reporting score. The sensitivity test shows consistent results across different measures of COE and *iCarbon*, and across different models with different sets of controlling variables. Overall, the results provide evidence that the dissemination of carbon-related information through Twitter assists many potential investors to learn about firm carbon information, and hence, reduces the gap between informed and uninformed investors. The efforts of firms in using Twitter to gain legitimacy among stakeholders, reduce investor acquisition cost of information and improve investor awareness of firms are compensated by the lowering of the COE.

In conclusion, the thesis found that dissemination of both financial and carbon information reduces a firm's equity financing. This thesis contributes to recent literature on firms' use of Twitter to disseminate financial information (e.g. Blankespoor *et al.*, 2014; Jung *et al.*,

2018b) by showing that tweeting financial and carbon information is meaningful and beneficial to investors, as well as firms, by reducing the COE.

5.3 Implication of the Research

The findings of this thesis provide several practical implications for firm managers, market participants and regulators, specifically with the recommendation of adopting Twitter for corporate dissemination practices. As the relevance of Twitter to investors has grown in the last decade, firms need to know the value of using this channel for dissemination purposes, and its relevance to firm communication policy. The thesis also sheds light on the role of dissemination to impact the COE. Accordingly, this thesis encourages firm managers to adopt Twitter as a dissemination channel for both financial and carbon-related information.

The findings of the thesis show that firm dissemination of financial and carbon-related information via Twitter can broaden the reach of this information to current and potential investors, including environmental concern groups. This should increase firms' investor base. This evidence should provide incentives for firm managers to actively engage in Twitter with both current and potential investors to attract their attention to the firm.

The thesis implies that firms' dissemination of financial information on Twitter provides real economic benefit to firms by reducing the COE, which encourages firms to consider the beneficial role of financial dissemination practices. In addition, the findings of the first study show greater benefits for firms with a lower degree of visibility. This finding suggests that managers of less visible firms should disseminate more financial information on Twitter to enhance their investor base, and reduce investor acquisition costs of information.

Regarding the findings of the second study specifically, firm managers' special attention may be drawn to the dissemination of non-financial information, particularly carbon-related information. Investors now care more about climate change and carbon emission-related information, which makes broader dissemination of carbon information essential. The dissemination of such information allows firms to gain legitimacy among shareholder. Furthermore, because of increasing concerns of investors about global warming and climate change, investors may consider not investing in firms that are environmentally irresponsible. The disseminating of carbon information allows firms to broaden the reach of their carbon-related information to investors, which allows them to enhance the firm's investor base, in

turn leading to a lower COE. Therefore, firm managers should consider adopting Twitter to disseminate carbon information to investors, as it decreases firm COE.

The thesis shed light on the influence of firms' dissemination of financial and carbon-related information over Twitter; it enhances the transparency and firm information environment to satisfy investors' need for information. The decision to disseminate over Twitter should provide an understanding for both regulators and investors about the reasons behind the firm's adoption of Twitter and the extent to which this channel is used to dissemination financial and non-financial information. In addition, firms' dissemination of financial and carbon-related information over Twitter increases investor awareness of firm news and allows them to receive firm information at a lower acquisition cost. This should assist investors to make better investment decisions by lowering the uncertainty of future cash flow and information asymmetry. Furthermore, regulators usually attempt to improve the availability of information to investors. Therefore, they should take into the consideration the benefits that Twitter provides for less-informed investors by allowing them to receive firm information on a real-time basis and to reduce their acquisition cost of information.

Policymakers usually refer to lowering firm risk, uncertainty, and COE as incentives to improve reporting practices (Dutta and Nezlobin, 2017). This thesis provides policymakers with a greater understanding of the association between disseminating financial and carbon-related information over Twitter and firm COE. In particular, it reveals the value added by and benefits of using social media as a dissemination channel to improve the firm information environment and transparency. This encourages firm managers to create new roles and policies to enhance the broadness of their information through social media at lower cost. In addition, the findings of the second empirical study encourage regulators, authorities and government policymakers to implement more guidance and planning regarding carbon emissions and climate change, and to consider the associated benefits. The Trump administration has proposed an easy Clean Power Plan that would cut approximately 0.7 to 1.5% of carbon emissions by 2030. This plan initially aimed to reduce emissions by 32% under the Obama administration. The findings of the second empirical chapter show that investors care about these issues, and firms with more effective information sharing have a lower COE. Hence, the study recommends the development of a more effective plan to address climate change and carbon emissions.

In addition, firm use of Twitter to disseminate carbon-related information provides a signal for regulators that firms address the potential risks of climate change and take this matter seriously. As such, regulators should take more actions to reduce the impact of firms on our environment. It is also important for regulators to take more actions to ensure that firms report carbon-related information. This should enhance the transparency of firm information. Regulators should also consider developing suitable mandatory rules in case firms fail to provide transparent and reliable information.

Generally, the findings of both studies imply that dissemination of financial and carbon information is useful for firms in enriching the broadness of firm news, hence, decreasing the expected rate of return compensated by investors, by meeting their demand for information and reaching a broad set of current and potential investors. Diffusing more carbon related information should help firms to gain legitimacy among their shareholder. Overall, the implications of the thesis suggest that firms' dissemination over Twitter can be an important influence on the COE with regard to financial and carbon related information.

5.4 Limitation and Recommendation for Further Research

The thesis provides several avenues for future research to extend the literature and address the limitations of the study. While this study has focused on firm Twitter activity, future research can focus on how this activity could motivate investors to interact and respond to firm information. Specifically, more focus can be placed on investors' perceptions of firm disseminated information on Twitter by investigating users' replies and comments. Users can share their concerns about firms' intended messages to the public. The broadness of these concerns may dilute or destroy firm messages, and can also facilitate negative perceptions of the firms. Therefore, firm failure to address and control these concerns over Twitter may lead to unpleasant consequences for firm reputation and value (Lee *et al.*, 2015a; Cade, 2018). Future studies may also investigate how managers respond to positive and negative comments about financial information. Future research can show greater consideration to understanding management strategy towards answering investor concerns and comments, as in the case of climate change and carbon emission issues. Hence, it may be worth investigating how firm management can attenuate the market reaction to climate change issues on Twitter by addressing investor concerns and replying to their comments.

The thesis focused on two types of information related to financial and carbon information on Twitter. Due to the time limitation of the PhD programme, further research might consider other types of corporate information, such as CSR and/or other interactive social media channels, such as Facebook. In addition, recently Twitter announced a new limit for messages, increasing the maximum length from 140 to 280 characters (Rosen, 2017). Future research could examine whether Twitter design influences firm participation and activity. Additionally, further research could examine whether allowing more characters would result in different capital market consequences.

Current research is limited to a sample of non-financial firms on the NASDAQ stock exchange. Further research can extend this study to other financial markets, where investors suffer from a low transparency level. Furthermore, the study has focused on the influence on COE, while further research may examine the effect of firms' dissemination of financial and carbon-related information over Twitter on the cost of debt – where debtholders have a different payoff function than equity holders.

Besides, instead of implementing words and phrases matching to quantify the number of *iDisc* and *iCarbon* tweets, as per this thesis, further research can also use machine learning techniques and methodology, such as the naïve Bayesian learning algorithm. Although this methodology is widely used in the literature, it is time-consuming, costly and difficult to replicate (e.g. Das and Chen, 2007; Li, 2010b; Kearney and Liu, 2014; Sprenger *et al.*, 2014; Ahmed and Elshandidy, 2016). While the first study examined the effect of tone, future research can give more consideration to other tweet sentiment, such as examining the effect of negative and positive words separately, as negative words may have more prominent effects than positive words (Tetlock, 2007; Garcia, 2013; Loughran and McDonald, 2015; Loughran and McDonald, 2016). However, the second empirical study did not control for the level of carbon emissions produced by firms (the intensity of carbon emissions), due to data limitation. In this regard, future research can give more consideration and attention to firm production of carbon emissions.

Appendices

Appendix A: Sample of *iDisc* Tweets

@CommScope: #ICYMI: CommScope reports strong third quarter 2014 #financial results. Click here to read our official #pressrelease http://ow.ly/DCnJ1

@CommScope: ICYMI: Our 2014 #annualreport and Form 10-K are available for download. Learn more by reading this blog http://ow.ly/KNVrV

@Cognizant: Cognizant reports #Q4FY15, FY'15 results; annual revenue of $12.42 bn, up 21% YoY http://cogniz.at/Q4FY15

@Cognizant: "During the quarter we added approximately 11,800 employees, including approximately 3,770 associates from the acquisition of #TriZetto,"

@Comcast: #Comcast Reports 3rd Quarter 2015 Results #earnings http://ow.ly/TTlW0

@CAinc: CEO gregoire: "although we saw a decline in q3 sales, we are on track for the full year." http://bit.ly/1c5s8w2 #earnings

@CAinc: CEO gregoire: "q3 fy15 total revenue $1.091b compared with $1.128b last year." http://bit.ly/1c5s8w2 #earnings

@Intuit: $INTU announced Q4 & FY'15 earnings results. @QuickBooks Online Grew 57% to 1,075,000 Subscribers. http://intuit.me/1NIaXxw

@Intuit: $INTU announced Q2 FY'15 earnings results. Highlights here: http://intuit.me/1BrBRHm

@Intuit: $INTU ongoing acceleration to the cloud delivered revenue of $672M, up 8% in Q1 FY15. http://intuit.me/1yYtpKB

@Seagate: Seagate Technology Provides Preliminary Fiscal Second Quarter 2012 Financial Results http://ow.ly/8its5

@Seagate: Seagate Technology PLC Declares Quarterly Cash Dividend And Provides Update On Fiscal Third Quarter Results http://ow.ly/4vzbW

@MSFTnews: Microsoft increases quarterly dividend by 22%; announces $40 billion share repurchase http://spr.ly/6016wssk

@MSFTnews: Microsoft reports record $0.77 earnings per share in Q2; Holiday sales & business demand drive revenue http://bit.ly/gUvn6G

@MarriottIntl: Statement by Marriott International, Inc. regarding proposed Starwood Merger Acquisition

@ExtremeNetworks: Extreme Networks Reports Fourth Quarter and Fiscal Year 2012 Financial Results: SANTA CLARA, CA http://yhoo.it/QsXSvV #ITNews #SDN

@Adobe: Just announced: Our Record Revenue in Q1 Fiscal 2011: http://adobe.ly/gHyXtk

@eBayNewsroom: Return on invested capital was 25.3% - a slight decline due to the acquisition of @gsicommerce http://cmp.ly/f/wwkkw2

@eBayNewsroom: $EBAY repurchased approx 13.6 million shares http://cmp.ly/f/mohjd5

@intelnews: Intel declares quarterly cash dividend http://intel.ly/nnx2pn

@intelnews: Intel declares quarterly cash dividend, authorizes additional $10 billion for share repurchases http://intel.ly/hrxui0

@intelnews: Intel reports record financial results for year and fourth quarter: http://intel.ly/ekbzty

@AdvEnergy: Advanced energy announces strong growth and profitability in fourth quarter results http://www.aei.com/en/news_2010_02_16.html

@AdvEnergy: AE announces 45.5% sequential revenue growth in third quarter 2009 results http://bit.ly/awakc

@Acxiom: Our fourth quarter & fiscal year results have been announced- us marketing & data services revenue up 4 percent http://bit.ly/16ap5c0 $acxm

@Acxiom: Acxiom announces first quarter results - diluted earnings per share up 31%, income from operations up 23% http://bit.ly/m1ur43 $acxm

Appendix B: Variables Definition and Measurements for the Whole Thesis:

Variable	Definition	Measurement	Source
Dependent Variables			
COE	Implied Cost of equity	The average of four cost of equity estimates (R_{OJ}, R_{MPEG}, R_{CT} and R_{GLS})	Bloomberg
$R_{PEG5\text{-}4}$	Easton (2004) Price Earnings Growth Model	$P_t^* = \frac{FEPS_5 - FEPS_4}{R_{PEG}}$ P_t = share price as of June next year $FEPS_t$ = median forecast of earnings per share	Bloomberg
Independent Variables			
iCarbon	Firm's carbon-related Tweets	The number of carbon-related tweets	Twitter API and Manual collection
iCarbon_Hyperlink	Firm's carbon-related Tweets with hyperlink	The number of carbon-related tweets that contain hyperlink	Twitter API and Manual collection
iCarbon_Retweet	Firm's carbon-related Tweets that are retweeted	The number of carbon-related tweets that are retweeted	Twitter API and Manual collection
iDisc	Firm's financial Tweets	Natural logarithm of one plus the number of financial tweets	Twitter API and Manual collection
iDisc_Hyperlink	Firm's financial Tweets with hyperlink	Natural logarithm of one plus the number of financial tweets that contain hyperlink	Twitter API and Manual collection
iDisc_NUMBER	Firm's financial Tweets	The number of financial tweets	Twitter API and Manual collection
Control Variables			
ACCRUAL	Discretionary accruals	The difference between discretionary accruals based on Jones model and firm's corresponding discretionary accruals	Bloomberg
ADVERTISING	Advertising intensity	Total advertising expenses divided by total revenue	Bloomberg
AGE	Firm age	The number of years since the firm is listed	CRSP
ANALYST	Analyst following	Natural log of number of analysts making an earnings forecast	Bloomberg
BETA	Firm beta	Beta coefficient of market model using 60 with at least 24 months stock and market return	Bloomberg
BOD_IND	Board Independence	The percentage of independent directors in the board	Bloomberg
BTM	Book value to market ratio	Book to market value ratio	Bloomberg
CAPX	Capital expenditure	Total capital expenditure divided by total revenue	Bloomberg

CD_NEWS	News coverage	Natural logarithm of number of carbon-related news articles	LexisNexis
CDP	CDP participation	Dummy variable that takes a value of 1 if a firm participate and report to CDP and 0 otherwise	Bloomberg
CEOAGE	CEO age	Dummy variable that takes 1 if CEO age is under the median value of other CEO age and 0 otherwise	DataStream
DISP	Analysts' forecast dispersion	Standard deviation of one-year consensus EPS forecast	Bloomberg
ENV_COMMITTEE	Environmental Committee	Dummy variable that takes a value of 1 if a firm has an environmental committee and 0 otherwise	Bloomberg
ENV_SCORE	Environmental reporting score	Disclosure score of the amount of environmental reports that available to the public	Bloomberg
EPA	EPA industry rules	Dummy variable that take a value of 1 if the firm belong to industry under GHG Mandatory Reporting Regulation and 0 otherwise	Manually
ESG_SCORE	Environmental, social and governance reporting score	Disclosure score of the amount of environmental, social and governance reports that available to the public	Bloomberg
INSTOWN	Institutional ownership	The percentage of firm's shares owned by institutions	Bloomberg
LEV	Financial leverage	Long-term debt to equity market value ratio	Bloomberg
LITI	Litigation	Dummy variable that take 1 if the firm belong to high litigation industry (SIC 2833-2836, 3570-3577, 5200-5961, 3600-3674, 7370) and 0 otherwise	Manually
LNOWN	Number of investors	Natural logarithm of number of shareholders	Bloomberg
LOSS	Negative earnings	Indicator variable that takes a value of 1 if a firm reports negative earnings and 0 otherwise	Bloomberg
LTG	The consensus long term growth forecast	The mean of long-term growth rate of earnings forecast or two minus one year ahead average EPS forecast scaled by one year ahead average EPS forecast	Bloomberg
MMT(12)	Price momentum	Compounded rate of return of the previous 12 months	Manually computed
MMT(6)	Price momentum	Compounded rate of return of the previous 6 months	Manually computed
NegSURP	Negative earnings surprise	Indicator variable equal to 1 if earning surprise is below zero and 0 otherwise	Manually computed
NEWS	News coverage	Natural logarithm of number of news articles about the firm	LexisNexis
R&D	Research and development	Research and development expenditure divided by total assets	Bloomberg
ROA	Return on assets	Income before extraordinary items divided by book value of assets (total common equity)	Bloomberg
SALES_GROWTH	Sales growth	Sales change from previous year divided by total sales of previous year	Bloomberg
SILICON	Silicon Valley	Indicator variable equal to 1 if firm is located in Silicon Valley and 0 otherwise	DataStream

SIZE	Firm size	Natural logarithm of firm's equity market value	Bloomberg
SURP	Earning surprise	Consensus earnings forecast minus firm's earnings scaled by share price	Bloomberg
|*Surp*|	Absolute earning surprise	Absolute value of the consensus earnings forecast for forthcoming fiscal year - actual earning / stock price	Bloomberg
TECH_FIRM	Technology firms	Indicator variable that takes a value of 1 if a firm belongs to technology industry (SIC 3570-3579, 3610-3699, 7370-7379, 3810-3849, 4800-4899, 4931, 4941) and 0 otherwise	Manually

Appendix C: Cost of Equity Measurements

COE estimates	Formula
COE	The cost of equity measured by the average of four measures (R_{OJ}, R_{MPEG}, R_{CT} and R_{GLS},) minus risk-free rate.
R_{CT} Claus and Thomas (2001)	$$P_t^* = B_t + \sum_{i=1}^{5} \frac{[FEPS_{t+i} - R_{CT} \times B_{t+i-1}]}{(1+R_{CT})^i} + \frac{[FEPS_{t+5} - R_{CT} \times B_{t+4}] \times (1+g_{lt})}{(R_{CT} - g_{lt})(1+R_{CT})^5}$$ The model measures earnings per share for the next 5 years by using analyst forecasts. The forecasted earnings for the 4th and 5th years are estimated by the earning forecast of the 3rd year and growth rate of long term earnings. If the long-term growth rate is not found, EPS_{t+2} and PS_{t+3} are used. The long term abnormal earning growth rate is measured as 10 years Treasury bonds minus 3%. Clean surplus relation is used to estimate future book value ($B_{t+i-1} = B_t + EPS_{t+1} - DPS_{t+1}$). Estimating future dividend is estimated by multiplying earnings per share by pay-out ratio ($DPS_{t+1} = EPS_{t+1} \times FDIV$).
R_{GLS} Gebhardt, Lee, and Swaminathan (2001)	$$P_t^* = B_t + \sum_{i=1}^{T-1} \frac{[FROE_{t+i} - R_{GLS}] \times B_{t+i-1}}{(1+R_{GLS})^i} + \frac{[FROE_{t+T} - R_{GLS}] \times B_{t+T-1}}{(1+R_{GLS})^{T-1} R_{GLS}}$$ The model measures forecasted return on equity by using analyst forecasts for the next 3 years. From the 4th year to T number of years, ROE is forecasted using linter interpolation to industry median based on 10 years historical industry specific ROE. In case the industrial ROE is lower than the risk-free rate, Industrial ROE would be replaced with risk free rate (Liu *et al.*, 2002). It is also assumed that *t* = 12, which indicates that ROE remains constant afterwards. The research also assumes that firms are classified under 48 industries as defined by Fama and French (1997). Additionally, the model applies a clean surplus to estimate forecasted book values of equity. Where, $B_{t+i-1} = B_t + EPS_{t+1} - DPS_{t+1}$ $DPS_{t+1} = EPS_{t+1} \times FDIV$

R_{MPEG} Modified Easton (2004) cost of equity module by Gode and Mohanram (2003)	$$P_t = \frac{E_t(EPS_{t+1})}{R_{MPEG}} + \frac{E_t(EPS_{t+1})E_t[g_{st} - R_{MPEG} \times (1 + \text{FDIV})]}{R^2_{MPEG}}$$ P_t = firm price in June in each year FEPS=the median of earning forecast per share for the next i year at time t FDIV=forecast dividend pay-out ratio equal to $\left(\frac{\text{DPS}}{\text{EPS}}\right)$ DPS=dividend per share EPS= earnings per share The model assumes positive FEPS but if EPS is negative, FDIV is measured by replacing EPS by 6% of return on asset.
R_{OJ} Ohlson and Juettner-Nauroth (2005) employed by Gode and Mohanram (2003) model	$$R_{OJN} = A + \sqrt{A^2 + \left(\frac{E_t(EPS_{t+1})}{P^*_t}\right)(g_2 - g_{lt})}$$ $$A = 0.5\left(g_{lt} + \frac{DPS_{t+1}}{P^*_t}\right)$$ EPS_{t+1} = The median of earning forecast per share for the next year in June $DEPS_{t+1}$ = Dividend per share for the next Year computed as pay-out ratio for firms with positive earning or 6% of ROA g_2 is the short-term earnings growth rate of EPS_{t+1} and EPS_{t+2} or long-term growth rate of analysts' forecasts. This model requires $EPS_{t+1} > 0$ and $EPS_{t+2} > 0$. g_{lt} is the difference between 10-year treasury bonds yield and 3%
R_{PEG} Easton (2004) Price Earnings Growth Model	$$P^*_t = \frac{FEPS_5 - FEPS_4}{R^2_{PEG}}$$ The first model is for the short-term horizon and the second is for the long-term horizon. P_t = = firm price in June of each year, $FEPS_t$ = median of earning forecast at year *t*.

Appendix D: Additional Test for Endogeneity

	(2) 2SLS	(2) GMM
iDisc	-0.0023**	-0.0019***
	(0.001)	(0.0006)
SIZE	-0.0027**	0.0034**
	(0.0011)	(0.0014)
BTM	0.0401***	0.0510***
	(0.0043)	(0.0042)
LEV	0.0285***	0.0188***
	(0.0061)	(0.0053)
DISP	0.0035	-0.0060
	(0.0081)	(0.0048)
BETA	0.0063***	0.0006
	(0.0018)	(0.0015)
LTG	0.0296***	0.0432***
	(0.0099)	(0.0057)
NEWS	0.0038***	0.0018
	(0.0014)	(0.0015)
INSTOWN	-0.0042	-0.0068**
	(0.0053)	(0.0033)
SURP	0.0037**	0.0006
	(0.0016)	(0.0012)
ROA	0.0341*	0.0079
	(0.0196)	(0.0112)
COE_{t-1}		0.109***
		(0.0281)
Year Effect	Yes	Yes
Industry Effect	Yes	Yes
Firm Effect	Yes	No
Wu-Hausman Test	0.39	
AR(1)		0.038
AR(2)		0.217
Hansen Test		0.291
Constant	0.0608***	-0.0709***
	(0.0200)	(0.0252)
Observations	1,051	553
R^2	0.394	

Notes: The table presents the regression results of the impact of *iDisc* on *COE*. The sample consists of nonfinancial firms in NASDAQ with Twitter accounts from 2009 to 2015. See Appendix (B and C) for definitions of the variables and measurements. Column (1) reports the results from the second stage of the 2SLS regression model. Column (2) estimate Model (1) by using GMM regression technique and including lagged value of COE (COE_{t-1}). *, **, *** signify the significance level at 10%, 5% and 1% respectively. Robust standard errors are in parentheses.

Appendix E: Examples of *iCarbon* tweets:

@Autodesk: Our carbon footprint is down by 38% since fy2009. more facts here: http://autode.sk/1lkvidp #infographic

@CSX: CSX was recognized for our commitment to carbon emission reduction by @cdproject. read more: http://bit.ly/o3vmjm

@ICFI: we're pleased to support @epagov as they reduce #GHG emissions & help communities become resilient to #climatechange: http://ow.ly/d6bo9

@MSFTnews: earth day 2012: a progress report - microsoft reduces carbon emissions by 30%, more updates http://cot.ag/hsfylg #earthday 2012

@Cisco: new on the @ciscocsr blog - cisco announces new greenhouse gas reduction goals. http://cs.co/6011njit #csr #climatechange #eco

@VirginAmerica: 1'st us airline to join the climate registry and will report all GHG emissions: http://twurl.nl/mnhjji

@TetraTech: we are implementing @usaid kazakhstan #climatechange mitigation program to reduce ghg emissions and train businesses. http://t.co/x2lcanv0t8

@YahooInc: showing our commitment to environmental sustainability: @cdp global 500 #climatechange report 2013 http://t.co/b8vk1vj430

@Kimball_Intl: kimball office and national office furniture complete carbon disclosure project report

@Brocade: As the fight against climate change continues, we scored a 98 on the latest carbon disclosure project: http://gobrcm.com/urb1r

@Brocade: #broadcom is a part of the carbon disclosure project. full report http://gobrcm.com/e3oxs , our details http://gobrcm.com/e3oxt

@eBayNewsroom: ebay surges in climate counts 3rd annual corporate climate scores report: http://bit.ly/4firqd #ebaygreen #ebaynews

@MGEMadison: Together, #mgegreenbiz partners offset more than 76,000 tons of co2 emissions per year. full list here: https://www.mge.com/marketplace

@MDLZ: $MDLZ accelerates action on #climate change with new 2020 global #sustainability goals. #call4wellbeing https://t.co/cstwdq6umh

@Orionlighting: Orion technology has saved customers $500 million and reduced greenhouse gases by 4.5 million tons since 2001. http://www.oesx.com

References

Adams, C. A. (2002) 'Internal organisational factors influencing corporate social and ethical reporting', *Accounting, Auditing & Accountability Journal*, 15(2), pp. 223-250

Adams, C.A., Hill, W.-Y. and Roberts, C.B. (1998) 'Corporate social reporting practices in Western Europe: legitimating corporate behaviour?', *The British accounting review*, 30(1), pp. 1-21.

Aerts, W. and Cormier, D. (2009) 'Media legitimacy and corporate environmental communication', *Accounting, organizations and society*, 34(1), pp. 1-27.

Agarwal, S., Kumar, S. and Goel, U. (2019) 'Stock market response to information diffusion through internet sources: A literature review', *International Journal of Information Management*, 45, pp. 118-131.

Agarwal, V., Taffler, R.J., Bellotti, X. and Nash, E.A. (2016) 'Investor relations, information asymmetry and market value', *Accounting and Business Research*, 46(1), pp. 31-50.

Ahmed, Y. and Elshandidy, T. (2016) 'The effect of bidder conservatism on M&A decisions: Text-based evidence from US 10-K filings', *International Review of Financial Analysis*, 46, pp. 176-190.

Al Guindy, M. (2017) *The Role of Social Media in Financial Markets*. Queen's University (Accessed: 7 June 2019).

Alden, W. (2013) 'Twitter Arrives on Wall Street, Via Bloomberg'. *The New York Times,* April 4. Available at: http://dealbook.nytimes.com/2013/04/04/twitter-arrives-on-wall-street-viabloomberg/? r=0 (Accessed:15 March 2019).

Alexander, R.M. and Gentry, J.K. (2014) 'Using social media to report financial results', *Business Horizons*, 57(2), pp. 161-167.

Álvarez-García, J., Maldonado-Erazo, C.P. and del Río, M.d.l.C. (2018) 'Organizational Legitimacy: Study of Academic Publications in Scientific Journals', in *Organizational Legitimacy*. Springer, pp. 69-84.

Amihud, Y. and Mendelson, H. (1986) 'Asset pricing and the bid-ask spread', *Journal of financial Economics*, 17(2), pp. 223-249.

Araujo, T. and Kollat, J. (2018) 'Communicating effectively about CSR on Twitter: The power of engaging strategies and storytelling elements', *Internet Research*, 28(2), pp. 419-431.

Ashbaugh, H., Johnstone, K.M. and Warfield, T.D. (1999) 'Corporate reporting on the Internet', *Accounting horizons*, 13(3), pp. 241-257.

Attig, N., Cleary, S., El Ghoul, S. and Guedhami, O. (2012) 'Institutional investment horizon and investment–cash flow sensitivity', *Journal of Banking & Finance*, 36(4), pp. 1164-1180.

Attig, N., Cleary, S., El Ghoul, S. and Guedhami, O. (2013) 'Institutional investment horizons and the cost of equity capital', *Financial Management*, 42(2), pp. 441-477.

Auger, P., Devinney, T.M., Dowling, G.R., Eckert, C. and Lin, N. (2013) 'How Much Does A Companys Reputation Matter in Recruiting?', *MIT Sloan management review*, 54(3), p. 23.

Balvers, R., Du, D. and Zhao, X. (2017) 'Temperature shocks and the cost of equity capital: Implications for climate change perceptions', *Journal of Banking & Finance*, 77, pp. 18-34.

Bansal, P. and Clelland, I. (2004) 'Talking trash: Legitimacy, impression management, and unsystematic risk in the context of the natural environment', *Academy of Management Journal*, 47(1), pp. 93-103.

Barnett, M.L. and Salomon, R.M. (2012) 'Does it pay to be really good? Addressing the shape of the relationship between social and financial performance', *Strategic Management Journal*, 33(11), pp. 1304-1320.

Barth, M.E. and Schipper, K. (2008) 'Financial reporting transparency', *Journal of Accounting, Auditing & Finance*, 23(2), pp. 173-190.

Bartov, E., Faurel, L. and Mohanram, P.S. (2018) 'Can Twitter Help Predict Firm-Level Earnings and Stock Returns?', *The Accounting Review*, 93(3), pp. 25-57.

BBC News. (2019) *Trump says 'climate change goes both ways*. Available at: https://www.bbc.com/news/world-us-canada-48531019 (Accessed: 7 July 2019).

Behringer, N. and Sassenberg, K. (2015) 'Introducing social media for knowledge management: Determinants of employees' intentions to adopt new tools', *Computers in Human Behavior*, 48, pp. 290-296.

Bellucci, M. and Manetti, G. (2017). 'Facebook as a tool for supporting dialogic accounting? Evidence from large philanthropic foundations in the United States', *Accounting, Auditing & Accountability Journal*, 30(4), pp.874-905.

Bernardi, C. and Stark, A.W. (2018) 'Environmental, social and governance disclosure, integrated reporting, and the accuracy of analyst forecasts', *The British Accounting Review*, 50(1), pp. 16-31.

Bewley, K. and Li, Y. (2000) 'Disclosure of environmental information by Canadian manufacturing companies: a voluntary disclosure perspective', in *Advances in environmental accounting & management*. Emerald Group Publishing Limited, pp. 201-226.

Beyer, A., Cohen, D.A., Lys, T.Z. and Walther, B.R. (2010) 'The financial reporting environment: Review of the recent literature', *Journal of accounting and economics*, 50(2-3), pp. 296-343.

Bhagwat, V. and Burch, T.R. (2016) 'Pump it up? Tweeting to manage investor attention to earnings news', *SSRN*.

Blankespoor, E. (2018) 'Firm communication and investor response: A framework and discussion integrating social media', *Accounting, Organizations and Society*, 68, pp. 80-87.

Blankespoor, E., Dehaan, E., Wertz, J., & Zhu, C. (2019) 'Why do individual investors disregard accounting information? The roles of information awareness and acquisition costs', *Journal of Accounting Research*, 57(1), 53-84.

Blankespoor, E., Miller, G.S. and White, H.D. (2014) 'The role of dissemination in market liquidity: Evidence from firms' use of Twitter™', *The Accounting Review*, 89(1), pp. 79-112.

Botosan, C.A. (1997) 'Disclosure level and the cost of equity capital', *Accounting review*, pp. 323-349.

Botosan, C.A. (2006) 'Disclosure and the cost of capital: what do we know?', *Accounting and business research*, 36(sup1), pp. 31-40.

Botosan, C.A., Plumlee, M.A. and Wen, H. (2011) 'The relation between expected returns, realized returns, and firm risk characteristics', *Contemporary Accounting Research*, 28(4), pp. 1085-1122.

Bowen, F. (2014) *After greenwashing: Symbolic corporate environmentalism and society*. Cambridge University Press.

Boyd, D., Golder, S. and Lotan, G. (2010) 'Tweet, tweet, retweet: Conversational aspects of retweeting on twitter', *2010 43rd Hawaii International Conference on System Sciences*. IEEE, pp. 1-10.

Boyd, D.M. and Ellison, N.B. (2007) 'Social network sites: Definition, history, and scholarship', *Journal of computer-mediated Communication*, 13(1), pp. 210-230.

Brandfog (2016) 'CEO, Social media & leadership survey'. Available at: http://brandfog. com/BRANDfog2016CEOSocialMediaSurvey.pdf (Accessed: 7 July 2019).

Brennan, N.M. and Merkl-Davies, D.M. (2018) 'Do firms effectively communicate with financial stakeholders? A conceptual model of corporate communication in a capital market context', *Accounting and Business Research*, 48(5), pp.553-577.

Breuer, W., Müller, T., Rosenbach, D. and Salzmann, A. (2018) 'Corporate social responsibility, investor protection, and cost of equity: A cross-country comparison', *Journal of Banking & Finance*, 96, pp. 34-55.

Brunsson, N. (2006) *The organization of hypocrisy: Talk, decisions and actions in organizations*. Copenhagen: Copenhagen Business School Press.

Brunswick (2014) 'The Investment Community's Use of Digital and Social Media'. Available at: http://www.brunswickgroup.com/media/266919/Infographic-Digital-Investor-Survey. pdf (Accessed: 7 July 2019).

Buhr, N. (1998) 'Environmental performance, legislation and annual report disclosure: the case of acid rain and Falconbridge', *Accounting, Auditing & Accountability Journal*, 11(2), pp. 163-190.

Busch, T. and Hoffmann, V.H. (2011) 'How hot is your bottom line? Linking carbon and financial performance', *Business & Society*, 50(2), pp. 233-265.

Bushee, B.J., Core, J.E., Guay, W. and Hamm, S.J. (2010) 'The role of the business press as an information intermediary', *Journal of Accounting Research*, 48(1), pp. 1-19.

Bushee, B.J., Matsumoto, D.A. and Miller, G.S. (2003) 'Open versus closed conference calls: the determinants and effects of broadening access to disclosure', *Journal of Accounting and Economics*, 34(1-3), pp. 149-180.

Bushee, B.J. and Miller, G.S. (2012) 'Investor relations, firm visibility, and investor following', *The Accounting Review*, 87(3), pp. 867-897.

Byun, S.K. and Oh, J.-M. (2018) 'Local corporate social responsibility, media coverage, and shareholder value', *Journal of Banking & Finance*, 87, pp. 68-86.

Cade, N.L. (2018) 'Corporate social media: How two-way disclosure channels influence investors', *Accounting, Organizations and Society*, 68, pp. 63-79.

Cahan, S.F., Chen, C., Chen, L. and Nguyen, N.H. (2015) 'Corporate social responsibility and media coverage', *Journal of Banking & Finance*, 59, pp. 409-422.

Campbell, D.J. (2000) 'Legitimacy theory or managerial reality construction? Corporate social disclosure in Marks and Spencer Plc corporate reports, 1969-1997', *Accounting Forum*, 24(1), pp. 80-100.

Campbell, J.L., Chen, H., Dhaliwal, D.S., Lu, H.-m. and Steele, L.B. (2014) 'The information content of mandatory risk factor disclosures in corporate filings', *Review of Accounting Studies*, 19(1), pp. 396-455.

Cao, Y., Myers, J.N., Myers, L.A. and Omer, T.C. (2015) 'Company reputation and the cost of equity capital', *Review of Accounting Studies*, 20(1), pp. 42-81.

Castelló, I., Etter, M. and Årup Nielsen, F. (2016) 'Strategies of legitimacy through social media: The networked strategy', *Journal of Management Studies*, 53(3), pp. 402-432.

Chava, S. (2014) 'Environmental externalities and cost of capital', *Management Science*, 60(9), pp. 2223-2247.

Chen, H., De, P., Hu, Y.J. and Hwang, B.-H. (2014) 'Wisdom of crowds: The value of stock opinions transmitted through social media', *The Review of Financial Studies*, 27(5), pp. 1367-1403.

Chen, K.C., Chen, Z. and Wei, K.J. (2009) 'Legal protection of investors, corporate governance, and the cost of equity capital', *Journal of Corporate Finance*, 15(3), pp. 273-289.

Chen, K.C., Chen, Z. and Wei, K.J. (2011) 'Agency costs of free cash flow and the effect of shareholder rights on the implied cost of equity capital', *Journal of Financial and Quantitative Analysis*, 46(1), pp. 171-207.

Chen, L.H. and Gao, L.S. (2011) 'The pricing of climate risk', *Journal of Financial and Economic Practice*, 12(2), pp. 115-131.

Chen, Z., Dhaliwal, D.S. and Xie, H. (2010) 'Regulation fair disclosure and the cost of equity capital', *Review of Accounting Studies*, 15(1), pp. 106-144.

Cheng, B., Ioannou, I. and Serafeim, G. (2014) 'Corporate social responsibility and access to finance', *Strategic management journal*, 35(1), pp. 1-23.

Cheynel, E. (2013) 'A theory of voluntary disclosure and cost of capital', *Review of Accounting Studies*, 18(4), pp. 987-1020.

Cho, C.H., Freedman, M. and Patten, D.M. (2012) 'Corporate disclosure of environmental capital expenditures: A test of alternative theories', *Accounting, Auditing & Accountability Journal*, 25(3), pp. 486-507.

Cho, C.H. and Patten, D.M. (2007) 'The role of environmental disclosures as tools of legitimacy: A research note', *Accounting, organizations and society*, 32(7-8), pp. 639-647.

Clarkson, P. M., Li, Y., Pinnuck, M., & Richardson, G. D. (2015) 'The valuation relevance of greenhouse gas emissions under the European Union carbon emissions trading scheme', *European Accounting Review*, 24(3), 551-580.

Clarkson, P.M., Li, Y., Richardson, G.D. and Vasvari, F.P. (2011) 'Does it really pay to be green? Determinants and consequences of proactive environmental strategies', *Journal of Accounting and Public Policy*, 30(2), pp. 122-144.

Claus, J. and Thomas, J. (2001) 'Equity premia as low as three percent? Evidence from analysts' earnings forecasts for domestic and international stock markets', *The Journal of Finance*, 56(5), pp. 1629-1666.

Cooper, S. A., Raman, K. K., & Yin, J. (2018) 'Halo effect or fallen angel effect? Firm value consequences of greenhouse gas emissions and reputation for corporate social responsibility', *Journal of Accounting and Public Policy*, 37(3), 226-240.

Crifo, P., Forget, V.D. and Teyssier, S. (2015) 'The price of environmental, social and governance practice disclosure: An experiment with professional private equity investors', *Journal of Corporate Finance*, 30, pp. 168-194.

Culnan, M.J., McHugh, P.J. and Zubillaga, J.I. (2010) 'How large US companies can use Twitter and other social media to gain business value', *MIS Quarterly Executive*, 9(4).

Da, Z., Engelberg, J. and Gao, P. (2011) 'In Search of Attention', *The Journal of Finance*, 66(5), pp. 1461-1499.

Dang, V.A., Michayluk, D. and Pham, T.P. (2018) 'The curious case of changes in trading dynamics: When firms switch from NYSE to NASDAQ', *Journal of Financial Markets*, 41, pp. 17-35.

Daniel, M., Neves, R.F. and Horta, N. (2017) 'Company event popularity for financial markets using Twitter and sentiment analysis', *Expert Systems with Applications*, 71, pp. 111-124.

Das, S.R. and Chen, M.Y. (2007) 'Yahoo! for Amazon: Sentiment extraction from small talk on the web', *Management science*, 53(9), pp. 1375-1388.

Davenport, C. and Rubin, A. (2018) 'Trump Signs Executive Order Unwinding Obama Climate Policies'. *The New York Times,* March 23. Available at: https://www.nytimes.com/2017/03/28/climate/trump-executive-order-climate-change.html, (Accessed 28 March 2017).

Dawkins, C. and Fraas, J.W. (2011) 'Coming clean: The impact of environmental performance and visibility on corporate climate change disclosure', *Journal of business ethics*, 100(2), pp. 303-322.

de Camargo Fiorini, P., Seles, B.M.R.P., Jabbour, C.J.C., Mariano, E.B. and de Sousa Jabbour, A.B.L. (2018) 'Management theory and big data literature: From a review to a research agenda', *International Journal of Information Management*, 43, pp. 112-129.

De Villiers, C. and Van Staden, C.J. (2006) 'Can less environmental disclosure have a legitimising effect? Evidence from Africa', *Accounting, organizations and society*, 31(8), pp. 763-781.

de Villiers, C. and Van Staden, C.J. (2011) 'Where firms choose to disclose voluntary environmental information', *Journal of Accounting and Public Policy*, 30(6), pp. 504-525.

Debreceny, R., Gray, G.L. and Rahman, A. (2002) 'The determinants of Internet financial reporting', *Journal of Accounting and Public policy*, 21(4-5), pp. 371-394.

Debreceny, R.S. (2015) 'Social media, social networks, and accounting', *Journal of Information Systems*, 29(2), pp. 1-4.

Deegan, C. (2002) 'The legitimising effect of social and environmental disclosures–a theoretical foundation', *Accounting, Auditing & Accountability Journal*, 15(3), 282-311.

Deegan, C. (2014) 'An overview of legitimacy theory as applied within the social and environmental accounting literature', *Sustainability accounting and accountability*, pp. 248-272.

Deegan, C. and Gordon, B. (1996) 'A study of the environmental disclosure practices of Australian corporations', *Accounting and business research*, 26(3), pp. 187-199.

Deegan, C. and Rankin, M. (1996) 'Do Australian companies report environmental news objectively? An analysis of environmental disclosures by firms prosecuted successfully by the Environmental Protection Authority', *Accounting, auditing & accountability journal*, 9(2), pp. 50-67.

Deegan, C. (2019) 'Legitimacy theory', *Accounting, auditing & accountability Journal*. In Press.

del Águila-Obra, A.R., Padilla-Meléndez, A. and Serarols-Tarres, C. (2007) 'Value creation and new intermediaries on Internet. An exploratory analysis of the online news industry and

the web content aggregators', *International journal of information management*, 27(3), pp. 187-199.

Demirkan, S., Radhakrishnan, S. and Urcan, O. (2012) 'Discretionary accruals quality, cost of capital, and diversification', *Journal of Accounting, Auditing & Finance*, 27(4), pp. 496-526.

Dhaliwal, D., Heitzman, S. and Zhen Li, O. (2006) 'Taxes, leverage, and the cost of equity capital', *Journal of Accounting Research*, 44(4), pp. 691-723.

Dhaliwal, D., Judd, J.S., Serfling, M. and Shaikh, S. (2016) 'Customer concentration risk and the cost of equity capital', *Journal of Accounting and Economics*, 61(1), pp. 23-48.

Dhaliwal, D., Li, O.Z., Tsang, A. and Yang, Y.G. (2011) 'Voluntary nonfinancial disclosure and the cost of equity capital: The initiation of corporate social responsibility reporting', *The accounting review*, 86(1), pp. 59-100.

Dhaliwal, D., Li, O.Z., Tsang, A. and Yang, Y.G. (2014) 'Corporate social responsibility disclosure and the cost of equity capital: The roles of stakeholder orientation and financial transparency', *Journal of Accounting and Public Policy*, 33(4), pp. 328-355.

Diamond, D.W. and Verrecchia, R.E. (1991) 'Disclosure, liquidity, and the cost of capital', *The journal of Finance*, 46(4), pp. 1325-1359.

Díez-de-Castro, E., Peris-Ortiz, M. and Díez-Martín, F. (2018) 'Criteria for Evaluating the Organizational Legitimacy: A Typology for Legitimacy Jungle', in *Organizational Legitimacy*. Springer, pp. 1-21.

Dimpfl, T. and Jank, S. (2016) 'Can internet search queries help to predict stock market volatility?', *European Financial Management*, 22(2), pp. 171-192.

Dobler, M., Lajili, K. and Zéghal, D. (2014) 'Environmental performance, environmental risk and risk management', *Business Strategy and the Environment*, 23(1), pp. 1-17.

Dorminey, J.W., Dull, R.B. and Schaupp, L.C. (2015) 'The effect of SEC approval of social media for information dissemination', *Research in Accounting Regulation*, 27(2), pp. 165-173.

Dowling, J. and Pfeffer, J. (1975) 'Organizational legitimacy: Social values and organizational behavior', *Pacific sociological review*, 18(1), pp. 122-136.

Drake, M.S., Guest, N.M. and Twedt, B.J. (2014) 'The media and mispricing: The role of the business press in the pricing of accounting information', *The Accounting Review*, 89(5), pp. 1673-1701.

Drake, M.S., Roulstone, D.T. and Thornock, J.R. (2012) 'Investor information demand: Evidence from Google searches around earnings announcements', *Journal of Accounting research*, 50(4), pp. 1001-1040.

Drake, M.S., Thornock, J.R. and Twedt, B.J. (2017) 'The internet as an information intermediary', *Review of Accounting Studies*, 22(2), pp. 543-576.

Du, H. and Jiang, W. (2014) 'Do social media matter? Initial empirical evidence', *Journal of Information Systems*, 29(2), pp. 51-70.

Dutta, S. and Nezlobin, A. (2017) 'Information disclosure, firm growth, and the cost of capital', *Journal of Financial Economics*, 123(2), pp. 415-431.

Easley, D. and O'hara, M. (2004) 'Information and the cost of capital', *The journal of finance*, 59(4), pp. 1553-1583.

Easton, P.D. (2004) 'PE ratios, PEG ratios, and estimating the implied expected rate of return on equity capital', *The accounting review*, 79(1), pp. 73-95.

Eberle, D., Berens, G. and Li, T. (2013) 'The impact of interactive corporate social responsibility communication on corporate reputation', *Journal of business ethics*, 118(4), pp. 731-746.

Eccles, R.G., Ioannou, I. and Serafeim, G. (2014) 'The impact of corporate sustainability on organizational processes and performance', *Management Science*, 60(11), pp. 2835-2857.

El Ghoul, S., Guedhami, O., Kim, H. and Park, K. (2018) 'Corporate environmental responsibility and the cost of capital: International evidence', *Journal of Business Ethics*, 149(2), pp. 335-361.

El Ghoul, S., Guedhami, O., Kwok, C.C. and Mishra, D.R. (2011) 'Does corporate social responsibility affect the cost of capital?', *Journal of Banking & Finance*, 35(9), pp. 2388-2406.

Elliott, W.B., Grant, S.M. and Hodge, F.D. (2018) 'Negative news and investor trust: The role of $ Firm and# CEO Twitter use', *Journal of Accounting Research*, 56(5), pp. 1483-1519.

Elliott, W.B., Hodge, F.D. and Sedor, L.M. (2012) 'Using online video to announce a restatement: Influences on investment decisions and the mediating role of trust', *The Accounting Review*, 87(2), pp. 513-535.

Elyasiani, E. and Jia, J. (2010) 'Distribution of institutional ownership and corporate firm performance', *Journal of banking & finance*, 34(3), pp. 606-620.

Elyasiani, E., Jia, J.J. and Mao, C.X. (2010) 'Institutional ownership stability and the cost of debt', *Journal of Financial Markets*, 13(4), pp. 475-500.

Ettredge, M., Richardson, V.J. and Scholz, S. (2002) 'Dissemination of information for investors at corporate Web sites', *Journal of Accounting and Public Policy*, 21(4-5), pp. 357-369.

Fama, E.F. and French, K.R. (1992) 'The cross-section of expected stock returns', *the Journal of Finance*, 47(2), pp. 427-465.

Fama, E.F. and French, K.R. (1997) 'Industry costs of equity', *Journal of financial economics*, 43(2), pp. 153-193.

Fang, L. and Peress, J. (2009) 'Media coverage and the cross-section of stock returns', *The Journal of Finance*, 64(5), pp. 2023-2052.

Fatemi, A., Glaum, M. and Kaiser, S. (2018) 'ESG performance and firm value: The moderating role of disclosure', *Global Finance Journal*, 38, pp. 45-64.

Ferris, S.P., Javakhadze, D. and Rajkovic, T. (2017) 'The international effect of managerial social capital on the cost of equity', *Journal of Banking & Finance*, 74, pp. 69-84.

Floreddu, P.B., Cabiddu, F. and Evaristo, R. (2014) 'Inside your social media ring: How to optimize online corporate reputation', *Business Horizons*, 57(6), pp. 737-745.

Fonseka, M., Rajapakse, T. and Tian, G.L. (2019) 'The Effects of Environmental Information Disclosure and Energy Types on the Cost of Equity: Evidence from the Energy Industry in China', *Abacus*, 55(2), pp.362-410.

Francis, J., Nanda, D. and Olsson, P. (2008) 'Voluntary disclosure, earnings quality, and cost of capital', *Journal of accounting research*, 46(1), pp. 53-99.

Francis, J. R., Khurana, I. K., & Pereira, R. (2005) 'Disclosure incentives and effects on cost of capital around the world', *The accounting review*, 80(4), 1125-1162.

Francis, J., LaFond, R., Olsson, P. M., & Schipper, K. (2004) 'Costs of equity and earnings attributes', *The accounting review*, 79(4), 967-1010.

Frankel, R., Johnson, M. and Skinner, D.J. (1999) 'An empirical examination of conference calls as a voluntary disclosure medium', *Journal of Accounting Research*, 37(1), pp. 133-150.

Friedman, M. (1991) 'Consumer boycotts: A conceptual framework and research agenda', *Journal of Social Issues*, 47(1), pp. 149-168.

Fu, R., Kraft, A. and Zhang, H. (2012) 'Financial reporting frequency, information asymmetry, and the cost of equity', *Journal of Accounting and Economics*, 54(2-3), pp. 132-149.

Gandomi, A. and Haider, M. (2015) 'Beyond the hype: Big data concepts, methods, and analytics', *International Journal of Information Management*, 35(2), pp. 137-144.

García-Sánchez, I.-M. and Noguera-Gámez, L. (2017) 'Integrated information and the cost of capital', *International Business Review*, 26(5), pp. 959-975.

Garcia, D. (2013) 'Sentiment during recessions', *The Journal of Finance*, 68(3), pp. 1267-1300.

Garriga, E. and Melé, D. (2004) 'Corporate social responsibility theories: Mapping the territory', *Journal of business ethics*, 53(1-2), pp. 51-71.

Gebhardt, W.R., Lee, C.M. and Swaminathan, B. (2001) 'Toward an implied cost of capital', *Journal of accounting research*, 39(1), pp. 135-176.

Giannarakis, G., Zafeiriou, E. and Sariannidis, N. (2017) 'The impact of carbon performance on climate change disclosure', *Business Strategy and the Environment*, 26(8), pp. 1078-1094.

Glosten, L.R. and Milgrom, P.R. (1985) 'Bid, ask and transaction prices in a specialist market with heterogeneously informed traders', *Journal of financial economics*, 14(1), pp. 71-100.

Gode, D. and Mohanram, P. (2003) 'Inferring the cost of capital using the Ohlson–Juettner model', *Review of accounting studies*, 8(4), pp. 399-431.

Grant, S.M., Hodge, F.D. and Sinha, R.K. (2018) 'How disclosure medium affects investor reactions to CEO bragging, modesty, and humblebragging', *Accounting, Organizations and Society*, 68, pp. 118-134.

Gray, R., Owen, D. and Dams, C. (1996) 'Accounting and Accountability: Changes and Challenges in Corporate Social and Environmental Reporting (Prenctice Hall Europe, Hemel Hempstead)'.

Griffin, P.A. and Sun, Y. (2013) 'Going green: Market reaction to CSRwire news releases', *Journal of Accounting and Public Policy*, 32(2), pp. 93-113.

Grimmelikhuijsen, S.G. and Meijer, A.J. (2015) 'Does Twitter Increase Perceived Police Legitimacy?', *Public Administration Review*, 75(4), pp. 598-607.

Gómez-Carrasco, P., Guillamón-Saorín, E. and García Osma, B. (2020) 'Stakeholders versus Firm Communication in Social Media: The Case of Twitter and Corporate Social Responsibility Information', *European Accounting Review*, pp.1-32.

Grossman, S. J., & Stiglitz, J. E. (1980) 'On the impossibility of informationally efficient markets', *American Economic Review*, 70(3), 393–408

Guedhami, O. and Mishra, D. (2009) 'Excess control, corporate governance and implied cost of equity: International evidence', *Financial Review*, 44(4), pp. 489-524.

Gupta, K. (2018) 'Environmental sustainability and implied cost of equity: international evidence', *Journal of Business Ethics*, 147(2), pp. 343-365.

Guthrie, J. and Parker, L.D. (1989) 'Corporate social reporting: a rebuttal of legitimacy theory', *Accounting and business research*, 19(76), pp. 343-352.

Hahn, R., Reimsbach, D. and Schiemann, F. (2015) 'Organizations, climate change, and transparency: Reviewing the literature on carbon disclosure', *Organization & Environment*, 28(1), pp. 80-102.

Hail, L. and Leuz, C. (2006) 'International differences in the cost of equity capital: Do legal institutions and securities regulation matter?', *Journal of accounting research*, 44(3), pp. 485-531.

Hail, L. and Leuz, C. (2009) 'Cost of capital effects and changes in growth expectations around US cross-listings', *Journal of financial economics*, 93(3), pp. 428-454.

Harjoto, M.A. and Jo, H. (2015) 'Legal vs. normative CSR: Differential impact on analyst dispersion, stock return volatility, cost of capital, and firm value', *Journal of Business Ethics*, 128(1), pp. 1-20.

Harvey, C.R. (1999) *Campbell R. Harvey's Hypertextual Finance Glossary*.

Hasseldine, J., Salama, A.I. and Toms, J.S. (2005) 'Quantity versus quality: the impact of environmental disclosures on the reputations of UK Plcs', *The British Accounting Review*, 37(2), pp. 231-248.

Heinkel, R., Kraus, A. and Zechner, J. (2001) 'The effect of green investment on corporate behavior', *Journal of financial and quantitative analysis*, 36(4), pp. 431-449.

Higgins, C. and Larrinaga, C. (2014) 'Sustainability reporting: Insights from institutional theory', in J. Bebbington, J.U., and B. O'Dwyer (ed.) *Sustainability accounting and accountability*. London: Routledge, pp. 273-285.

Hirshleifer, D., Lim, S.S. and Teoh, S.H. (2009) 'Driven to distraction: Extraneous events and underreaction to earnings news', *The Journal of Finance*, 64(5), pp. 2289-2325.

Hirshleifer, D., Lim, S.S. and Teoh, S.H. (2011) 'Limited investor attention and stock market misreactions to accounting information', *The Review of Asset Pricing Studies*, 1(1), pp. 35-73.

Hirshleifer, D. and Teoh, S.H. (2003) 'Limited attention, information disclosure, and financial reporting', *Journal of accounting and economics*, 36(1-3), pp. 337-386.

Hong, H. and Stein, J.C. (1999) 'A unified theory of underreaction, momentum trading, and overreaction in asset markets', *The Journal of finance*, 54(6), pp. 2143-2184.

Hsu, A.W.-h. and Wang, T. (2013) 'Does the market value corporate response to climate change?', *Omega*, 41(2), pp. 195-206.

Hsueh, L. (2019) 'Voluntary climate action and credible regulatory threat: evidence from the carbon disclosure project', *Journal of Regulatory Economics*, 56(2-3), 188-225.

Huang, W., Lu, H. and Su, B. (2016) *Green disclosure? Social media and prosocial behavior*. Working paper. University of Toronto.

Huang, Y., Singh, P.V. and Ghose, A. (2015) 'A structural model of employee behavioral dynamics in enterprise social media', *Management Science*, 61(12), pp. 2825-2844.

Hughes, J.S., Liu, J. and Liu, J. (2007) 'Information asymmetry, diversification, and cost of capital', *The accounting review*, 82(3), pp. 705-729.

Ibrahim, N.F., Wang, X. and Bourne, H. (2017) 'Exploring the effect of user engagement in online brand communities: Evidence from Twitter', *Computers in Human Behavior*, 72, pp. 321-338.

Iglesias-Pérez, F., Blanco-González, A. and Navalón, J.G.M. (2018) 'Informal Economy and Legitimacy. The Spanish Case', in *Organizational Legitimacy*. Springer, pp. 231-242.

Investis. (2015) *Social media for corporate communications: A review of corporate social media use in the US and the UK*. Available at: http://www.biztositasiszemle.hu/files/201502/investis-sm-brochure-_1_.pdf (Accessed: 22 March 2017).

Jame, R., Johnston, R., Markov, S. and Wolfe, M.C. (2016) 'The value of crowdsourced earnings forecasts', *Journal of Accounting Research*, 54(4), pp. 1077-1110.

Jia, M., Tong, L., Viswanath, P. and Zhang, Z. (2016) 'Word power: the impact of negative media coverage on disciplining corporate pollution', *Journal of business ethics*, 138(3), pp. 437-458.

Johnstone, D. (2016) 'The effect of information on uncertainty and the cost of capital', *Contemporary Accounting Research*, 33(2), pp. 752-774.

Jung, J., Herbohn, K. and Clarkson, P. (2018a) 'Carbon risk, carbon risk awareness and the cost of debt financing', *Journal of Business Ethics*, 150(4), pp. 1151-1171.

Jung, M.J., Naughton, J.P., Tahoun, A. and Wang, C. (2018b) 'Do Firms Strategically Disseminate? Evidence from Corporate Use of Social Media', *The Accounting Review*, 93(4), pp. 225-252.

Kaplan, A.M. (2012) 'If you love something, let it go mobile: Mobile marketing and mobile social media 4x4', *Business horizons*, 55(2), pp. 129-139.

Kaplan, A.M. and Haenlein, M. (2010) 'Users of the world, unite! The challenges and opportunities of Social Media', *Business horizons*, 53(1), pp. 59-68.

Kearney, C. and Liu, S. (2014) 'Textual sentiment in finance: A survey of methods and models', *International Review of Financial Analysis*, 33, pp. 171-185.

Kietzmann, J.H., Hermkens, K., McCarthy, I.P. and Silvestre, B.S. (2011) 'Social media? Get serious! Understanding the functional building blocks of social media', *Business horizons*, 54(3), pp. 241-251.

Kim, E.H. and Youm, Y.N. (2017) 'How Do Social Media Affect Analyst Stock Recommendations? Evidence from S&P 500 Electric Power Companies' Twitter Accounts', *Strategic Management Journal*, 38(13), pp. 2599-2622.

Kim, J.W. and Shi, Y. (2011) 'Voluntary disclosure and the cost of equity capital: Evidence from management earnings forecasts', *Journal of Accounting and Public Policy*, 30(4), pp. 348-366.

Kim, O. and Verrecchia, R.E. (1994) 'Market liquidity and volume around earnings announcements', *Journal of accounting and economics*, 17(1-2), pp. 41-67.

Kim, Y.-B., An, H.T. and Kim, J.D. (2015) 'The effect of carbon risk on the cost of equity capital', *Journal of Cleaner Production*, 93, pp. 279-287.

Kimbrough, M.D. and Louis, H. (2011) 'Voluntary disclosure to influence investor reactions to merger announcements: An examination of conference calls', *The Accounting Review*, 86(2), pp. 637-667.

Kothari, S. (2000) 'The role of financial reporting in reducing financial risks in the market', *Conference Series-Federal Reserve Bank of Boston*. Federal Reserve Bank of Boston, Boston, 1998. pp. 89-102.

Kothari, S.P., Li, X. and Short, J.E. (2009a) 'The effect of disclosures by management, analysts, and business press on cost of capital, return volatility, and analyst forecasts: A study using content analysis', *The Accounting Review*, 84(5), pp. 1639-1670.

Kothari, S.P., Shu, S. and Wysocki, P.D. (2009b) 'Do managers withhold bad news?', *Journal of Accounting research*, 47(1), pp. 241-276.

Kravet, T. and Muslu, V. (2013) 'Textual risk disclosures and investors' risk perceptions', *Review of Accounting Studies*, 18(4), pp. 1088-1122.

Kumar, V. and Mirchandani, R. (2012) 'Increasing the ROI of social media marketing', *MIT sloan management review*, 54(1), p. 55.

Kwahk, K.-Y. and Park, D.-H. (2016) 'The effects of network sharing on knowledge-sharing activities and job performance in enterprise social media environments', *Computers in Human Behavior*, 55, pp. 826-839.

Kwak, H., Lee, C., Park, H. and Moon, S. (2010) 'What is Twitter, a social network or a news media?', *Proceedings of the 19th international conference on World wide web*. AcM, pp. 591-600.

Lambert, R., Leuz, C. and Verrecchia, R.E. (2007) 'Accounting information, disclosure, and the cost of capital', *Journal of accounting research*, 45(2), pp. 385-420.

Lambert, R.A., Leuz, C. and Verrecchia, R.E. (2011) 'Information asymmetry, information precision, and the cost of capital', *Review of Finance*, 16(1), pp. 1-29.

Lambert, R.A. and Verrecchia, R.E. (2015) 'Information, illiquidity, and cost of capital', *Contemporary Accounting Research*, 32(2), pp. 438-454.

Lau, M.-L. and Wydick, B. (2014) 'Does new Information technology lower media quality? The paradox of commercial public goods', *Journal of Industry, Competition and Trade*, 14(2), pp. 145-157.

Lee, D., Hosanagar, K. and Nair, H.S. (2018) 'Advertising content and consumer engagement on social media: evidence from Facebook', *Management Science*, 64(11), pp. 5105-5131.

Lee, K., Oh, W.-Y. and Kim, N. (2013) 'Social media for socially responsible firms: Analysis of Fortune 500's Twitter profiles and their CSR/CSIR ratings', *Journal of business ethics*, 118(4), pp. 791-806.

Lee, L.F., Hutton, A.P. and Shu, S. (2015a) 'The role of social media in the capital market: Evidence from consumer product recalls', *Journal of Accounting Research*, 53(2), pp. 367-404.

Lee, S.Y. (2012) 'Corporate carbon strategies in responding to climate change', *Business Strategy and the Environment*, 21(1), pp. 33-48.

Lee, S.Y., Park, Y.S. and Klassen, R.D. (2015b) 'Market responses to firms' voluntary climate change information disclosure and carbon communication', *Corporate Social Responsibility and Environmental Management*, 22(1), pp. 1-12.

Lee, Y.-J., Yoon, H.J. and O'Donnell, N.H. (2018b) 'The effects of information cues on perceived legitimacy of companies that promote corporate social responsibility initiatives on social networking sites', *Journal of Business Research*, 83, pp. 202-214.

Leek, S. and Christodoulides, G. (2011) 'Brands: Just for consumers? Introduction to the special issue on B2B branding', *Industrial Marketing Management*, 40(7), pp. 1060-1062.

Leek, S., Houghton, D. and Canning, L. (2017) 'Twitter and behavioral engagement in the healthcare sector: An examination of product and service companies', *Industrial Marketing Management*.

Lehavy, R. and Sloan, R.G. (2008) 'Investor recognition and stock returns', *Review of Accounting Studies*, 13(2-3), pp. 327-361.

Lei, L., Li, Y. and Luo, Y. (2018) 'Social Media and Voluntary Nonfinancial Disclosure: Evidence from Twitter Presence and Corporate Political Disclosure', *Journal of Information Systems*, In Press.

Lei, L.G., Li, Y. and Luo, Y. (2019) 'Production and dissemination of corporate information in social media: A review', *Journal of Accounting Literature*, 42, pp. 29-43.

Lemma, T.T., Feedman, M., Mlilo, M. and Park, J.D. (2019) 'Corporate carbon risk, voluntary disclosure, and cost of capital: South African evidence', *Business Strategy and the Environment*, 28(1), pp. 111-126.

Leuz, C. and Verrecchia, R.E. (2000) 'The economic consequences of increased disclosure', *Journal of accounting research*, pp. 91-124.

Leuz, C. and Wysocki, P.D. (2016) 'The economics of disclosure and financial reporting regulation: Evidence and suggestions for future research', *Journal of Accounting Research*, 54(2), pp. 525-622.

Li, C. (2010a) 'Groundswell. Winning in a world transformed by social technologies', *Strategic Direction*, 26(8).

Li, E.X., Ramesh, K. and Shen, M. (2011) 'The role of newswires in screening and disseminating value-relevant information in periodic SEC reports', *The Accounting Review*, 86(2), pp. 669-701.

Li, F. (2010b) 'The information content of forward-looking statements in corporate filings—A naïve Bayesian machine learning approach', *Journal of Accounting Research*, 48(5), pp. 1049-1102.

Li, L., Liu, Q., Tang, D. and Xiong, J. (2017) 'Media reporting, carbon information disclosure, and the cost of equity financing: evidence from China', *Environmental Science and Pollution Research*, 24(10), pp. 9447-9459.

Li, X., Xie, Q., Jiang, J., Zhou, Y. and Huang, L. (2018) 'Identifying and monitoring the development trends of emerging technologies using patent analysis and Twitter data mining: The case of perovskite solar cell technology', *Technological Forecasting and Social Change*.

Lindblom, C.K. (1994) 'The implications of organizational legitimacy for corporate social performance and disclosure', *Critical Perspectives on Accounting Conference, New York, 1994*.

Lui, A.K., Ngai, E.W. and Lo, C.K. (2016) 'Disruptive information technology innovations and the cost of equity capital: The moderating effect of CEO incentives and institutional pressures', *Information & Management*, 53(3), pp.345-354.

Liu, J., Nissim, D. and Thomas, J. (2002) 'Equity valuation using multiples', *Journal of Accounting Research*, 40(1), pp. 135-172.

Loughran, T. and McDonald, B. (2011) 'When is a liability not a liability? Textual analysis, dictionaries, and 10-Ks', *The Journal of Finance*, 66(1), pp. 35-65.

Loughran, T. and McDonald, B. (2014) 'Measuring readability in financial disclosures', *The Journal of Finance*, 69(4), pp. 1643-1671.

Loughran, T. and McDonald, B. (2015) 'The use of word lists in textual analysis', *Journal of Behavioral Finance*, 16(1), pp. 1-11.

Loughran, T. and McDonald, B. (2016) 'Textual analysis in accounting and finance: A survey', *Journal of Accounting Research*, 54(4), pp. 1187-1230.

Luo, L. and Tang, Q. (2014) 'Does voluntary carbon disclosure reflect underlying carbon performance?', *Journal of Contemporary Accounting & Economics*, 10(3), pp. 191-205.

Luo, N., Guo, X., Lu, B. and Chen, G. (2018) 'Can non-work-related social media use benefit the company? A study on corporate blogging and affective organizational commitment', *Computers in Human Behavior*, 81, pp. 84-92.

Manetti, G. and Bellucci, M. (2016) 'The use of social media for engaging stakeholders in sustainability reporting', *Accounting, Auditing & Accountability Journal*, 29(6), pp. 985-1011.

Mangena, M., Li, J. and Tauringana, V. (2016) 'Disentangling the effects of corporate disclosure on the cost of equity capital: a study of the role of intellectual capital disclosure', *Journal of Accounting, Auditing & Finance*, 31(1), pp. 3-27.

Manika, D., Papagiannidis, S. and Bourlakis, M. (2015) 'The effects of a CEO's YouTube apology for service failure on customer's behavioural intentions', *Technological Forecasting and Social Change*, 95, pp. 87-97.

Margolis, J.D. and Walsh, J.P. (2003) 'Misery loves companies: Rethinking social initiatives by business', *Administrative science quarterly*, 48(2), pp. 268-305.

Marshall, G.W., Moncrief, W.C., Rudd, J.M. and Lee, N. (2012) 'Revolution in sales: The impact of social media and related technology on the selling environment', *Journal of Personal Selling & Sales Management*, 32(3), pp. 349-363.

Martinviita, A. (2016) 'Online community and the personal diary: Writing to connect at Open Diary', *Computers in Human Behavior*, 63, pp. 672-682.

Marwick, A.E. and Boyd, D. (2011) 'I tweet honestly, I tweet passionately: Twitter users, context collapse, and the imagined audience', *New media & society*, 13(1), pp. 114-133.

Matsumoto, D., Pronk, M. and Roelofsen, E. (2011) 'What makes conference calls useful? The information content of managers' presentations and analysts' discussion sessions', *The Accounting Review*, 86(4), pp. 1383-1414.

Matsumoto, D.A. (2002) 'Management's incentives to avoid negative earnings surprises', *The accounting review*, 77(3), pp. 483-514.

Matsumura, E.M., Prakash, R. and Vera-Muñoz, S.C. (2014) 'Firm-value effects of carbon emissions and carbon disclosures', *The Accounting Review*, 89(2), pp. 695-724.

Mayew, W.J. (2008) 'Evidence of management discrimination among analysts during earnings conference calls', *Journal of Accounting Research*, 46(3), pp. 627-659.

Mayew, W. J. (2012) 'Disclosure Outlets and Corporate Financial Communication: A Discussion of "Managers' Use of Language Across Alternative Disclosure Outlets: Earnings Press Releases versus MD&A"* ', *Contemporary Accounting Research*, 29: 838-844.

Mazboudi, M. and Khalil, S. (2017) 'The attenuation effect of social media: Evidence from acquisitions by large firms', *Journal of Financial Stability*, 28, pp. 115-124.

Meek, G. K., Roberts, C. B., & Gray, S. J. (1995) 'Factors influencing voluntary annual report disclosures by US, UK and continental European multinational corporations', *Journal of international business studies, 26*(3), 555-572.

Merton, R.C. (1987) 'A simple model of capital market equilibrium with incomplete information', *The journal of finance*, 42(3), pp. 483-510.

Meshcheryakov, A. and Winters, D.B. (2019) 'CAN NONLOCAL TRADERS CAPTURE THE LOCAL INFORMATION ADVANTAGE AND PROFIT?', *Journal of Financial Research*, 42(1), pp. 41-69.

Meyer, J.W. and Rowan, B. (2004) *Institutionalised organisations: Formal structure as myth and ceremony*. Princeton University Press Princeton, NJ.

Mikhail, M.B., Walther, B.R. and Willis, R.H. (2004) 'Earnings surprises and the cost of equity capital', *Journal of Accounting, Auditing & Finance*, 19(4), pp. 491-513.

Miller, G.S. (2006) 'The press as a watchdog for accounting fraud', *Journal of Accounting Research*, 44(5), pp. 1001-1033.

Miller, G.S. and Skinner, D.J. (2015) 'The evolving disclosure landscape: How changes in technology, the media, and capital markets are affecting disclosure', *Journal of Accounting Research*, 53(2), pp. 221-239.

Miranda, S., Cruz-Suarez, A. and Prado-Román, M. (2018) 'Relationship Between Legitimacy and Organizational Success', in *Organizational Legitimacy*. Springer, pp. 171-195.

Misirlis, N. and Vlachopoulou, M. (2018) 'Social media metrics and analytics in marketing–S3M: A mapping literature review', *International Journal of Information Management*, 38(1), pp. 270-276.

Modigliani, F. and Miller, M.H. (1958) 'The cost of capital, corporation finance and the theory of investment', *The American economic review*, 48(3), pp. 261-297.

National Investor Relations Institute (NIRI, 2013) 'Social media use in investor relations – 2013 survey results'. Available at: https://www.niri.org/memberLogin.aspx?

ReturnURL=/NIRI/media/NIRI/niri-Analytics/2013-SocialMedia-Analytics.pdf (Accessed 07 June 2017).

Ng, A.C. and Rezaee, Z. (2015) 'Business sustainability performance and cost of equity capital', *Journal of Corporate Finance*, 34, pp. 128-149.

Ngai, E.W., Tao, S.S. and Moon, K.K. (2015) 'Social media research: Theories, constructs, and conceptual frameworks', *International journal of information management*, 35(1), pp. 33-44.

Niessner, M. and So, E.C. (2018) *Bad news bearers: The negative tilt of financial press*. Yale University and Massachusetts Institute of Technology.

Nikolaev, V. and Van Lent, L. (2005) 'The endogeneity bias in the relation between cost-of-debt capital and corporate disclosure policy', *European Accounting Review*, 14(4), pp. 677-724.

Ohlson, J.A. and Juettner-Nauroth, B.E. (2005) 'Expected EPS and EPS growth as determinantsof value', *Review of accounting studies*, 10(2-3), pp. 349-365.

Oliver, C. (1996) 'The institutional embeddedness of economic activity', *Advances in strategic management*, 13, pp. 163-186.

Orens, R., Aerts, W. and Cormier, D. (2010) 'Web-based non-financial disclosure and cost of finance', *Journal of Business Finance & Accounting*, 37(9-10), pp. 1057-1093.

Orlitzky, M. and Benjamin, J.D. (2001) 'Corporate social performance and firm risk: A meta-analytic review', *Business & Society*, 40(4), pp. 369-396.

Orlitzky, M., Schmidt, F.L. and Rynes, S.L. (2003) 'Corporate social and financial performance: A meta-analysis', *Organization studies*, 24(3), pp. 403-441.

Palazzo, G. and Scherer, A.G. (2006) 'Corporate legitimacy as deliberation: A communicative framework', *Journal of business ethics*, 66(1), pp. 71-88.

Parsons, T. (1960) *Structure and process in modern societies*. Free Pr.

Pástor, Ľ., Sinha, M. and Swaminathan, B. (2008) 'Estimating the intertemporal risk–return tradeoff using the implied cost of capital', *The Journal of Finance*, 63(6), pp. 2859-2897.

Patten, D.M. (1992) 'Intra-industry environmental disclosures in response to the Alaskan oil spill: a note on legitimacy theory', *Accounting, organizations and Society*, 17(5), pp. 471-475.

Peng, J., Sun, J. and Luo, R. (2015) 'Corporate voluntary carbon information disclosure: Evidence from China's listed companies', *The World Economy*, 38(1), pp. 91-109.

Peress, J. (2014) 'The Media and the Diffusion of Information in Financial Markets: Evidence from Newspaper Strikes', *Journal of Finance*, 69, 2007–2043.

Petersen, M.A. (2009) 'Estimating standard errors in finance panel data sets: Comparing approaches', *The Review of Financial Studies*, 22(1), pp. 435-480.

Plumlee, M., Brown, D., Hayes, R.M. and Marshall, R.S. (2015) 'Voluntary environmental disclosure quality and firm value: Further evidence', *Journal of Accounting and Public Policy*, 34(4), pp. 336-361.

PR Newswire. (2015) *Apple, Facebook and Google underperform in use of social media.* Available at: http://www.prnewswire.com/news-releases/apple-facebook-and-googleunderperform- in-use-of-social-media-290518351.html (Accessed 07 June 2017).

Prokofieva, M. (2015) 'Twitter-based dissemination of corporate disclosure and the intervening effects of firms' visibility: Evidence from Australian-listed companies', *Journal of Information Systems*, 29(2), pp. 107-136.

Qiu, Y., Shaukat, A. and Tharyan, R. (2016) 'Environmental and social disclosures: Link with corporate financial performance', *The British Accounting Review*, 48(1), pp. 102-116.

Raguseo, E. (2018) 'Big data technologies: An empirical investigation on their adoption, benefits and risks for companies', *International Journal of Information Management*, 38(1), pp. 187-195.

Raguseo, E. and Vitari, C. (2018) 'Investments in big data analytics and firm performance: an empirical investigation of direct and mediating effects', *International Journal of Production Research*, 56(15), pp. 5206-5221.

Recuero, R., Araujo, R. and Zago, G. (2011) 'How does social capital affect retweets?', *Fifth International AAAI Conference on Weblogs and Social Media*.

Rehbein, K., Waddock, S. and Graves, S.B. (2004) 'Understanding shareholder activism: Which corporations are targeted?', *Business & Society*, 43(3), pp. 239-267.

Reidmiller, D.R., Avery, C.W., Easterling, D.R., Kunkel, K.E., Lewis, K.L.M., Maycock, T.K., Stewart, B.C., Wuebbles, D.J., Fahey, D.W. and Hibbard, K.A. (2018) 'Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment'. *US Global Change Research Program, Washington, DC, USA*.

Reilly, A.H. and Hynan, K.A. (2014) 'Corporate communication, sustainability, and social media: It's not easy (really) being green', *Business horizons*, 57(6), pp. 747-758.

Richardson, A.J. and Welker, M. (2001) 'Social disclosure, financial disclosure and the cost of equity capital', *Accounting, organizations and society*, 26(7-8), pp.597-616.

Rogers, J.L., Skinner, D.J. and Van Buskirk, A. (2009) 'Earnings guidance and market uncertainty', *Journal of Accounting and Economics*, 48(1), pp. 90-109.

Rosen, A. (2017) '*Tweeting made easier*', *Rosen Aliza blog,* 7 November. Available at: https://blog.twitter.com/en_us/topics/product/2017/tweetingmadeeasier.html (Accessed: 7 July 2019).

Rui, H., Liu, Y. and Whinston, A. (2013) 'Whose and what chatter matters? The effect of tweets on movie sales', *Decision Support Systems*, 55(4), pp. 863-870.

Salama, A., Anderson, K. and Toms, J. (2011) 'Does community and environmental responsibility affect firm risk? Evidence from UK panel data 1994–2006', *Business Ethics: A European Review*, 20(2), pp. 192-204.

Salmi, O. (2008) 'Drivers for adopting environmental management systems in the post-Soviet mining industry', *International Environmental Agreements: Politics, Law and Economics*, 8(1), pp. 51-77.

Salo, J. (2017) 'Social media research in the industrial marketing field: Review of literature and future research directions', *Industrial Marketing Management*, 66, pp. 115-129.

Sashittal, H.C., Hodis, M. and Sriramachandramurthy, R. (2015) 'Entifying your brand among Twitter-using millennials', *Business Horizons*, 58(3), pp. 325-333.

Securities and Exchange Commission (SEC, 2008) *Commission Guidance on the Use of Company Websites*. Release No. 34-58288. Washington, DC: SEC.

Securities and Exchange Commission (SEC, 2013a) *SEC Says Social Media OK for Company Announcements if Investors Are Alerted*. No. 2013-51. Available at: https://www.sec.gov/news/press-release/2013-2013-51htm (Accessed: 7 July 2019).

Securities And Exchange Commission (SEC, 2013b) *Securities and Exchange Act of 1934 Release No. 69279: Report of Investigation Pursuant to Section 21(a) of the Securities Exchange Act of 1934: Netflix, Inc., and Reed Hastings*. Available at https://www.sec.gov/litigation/investreport/34-69279.pdf (Accessed: 7 July 2019).

Schäfer, M.S. (2012) 'Online communication on climate change and climate politics: a literature review', *Wiley Interdisciplinary Reviews: Climate Change*, 3(6), pp. 527-543.

Schepers, D.H. (2010) 'Challenges to legitimacy at the Forest Stewardship Council', *Journal of business ethics*, 92(2), pp. 279-290.

Scherer, A.G., Palazzo, G. and Seidl, D. (2013) 'Managing legitimacy in complex and heterogeneous environments: Sustainable development in a globalized world', *Journal of Management Studies*, 50(2), pp. 259-284.

Schmidt, A., Ivanova, A. and Schäfer, M.S. (2013) 'Media attention for climate change around the world: A comparative analysis of newspaper coverage in 27 countries', *Global Environmental Change*, 23(5), pp. 1233-1248.

Schreck, P. (2011) 'Reviewing the business case for corporate social responsibility: New evidence and analysis', *Journal of Business Ethics*, 103(2), p. 167.

Schreder, M. (2018) 'Idiosyncratic information and the cost of equity capital: A meta-analytic review of the literature', *Journal of Accounting Literature*, 41, pp. 142-172.

Seele, P. and Lock, I. (2015) 'Instrumental and/or deliberative? A typology of CSR communication tools', *Journal of Business Ethics*, 131(2), pp. 401-414.

Servaes, H. and Tamayo, A. (2013) 'The impact of corporate social responsibility on firm value: The role of customer awareness', *Management science*, 59(5), pp. 1045-1061.

Sharfman, M.P. and Fernando, C.S. (2008) 'Environmental risk management and the cost of capital', *Strategic management journal*, 29(6), pp. 569-592.

Shiau, W.-L., Dwivedi, Y.K. and Yang, H.S. (2017) 'Co-citation and cluster analyses of extant literature on social networks', *International Journal of Information Management*, 37(5), pp. 390-399.

Siamagka, N.-T., Christodoulides, G., Michaelidou, N. and Valvi, A. (2015) 'Determinants of social media adoption by B2B organizations', *Industrial Marketing Management*, 51, pp. 89-99.

Siikanen, M., Baltakys, K., Kanniainen, J., Vatrapu, R., Mukkamala, R. and Hussain, A. (2018) 'Facebook drives behavior of passive households in stock markets', *Finance Research Letters*, 27, pp. 208-213.

Sivarajah, U., Kamal, M.M., Irani, Z. and Weerakkody, V. (2017) 'Critical analysis of Big Data challenges and analytical methods', *Journal of Business Research*, 70, pp. 263-286.

Skinner, D.J. (1994) 'Why firms voluntarily disclose bad news', *Journal of accounting research*, 32(1), pp. 38-60.

Sprengel, D.C. and Busch, T. (2011) 'Stakeholder engagement and environmental strategy–the case of climate change', *Business Strategy and the Environment*, 20(6), pp. 351-364.

Sprenger, T.O., Sandner, P.G., Tumasjan, A. and Welpe, I.M. (2014) 'News or noise? Using Twitter to identify and understand company-specific news flow', *Journal of Business Finance & Accounting*, 41(7-8), pp. 791-830.

Staiger, D. and Stock, J.H. (1997) 'Instrumental Variables Regression with Weak Instruments', *Econometrica*, 65(3), pp. 557-586.

Staiger, D.O. and Stock, J.H. (1994) 'Instrumental variables regression with weak instruments'. National Bureau of Economic Research Cambridge, Mass., USA.

Stanny, E. (2013) 'Voluntary disclosures of emissions by US firms', *Business Strategy and the Environment*, 22(3), pp. 145-158.

Stieglitz, S., Mirbabaie, M., Ross, B. and Neuberger, C. (2018) 'Social media analytics–Challenges in topic discovery, data collection, and data preparation', *International journal of information management*, 39, pp. 156-168.

Suchman, M.C. (1995) 'Managing legitimacy: Strategic and institutional approaches', *Academy of management review*, 20(3), pp. 571-610.

Sun, J. and Liu, G. (2016) 'Does analyst coverage constrain real earnings management? ', *The Quarterly Review of Economics and Finance*, 59, pp.131-140.

Teoh, S.H. (2018) 'The promise and challenges of new datasets for accounting research', *Accounting, Organizations and Society*, 68, pp. 109-117.

Tetlock, P.C. (2007) 'Giving content to investor sentiment: The role of media in the stock market', *The Journal of finance*, 62(3), pp. 1139-1168.

The Economist. (2017) *The Road to Action: Financial Regulation Addressing Climate Change*. Available at: https://perspectives.eiu.com/sites/default/files/The%20road%20to%20action%20-%20WEB.pdf (Accessed: 7 February 2019).

The White House. (2019) *Statement by President Trump on the Paris Climate Accord | The White House*. Available at: https://www.whitehouse.gov/briefings-statements/statement-president-trump-paris-climate-accord/ (Accessed: 7 July 2019).

Thelwall, M., Buckley, K. and Paltoglou, G. (2011) 'Sentiment in Twitter events', *Journal of the American Society for Information Science and Technology*, 62(2), pp. 406-418.

Treviño, L.K., den Nieuwenboer, N.A., Kreiner, G.E. and Bishop, D.G. (2014) 'Legitimating the legitimate: A grounded theory study of legitimacy work among Ethics and Compliance Officers', *Organizational Behavior and Human Decision Processes*, 123(2), pp. 186-205.

Trinkle, B.S., Crossler, R.E. and Bélanger, F. (2015) 'Voluntary Disclosures via Social Media and the Role of Comments', *Journal of Information Systems*, 29(3), pp. 101-121.

Twedt, B. (2016) 'Spreading the word: Price discovery and newswire dissemination of management earnings guidance', *The Accounting Review*, 91(1), pp. 317-346.

Twitter. (2013) *Annual Report 2013*. Available at: https://s22.q4cdn.com/826641620/files/doc_financials/ar/Twitter-Inc-2013-Annual-Report.pdf (Accessed: 7 July 2019).

Twitter. (2014) *Annual Report 2014*. Available at: https://s22.q4cdn.com/826641620/files/doc_financials/ar/FiscalYR2014_Twitter_Annual_Report.pdf (Accessed: 7 July 2019).

Twitter. (2015) *Annual Report 2015*. Available at: https://s22.q4cdn.com/826641620/files/doc_financials/ar/FiscalYR2015_Twitter_Annual_Report.pdf (Accessed: 7 July 2019).

Ullmann, A.A. (1985) 'Data in search of a theory: A critical examination of the relationships among social performance, social disclosure, and economic performance of US firms', *Academy of management review*, 10(3), pp. 540-557.

Verrecchia, R.E. (1983) 'Discretionary disclosure', *Journal of accounting and economics*, 5, pp. 179-194.

Wang, D.D. and Sueyoshi, T. (2018) 'Climate change mitigation targets set by global firms: Overview and implications for renewable energy', *Renewable and Sustainable Energy Reviews*, 94, pp. 386-398.

Wang, W.Y., Pauleen, D.J. and Zhang, T. (2016) 'How social media applications affect B2B communication and improve business performance in SMEs', *Industrial Marketing Management*, 54, pp. 4-14.

Warren Jr, J.D., Moffitt, K.C. and Byrnes, P. (2015) 'How Big Data will change accounting', *Accounting Horizons*, 29(2), pp. 397-407.

Weinhofer, G. and Hoffmann, V.H. (2010) 'Mitigating climate change–how do corporate strategies differ?', *Business Strategy and the Environment*, 19(2), pp. 77-89.

Wild, D. (2004) 'International benefits', *Times Online*. Available at: http://business.timesonline.co.uk/tol/business/article478072.ece (Accessed: 15 March 2015).

Williams, S.M. (1999) 'Voluntary environmental and social accounting disclosure practices in the Asia-Pacific region: An international empirical test of political economy theory', *The International Journal of Accounting*, 34(2), pp. 209-238.

Woodward, D., Edwards, P. and Birkin, F. (2001) 'Some evidence on executives' views of corporate social responsibility', *The British Accounting Review*, 33(3), pp. 357-397.

Wooldridge, J.M. (2015) *Introductory econometrics: A modern approach*. Nelson Education.

Xiong, F., Chapple, L. and Yin, H. (2018) 'The use of social media to detect corporate fraud: A case study approach', *Business Horizons*.

Yu, E.P.y., Guo, C.Q. and Luu, B.V. (2018) 'Environmental, social and governance transparency and firm value', *Business Strategy and the Environment*.

Zeng, S., Xu, X., Yin, H. and Tam, C.M. (2012) 'Factors that drive Chinese listed companies in voluntary disclosure of environmental information', *Journal of Business Ethics*, 109(3), pp. 309-321.

Zhang, J. (2015) 'Voluntary information disclosure on social media', *Decision Support Systems*, 73, pp. 28-36.

Zhao, M. (2012) 'CSR-based political legitimacy strategy: Managing the state by doing good in China and Russia', *Journal of Business Ethics*, 111(4), pp. 439-460.

Zhao, Y., Davis, M. and Berry, K.T. (2009) 'Disclosure channel and cost of capital: evidence from open vs closed conference calls', *Review of Accounting and Finance*, 8(3), pp. 253-278.

Zhou, M., Lei, L., Wang, J., Fan, W. and Wang, A.G. (2015) 'Social media adoption and corporate disclosure', *Journal of information systems*, 29(2), pp. 23-50.

Zhou, Z., Zhang, T., Wen, K., Zeng, H. and Chen, X. (2018) 'Carbon risk, cost of debt financing and the moderation effect of media attention: Evidence from Chinese companies operating in high-carbon industries', *Business Strategy and the Environment*.

Zyglidopoulos, S.C., Georgiadis, A.P., Carroll, C.E. and Siegel, D.S. (2012) 'Does media attention drive corporate social responsibility?', *Journal of Business Research*, 65(11), pp. 1622-1627.