The role of carbon risk disclosure in the relation between analyst following and market value

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Abstract

In times when environmental disclosure by firms becomes more and more important, this research investigates to what extent carbon risk disclosure moderates the relationship between analyst following and market value for 3.715 European and US firms in the period 2011-2017. In this research, analyst following is defined as the number of analysts following a firm. The results suggest that carbon risk disclosure has a positive moderating role. This implicates that the relationship between analyst following and market value becomes stronger when a firm discloses its carbon risks. These results were found for all three sorts of carbon risk disclosure: regulatory, physical and miscellaneous. In addition, carbon risk disclosure positively moderates the relationship between analyst following and information asymmetry, implicating that it weakens the negative effect of analyst following on information asymmetry. This study also provides further elaborations, limitations and suggestions for future research.

Keywords: carbon risk disclosure; market value; analyst following; information asymmetry

Content

Overview tables

1. Introduction

According to Cambridge Dictionary (2019), a financial analyst is *"someone whose job is to study companies' financial performance, usually in order to decide which ones to invest in"*. Literature shows that financial analysts are important to the value of firms. Chung & Jo (1996) and Jung et al. (2012), for example, find that analyst following[1] has a positive effect on the (market) value of firms. The reasoning behind this is that monitoring of firm activities by analysts could decrease information asymmetry between management of a firm and outside investors. As a result, agency- and transaction costs decrease, through which firm and market value increase (Jensen & Meckling, 1976; Akerlof, 1970; Healy & Palepu, 2001).

A factor that could play a role in this relationship is carbon risk disclosure. Carbon dioxide is an important driver of climate change. According to the Environmental Protection Agency (EPA), 82% of the US greenhouse gases, which are the gases that heat up the atmosphere, consist of carbon dioxide (EPA, 2019). That is why it is important for firms to get an insight in its carbon emissions and related risks. Görgen et al. (2018, p. 4) describe carbon risk as *"the role carbon plays in a firms' value chain, the public perception of a firms carbon emissions and the ability of a firm with respect to regulatory and technology changes"*. The main reason why carbon risk disclosure could have an effect on the relationship between analyst following and market value is that it reduces information asymmetry between the firm and its outside investors. According to Akerlof (1970), disclosing information in general results in lower information asymmetry. In addition, Schiemann & Sakhel (2018) find that the disclosure of physical risks leads to lower information asymmetry, which could increase market value by lowering agency- and transaction costs. Furthermore, not disclosing carbon risks could give an adverse signal to investors, through which non-disclosing firms could be penalised on the market (Milgrom, 1981). This is also the case for the cost of debt, which is higher when a firm does not disclose its carbon risks (Jung et al., 2018).

In view of the foregoing, this research examines *to what extent carbon risk disclosure moderates the relationship between analyst following and the market value of firms.* Therefore, four relationships will be analysed. First, the effects of analyst following on both

[1] The number of analysts following a firm.

information asymmetry and market value are tested. These tests are conducted for the completeness of this research i.e. to compare the results with previous results found in the literature consulted. Secondly, carbon risk disclosure[2] will be used as a moderator in both relationships in order to determine whether it has an effect on the strength and/or direction of the relationships.

The theoretical relevance of this research is that it investigates a relatively under-researched phenomenon: carbon risk disclosure. As described above, the effect of analyst following on information asymmetry and market value has been researched before. Nevertheless, consulted literature suggests that carbon risk disclosure could play a moderating role in these relationships. This research shows that carbon risk disclosure, indeed, plays a positive moderating role. In practical terms, this means that when a firm discloses its carbon risks, the relationship between analyst following and market value becomes stronger. This information can be very useful to firms and stimulate them to start disclosing their carbon risks and, thereby, increase their market value. The societal relevance of this research can be found in the fact that climate change, which is mainly caused by carbon emissions (EPA, 2019), is a crucial issue in all levels of society. According to Matisoff (2013), by disclosing carbon emissions, management of these emissions can be improved, leading to lower energy consumption and costs. Based on this, it is also likely that carbon risk disclosure could lead to a better management of the carbon risks and, therefore, a reduction of the risks, which would not only be beneficial to firms, but also to society in general.

The remainder of this research will be structured as follows. Chapter two gives an overview of relevant literature regarding the relationship between analyst following and information asymmetry, and between analyst following and market value. A separate section will be dedicated to the moderating role of carbon risk disclosure. Based on this review, hypotheses will be formulated. Subsequently, in chapter three, the data and methodology used to test the hypotheses and answer the research question, will be described. In chapter four, the results will be presented on which in chapter five the conclusion and discussion will be based.

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[2] This includes carbon risk disclosure in general, regulatory carbon risk disclosure, physical carbon risk disclosure and miscellaneous carbon risk disclosure.

2. Literature review

This chapter gives an overview of the relevant literature. First, the literature regarding the relationships of analyst following on information asymmetry and market value will be described. Based on this, two hypothesis are formulated. Secondly, the literature concerning the moderating role of carbon risk disclosure on the two relationships will be presented, by looking at carbon risk in general, why firms disclose their carbon risks and finally how carbon risk disclosure could moderate the mentioned relationships. Again, two hypotheses will be formulated.

2.1 Analyst following and market value

Analysts can have a positive and negative effect on the value of a firm. The positive effect, which is also known as the 'monitoring effect' (Jung et al, 2012), is described by Jensen & Meckling (1976), who theorise that security analysis of analysts can reduce agency- and transaction costs between management and outside investors of a firm, through which the value of that firm increases. The agency problem between management and outside investors is created because outside investors usually do not interfere with the firm's management. After outside investors have invested in the firm, the self-interested manager can make certain expenditures with the invested funds, which could be harmful to the outside investors. This problem of information asymmetry can be solved by financial analysts producing information about a firm, which could shed light on the misuse of funds (Healy & Palepu, 2001). The information production by analysts about a firm is also known as 'analyst following' i.e. the number of analysts following a firm. Chung & Jo (1996) find empirical evidence for the positive relationship between analyst following and market value in the period 1984-1987 for US firms. However, more recent studies find a negative or even no effect of analysts on market value, also described as the 'pressure effect' of analysts. Fuller and Jensen (2002), for example, suggest that when internal budgets or forecasts are not in line with external expectations from analysts on Wall Street, top managers will stimulate middle- and lower management to re-examine the forecasts and budgets in order to let them deviate less from the external expectations. Subsequently, this leads to an overvalued stock which has negative long term effects on the firm and, therefore, its value. In addition, He & Tian (2012) find that a higher analyst following leads to lower firm innovation. The reasoning behind this

is that more analyst following results in higher pressure on short time performance, causing fewer investments in long term projects. It is also possible that conflicted interests of analysts could weaken or even undo the positive effect of analyst following on firm value. This can occur when the analyst works for an investment bank which arranged the initial public offering (IPO) of a firm. As a result, the analyst could have conflicting interests in recommending that specific firm stock (Michaely & Womack, 1999). Because conflicting results have been found in more recent studies, Jung et al. (2012) re-examine the relationship between analysts following and firm value for a broad sample of US firms in the period 1988-2006. Their study shows a significant positive relationship, which overrules the potential negative effects of the 'pressure effect' by financial analysts on managers.

Other ways in which market value could be enhanced by analyst following is that it increases the market liquidity of a firm (Roulestone, 2003). In line with this, Derrien & Kecskés (2010) find that lower analyst following leads to lower investments and financing. The reason is that lower analyst following results in more information asymmetry, through which the cost of capital increase and investments decrease. Subsequently, lower financing and investments leads to less profit generating projects on the long term, which could have negative effects on the value of firms. Lastly, also the cost of raising equity are lower when a firm has more analyst following, due to lower information asymmetry among outside investors (Bowen et al., 2007).

Based on what is stated in the previous paragraphs and the most recent study of Jung et al. (2012), which finds a positive significant relationship between analyst following and firm value that overrules the pressure effect as described by e.g. Michaely & Womack (1999), the following hypothesis is formulated:

Hypothesis 1: Analyst following is positively associated with the market value of firms.

Information asymmetry can be seen as the underlying mechanism in the relationship between analyst following and market value. The reason is that analyst following decreases information asymmetry between the firm and its outside investors. As a result, transaction- and agency costs are reduced through which the value of a firm increases (Jensen &

Meckling, 1976; Akerlof, 1970; Healy & Palepu, 2001). Based on this, the following hypothesis is formulated:

Hypothesis 2: Analyst following is negatively associated with information asymmetry.

What should be noted is that these two hypotheses are formulated for the completeness of this research i.e. to compare the generated results with the results in the consulted literature. The main hypotheses of this research will be presented in the upcoming section.

2.2 The role of carbon risk disclosure

2.2.1 Carbon risk

The term 'carbon risk' is often linked to the terms climate or environmental risk. Climate or environmental risk can be described as the long term risks of climate change on the business activities of firms (Romilly, 2007). Firms, for example, need to invest in newer and cleaner technologies. In addition, customers and suppliers can become more environmentally aware, which requires new or adjusted products, services and supply chains with lower impact on the environment (Görgen et al., 2018). Carbon risk can be seen as an element of climate or environmental risk (e.g. Zhou et al. 2018). The reason is that 82% of the US greenhouse gasses, which are the gases that heat up the atmosphere, consist of carbon dioxide (EPA, 2019).

There are several definitions of the term 'carbon risk' in the literature. Hoffmann & Busch (2008, p. 514) state that the general definition of carbon risk is *"any corporate risk related to climate change or the use of fossil fuels"*. However, for their research they state that carbon risk is *"the change in a company's monetary carbon performance within a given time period"*. According to Görgen et al. (2018, p. 4), carbon risk is defined as *"the role carbon plays in a firms' value chain, the public perception of a firms carbon emissions and the ability of a firm with respect to regulatory and technology changes"*. Especially the last definition gives a broad insight in what carbon risk exactly implies. That is why it will be used in this research.

There are three different forms of carbon risk that can affect a firm: regulatory risk, physical risk and business risk (Zhou et al., 2018; Dobler et al., 2014). Regulatory risk is the impact of carbon policies and regulations on the cost of capital and financial performance of a firm, both now and in the future. This risk is the largest for firms in greenhouse-gas-intensive industries. Physical risk covers the direct risks of climate change, like rising sea levels, droughts and floods. Lastly, business risk can be divided in legal risks, reputational risks and competitive risks. Legal risks are the risks of litigation against firms which play a major role in climate change. Reputational risk is the change in reputation of the firm according to its stakeholders, based on a firm's response to climate change. Competitive risk is the risk of changing demand for goods and services of firms and the potential effects of carbon constraints on liquidity and usage of certain assets (Labatt & White, 2011). These three risks will all be taken into account in this research.

2.2.2 Motives for carbon risk disclosure

In general, there are three theories that explain why a firm voluntarily discloses non-financial information (Hahn et al., 2015), like its carbon risks. First of all, socio-political theories, stating that firms do not disclose non-financial information to participants in capital markets, but to give in social and political pressure of non-market stakeholders, like the media or policy makers (Hahn & Lülfs, 2014). Two sub theories are central in the socio-political theories: the legitimacy and stakeholder theory (Hahn et al., 2015). According to the legitimacy theory, firms disclose non-financial information to answer the pressure of the entire society, while according to the stakeholder theory, firms only disclose non-financial information for their stakeholders (Cotter & Najah, 2012; Hahn et al., 2015). Hence, in socio-political theories, firms disclose non-financial information to validate the impact they have on the environment or society as a whole (Schiemann & Sakhel, 2018). Secondly, there are economic-based theories, which state that the decision of voluntary non-financial disclosure depends on a cost and benefits analysis (Clarkson et al., 2008; Hahn et al., 2015). One important economic-based theory is the signalling theory, according to which parties share information to signal trust and transparency. So when a firm discloses (non-financial) information, information asymmetry decreases and as a result the principal agent problem, with its related costs, is reduced (Hahn et al. 2015). Lastly, there are institutional theories,

which imply that firms disclose non-financial information as a result of the requirements of certain institutions, like governments or institutional investors (Hahn, et al. 2015).

2.2.3 Moderating role of carbon risk disclosure

With the lemons problem, Akerlof (1970) illustrated how information asymmetry could lead to transaction costs. However, the lemons problem could also be applied to firms and their carbon risks. The reason is that outside investors cannot determine whether a company has low or high carbon risks. To prevent themselves from being driven out of the market, low risk firms, therefore, will start to disclose their carbon risks. According to Diamond & Verrecchia (1991), disclosure of information in general already reduces information asymmetry. In addition, Schiemann & Sakhel (2018) find that the voluntary disclosure of physical carbon risks by firms also leads to lower information asymmetry. As a result, carbon risk disclosure could further reduce the information asymmetry between outside investors and the management of the firm. Consequently, agency- and transaction costs are decreased and market value increased.

Additional ways in which carbon risk disclosure could, indirectly, affect information asymmetry and market value, is for example when a firm does not disclose its carbon risks. Outside investors could interpret this as an adverse signal and get suspicious about the firm's carbon risks. As a result, the firm could be penalised on the market (Milgrom, 1981). Besides, there is a chance that investors themselves will try to reveal the non-disclosed information by themselves, which is not only costly for the investors, but eventually also for the firm (Johnston, 2005; Mae Matsumura et al., 2014). So, by disclosing its carbon risks, a firm cannot only decrease information asymmetry, but also prevent the negative penalising effects on its market value. Secondly, Jung et al. (2018) look at whether a firm's carbon risk effects the costs of debt. They find a significant positive relation between the cost of debt and a firm's carbon risks. However, this relationship is invalidated when firms show carbon risk 'awareness', which is mainly determined by whether or not a firm responds to the Carbon Disclosure Project (CDP) survey. The CDP survey yearly requests companies to voluntarily disclose information on, amongst others, their greenhouse gas emissions, risks and opportunities regarding climate change (Bae Choi et al. 2013). By disclosing its risks, a firm thus can decrease its cost of debt which, in turn, can increase the overall financial

performance of the firm and, therefore, its market value. Looking at non-financial disclosure in general, of which carbon risk disclosure is a part, Albertini (2013) finds a positive relationship between environmental disclosure and the financial performance of a firm. In addition, Dhaliwal, Li, Tsang, & Yang (2011) find that when a firm discloses its above industry-average non-financial performance, the cost of equity for that firm is lower. Furthermore, the disclosure of the above industry-average non-financial performance also leads to more analyst following, which again leads to lower information asymmetry and higher market value, as described in the first part of this chapter.

What should be noted is that disclosure not always leads to lower information asymmetry and, therefore, a higher market value. It could be possible that uncertainty rises because of the disclosed information. As a result, information asymmetries increase (Kothari et al., 2009; Schiemann & Sakhel, 2018). In the case of carbon risk disclosure, commotion among shareholders may arise when disclosure reveals high carbon risks. Furthermore, Luo et al. (2015) state that corporate social performance (CSP) information is complex and multi-dimensional. The reason is that outside investors do not always have the specific knowledge or time and resources to gain the specific knowledge. As a result, it is hard for them to understand and, therefore, value the information. Because this could also be the case for disclosed carbon risk information, information asymmetry may not always be reduced. However, when analysts are already following the firm, it should lead to lower information asymmetry. The reason is that these analysts, who are experts in the field, understand the disclosed information and will incorporate it in their recommendations for general investors.

Based on the above, carbon risk disclosure could on the one hand decrease information asymmetry, as described by Diamond & Verrecchia (1991) and Schiemann & Sakhel (2018). As a result, agency- and transaction costs would decrease and market value increase. However, on the other hand, carbon risk disclose could increase information asymmetry because of increased uncertainty among investors or investors not being able to understand and value the disclosed carbon risks. Nevertheless, because disclosing carbon risks also could lead to less penalisation on the market, lower cost of debt and equity, and better financial performance, the following hypothesis is formulated:

Hypothesis 3: Carbon risk disclosure will have a positive moderating effect on the relationship between analyst following and information asymmetry.

As explained in the beginning of this literature review, lower information asymmetry between a firm and its outside investors, leads to lower agency- and transaction costs, causing the value of a firm to increases (Jensen & Meckling, 1976; Akerlof, 1970; Healy & Palepu, 2001). Based on this, the following hypothesis is formulated:

Hypothesis 4: Carbon risk disclosure will have a positive moderating effect on the relationship between analyst following and market value.

3. Research method

3.1 Data sample

The most suitable method to test the hypotheses formulated in the previous chapter, is a panel data analysis. With a panel data analysis, multiple variables can be analysed over time (Hsiao, 2014). In general, two tests are suitable for a panel data analysis: the fixed- and random effects model (Torres-Reyna, 2007). The results in appendix 1 and 2 show that the random effects model is most suitable for the data. Therefore, it will be used for all the regressions. The data sample that is used for this research consists of both European and US firms in the period 2011-2017, and is retrieved from two databases: Thomas Reuters Eikon and data provided by the CDP questionnaire. Within Thomas Reuters Eikon, two sub-databases are used: Asset4 and the Institutional Brokers Estimate System (I/B/E/S). The Asset4 database consists of data regarding firms' environmental, social and governance (ESG) performance (Thomas Reuters, 2019). Information regarding the market value of firms, information asymmetry and controls will be retrieved from this database. In the I/B/E/S database, information about a firm's earnings forecasts and stock recommendations are given (Refinitiv, 2019). This database will be used for information regarding analyst following. To determine whether and to what extent a firm discloses its carbon risk, the data provided by the CDP questionnaire will be used. The reason for a sample with both European and US firms is that it increases the number of firms in the sample and, therefore, the external validity of this research. In addition, there is no indication in the consulted literature that both the relationship between analyst following and information asymmetry, and between analyst following and market value, would be different among these continents. However, to be sure,

country controls will be added to the regressions. The period 2011-2017 is researched because all the required carbon risk disclosure data are available in this period.

The total data sample consist of 3.715 firms, from which 2.556 are US firms and 1.159 are European firms. As can be seen in table 3.1, firms from the United Kingdom (UK) are represented the most in the data sample of all the European countries, namely with 10,58%. The European countries that are least represented are both Czech-Republic and Hungary, with 0,11%. The external validity of the results could be affected by the overrepresentation of US firms in the sample. Therefore, the analyses are repeated in the robustness tests section, without US firms.

Table 3.1 Firms per country

Country	Number of Firms	Percentage of Total
Austria	16	0,43%
Belgium	32	0,83%
Czech-Republic	5	0,11%
Denmark	28	0,75%
Finland	25	0,67%
France	116	3,01%
Germany	121	3,15%
Greece	19	0,51%
Hungary	4	0,11%
Ireland	12	0,94%
Italy	63	1,59%
Netherlands	43	1,53%
Norway	33	0,62%
Poland	34	0,86%
Portugal	9	0,24%
Spain	51	1,35%
Sweden	68	1,83%
Switserland	62	1,78%
Turkey	30	0,83%
United Kingdom	388	10,58%
United States	2.556	66,89%
Total	3.715	100,00%

When looking at the different industries, table 3.2 shows that the financial- and consumer services industry are most represented in the sample (24,79% and 17,95%, respectively). The industry least represented is the telecommunications industry (1,67%). To prevent that the over-representation of firms in the financial industry will affect the external validity of the results, the analyses are re-conducted in the robustness tests section, excluding the financial firms.

Table 3.2 Firms per industry

Industry	Number of Firms	Percentage of Total
Basic materials	178	4,79%
Consumer goods	334	8,99%
Consumer services	667	17,95%
Financials	921	24,79%
Health Care	441	11,87%
Industrials	667	17,95%
Technology	335	9,02%
Telecommuncations	62	1,67%
Utilities	110	2,96%
Total	3.715	100%

3.2 Measurement of variables

3.2.1 Dependent variables

There are two dependent variables in this research. In the relationship between analyst following and market value, market value is the dependent variable. In addition, also the relationship between analyst following and information asymmetry will be analysed, causing information asymmetry to be a dependent variable as well. The most straightforward way to measure the market value of firm *i* at time *t* is by looking at the value of the common shares, i.e. the number of common shares multiplied by the share price. However, some studies (e.g. Chung & Jo, 1996; Nekhili et al., 2017; Ararat et al., 2017) use Tobin's q, which is useful to normalise differences in size between firms. Tobin's q can be calculated by dividing the equity market value plus the liabilities market value by the equity book value plus liabilities

book value (Finabase, 2019). Based on these previous studies, Tobin's q will be used as an additional variable to measure market value in the robustness tests section.

To measure information asymmetry, the bid-ask spread will be used as a proxy. This has been done in previous studies (e.g. Cho, et al., 2013; Fuhrmann et al., 2017; Schiemann & Sakhel, 2018) and is a common way in accounting studies to measure information asymmetry. The reason behind using the bid-ask spread is that captures the cost of information in the case a participant in the stock market has more information than other participants (Stoll, 1978). So the bid-ask spread measures adverse selection, which is lower when the information asymmetry between participants in the market is lower. Subsequently, lower adverse selection leads to a lower bid-ask spread (Glosten & Milgrom, 1985). Schiemann & Sakhel (2018) measure the bid-ask spread as the average of the daily bid-ask spreads of a firm in a specific time period. They calculate the daily bid-ask spread by dividing the closing ask price minus the closing bid price by the average of the closing bid and ask price. This method is also suitable for this research and, therefore, used.

3.2.2 Independent variables

The independent variables are analyst following and carbon risk disclosure. Analyst following is measured by the number of analysts following firm *i* in year *t*. This data can be retrieved at the I/B/E/S database at the number of analysts who report a one-year earnings forecast for a specific firm, which is usually in July (Chung & Jo, 1996). Schiemann & Sakhel (2018) measure physical risk reporting using a binary variable. The binary variable is 'one' when a firm reports at least one physical risk, together with information about the probability that it occurs, the size of the impact and what the expected time period is. If a firm reports nothing, the binary variable is 'zero'. In this research, a two step analysis will be conducted using a binary variable like in Schiemann & Sakhel (2018). The first step is to see whether a firm has responded to the CDP questionnaire, and thus, discloses its carbon risks. A firm will get a binary variable value of 'one' if it has responded and 'zero' if it is has not responded. The second step is to look at the sort of risk the firm discloses. This can be physical and/or regulatory and/or miscellaneous risk. Again, a firm will get a binary variable value of 'one' for each risk it discloses and 'zero' for the risks it does not disclose.

3.2.3 Control variables

To make sure the measured relationships are not influenced by other factors, control variables are added to the regressions. The first control variable that is used for market value is profitability. According to previous research, profitability is positively related to a firm's market value (e.g. Cho & Pucik, 2005). The proxy that will be used for profitability is the return on assets (Joo & Hussanie, 2017). Secondly, also a positive relationship between leverage and market value is found (e.g. Rajan & Zingales, 1994). The proxy used for leverage is the logarithm of the total assets divided by the total liabilities at the end of year t-1 (Lee & Lee, 2019). Also firm size and growth are commonly used control variables in corporation finance (Lee & Lee, 2019). The proxy used for firm size is the logarithm of the book value of total assets of firm *i* in year *t* (Chung & Jo, 1996). The proxy used for growth is the average sales growth over the past four years of firm *i* in year *t*. (Lehavy et al., 2011). In addition, Chauvin & Hirschey (1993) find that Research and Development (R&D) has a positive effect on the market value of a firm. The proxy used for this control variable is the R&D expenditures firm *i* has in year *t*. However, when using this control variable, the sample was reduced by 50%. Therefore, the control variable will be used in the robustness tests section.

The control variables used for information asymmetry are based on previous research as well (e.g. Cho et al., 2013; Muller et al., 2011; Schiemann & Sakhel, 2018). Again, firm size and profitability will be proxied by the book value of the total assets and return on assets of a firm, respectively. In addition, the yearly average share price of each firm and the price volatility will be added. Price volatility is measured by dividing the standard deviation of the daily stock prices by the average daily share prices during each year (Schiemann & Sakhel, 2018). Furthermore, free float, which can be measured by the percentage of firm shares that can be freely exchanged on the stock exchange, will be used to proxy the level of institutional investors. Lastly, the country bid-ask spread will be added to the regression, which is measured by the average bid-ask spreads of all firms in a specific country of each year (Schiemann & Sakhel, 2018).

Furthermore, for both relationships, country-, industry-, and year controls are added to the models in order to prevent biased results from these factors.

Table 3.3 Variable definitions

Variable	Defintion
Dependent variables	
Market value	Number of ordinary shares multiplied by the share price. In addition, Tobin's q will be used in the robustness tests, which is measured as follows: (equity market value + liabilities market value) / (equity book value + liabilities book value).
Information asymmetry	The average of the daily bid-ask spreads of firm *i* in year *t*. The daily bid-ask spread is calculated by dividing the closing ask prices minus the closing bid price by the average of the closing bid and ask price.
Independent variables	
Analyst following	The number of analysts following firm *i* in year *t*.
Carbon risk disclosure	The binary variable will be 'one' if a firm discloses its carbon risks and 'zero' if it does not disclose its carbon risks. Subsequently, a firm will get a binary variable value of 'one' for every of the three risks (physical, regulatory and market risk) it discloses and 'zero' for every of the three risks it does not disclose.
Control variables	
Profitability	The return on assets (roa) of firm *i* in year *t*.
Leverage	The logarithm of the total assets divided by the total liabilities at the end of year t.
Firm size	The logarithm of the book value of the total assets of firm *i* in year *t*.
Growth	The average sales growth over the past four years of firm *i* in year *t*.
Research & Development	The R&D expenditures of firm *i* in year *t*.
Share price	The average share price of firm *i* in year *t*.
Price volatility	Dividing the standard deviation of the daily stock prices by the average daily share prices during each year of firm *i* in year *t*.
Free float	The percentage of firm shares that can be freely exchanged on the stock exchange of firm *i* in year *t*.
Country bid-ask spread	The average bid-ask spreads of al firms in a specific country of each year.
Country controls	To prevent that the firm's country will bias the results, country controls are added by using a dummy variable (i.country).
Industry controls	To prevent that the firm's industry will bias the results, industry controls are added by using a dummy variable (i.industry).
Year controls	To prevent that a certain year of the sample period will bias the results, year controls for the period 2011-2017 are added by using a dummy variable (i.year).

3.3. Models

To test whether analyst following has an effect on information asymmetry, the following model is constructed.

1. $Information\ Asymmetry_{i,t} = \beta_0 + \beta_1 Analyst\ Following_{i,t} + \beta_2 Firm\ Size_{i,t} + \beta_3 Profitability_{i,t} + \beta_4 Share\ Price_{i,t} + \beta_5 Price\ Volatility_{i,t} + \beta_6 Free\ Float_{i,t} + \beta_7 Country\ Bid\text{-}Ask\ Spread_{i,t} + Country\ Controls + Industry\ Controls + Year\ Controls + \varepsilon_{i,t}$

The second model below tests whether analyst following has an effect on the market value of firms.

2. $Market\ Value_{i,t} = \beta_0 + \beta_1 Analyst\ Following_{i,t} + \beta_2 Profitability_{i,t} + \beta_3 Leverage_{i,t} + \beta_4 Firm\ Size_{i,t} + \beta_5 Growth_{i,t} + Country\ Controls + Industry\ Controls + Year\ Controls + \varepsilon_{i,t}$

To measure if carbon risk disclosure has a moderating effect on the relationship between analyst following and information asymmetry, model 3 is constructed.

3. $Information\ asymmetry = \beta_0 + \beta_1 Analyst\ Following_{i,t} + \beta_2 Carbon\ Risk\ Disclosure_{i,t} + \beta_3 Analyst\ Following{*}Carbon\ Risk\ Disclosure_{i,t} + \beta_4 Firm\ Size_{i,t} + \beta_5 Profitability_{i,t} + \beta_6 Share\ Price_{i,t} + \beta_7\ Price\ Volatility_{i,t} + \beta_8 Free\ Float_{i,t} + \beta_9 Country\ Bid\text{-}Ask\ Spread_{i,t} + Country\ Controls + Industry\ Controls + Year\ Controls + \varepsilon_{i,t}$

Lastly, to test whether carbon risk disclosure has a moderating effect on the relationship between analyst following and market value, model 4 is constructed.

4. $Market\ Value = \beta_0 + \beta_1 Analyst\ Following_{i,t} + \beta_2 Carbon\ Risk\ Disclosure_{i,t} + \beta_3 Analyst\ Following{*}Carbon\ Risk\ Disclosure_{i,t} + \beta_4 Profitability_{i,t} + \beta_5 Leverage_{i,t} + \beta_6 Firm\ Size_{i,t} + \beta_7 Growth_{i,t} + Country\ Controls + Industry\ Controls + Year\ Controls + \varepsilon_{i,t}$

4. Results

4.1 Descriptive statistics

Table 4.1 gives an overview of the descriptive statistics of the dependent-, independent-, and control variables. The sample consists of two dependent variables, five independent variables and ten control variables. The number of observations lies between 22.419 and 26.005, depending on the variable. To be noted, Research and Development (R&D) expenditures only has 10.248 observations. However, this variable will be used for the robustness tests, which will be elaborated upon later in this chapter. As can be seen in the table, the average number of analysts following a firm is 10,89. In addition, the minimum number of analyst following a firm is zero and the maximum 58. On average, 16,69% of the firms in the sample discloses its carbon risks. When looking at the different forms of carbon risk disclosure, 15,79%, 14,85%, and 13,44% of the firms disclose their regulatory-, physical-, and miscellaneous carbon risks, respectively. Furthermore, the mean return on assets of the total sample is 2,7% and the mean leverage ratio is 58,97%. In addition, the descriptive statistics show that the average number of shares that can be freely exchanged on the market is 67%. This implicates that, on average, 33% of the shares of firms is owned by institutional investors.

Table 4.1 Descriptive statistics

Variable	Obs.	Mean	Std. Deviation	Min.	Max.
Dependent variables					
Market Value	22.417	11.900*	56.900*	270.000	2.500.000*
Information asymmetry	22.860	0,0025	0,0254	-0,6954	1
Independent variables					
Analysts	24.780	10,89245	9,294545	0	58
Carbon Risk Disclosure (CRD)	26.005	0,1669294	0,37292	0	1
CRD Regulatory	26.005	0,1578543	0,3646113	0	1
CRD Physical	26.005	0,1485484	0,3556496	0	1
CRD Miscellaneous	26.005	0,1343972	0,3410852	0	1

Variable	Obs.	Mean	Std. Deviation	Min.	Max.
Control variables					
Profitability (ROA)	23.917	0,0262262	0,1950817	-3,5149	2,6911
Leverage	24.860	0,5897314	0,3059273	-0,7514772	3,914328
Firm Size	24.945	33*	251*	0	13.200*
Growth	23.183	-0,0079154	1,494905	-18,29469	17,94996
Share price	22.571	111,6897	308,8381	0,0160869	4952,406
Free Float	26.005	0,6700165	0,3202304	0	1
Country Bid-Ask Spread	26.005	0,0026185	0,0016575	-0,0156124	0,0412399
Share price volatility	22.731	0,1199996	0,0908965	0	2,405978
R&D	10.248	372.250,6	1.761.509	0	43.700.000
Tobin's q	22.917	2,024899	1,793653	-4,75386	40,46644

* *Numbers in millions*

The correlation matrix of the dependent, independent and control variables can be found in table 4.2. In general, a correlation higher than 0,70 among variables is considered as strong (Moore & Kirkland, 2012). As can be seen in the table, the carbon risk (interaction) variables have a correlation higher than 0,70. To prevent that this high correlation will affect the results, the four sorts of carbon risks and the related interaction variables, will be analysed in separate models. This means there is a model with carbon risk disclosure in general, a model with regulatory carbon risk disclosure, a model with physical carbon risk disclosure, and a model with miscellaneous carbon risk disclosure.

Table 4.2 Correlation matrix

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
(1) Market value	1																					
(2) Analysts	0,4144	1																				
(3) Profitability	0,0833	0,0885	1																			
(4) Leverage	0,0369	0,0830	-0,0794	1																		
(5) Firm size	0,4711	0,5779	0,1151	0,3473	1																	
(6) Growth	0,0068	0,0048	-0,0080	-0,0249	0,0061	1																
(7) CRD	0,2776	0,4074	0,0508	0,0950	0,4130	0,0035	1															
(8) CRD Regulatory	0,2776	0,4074	0,0508	0,0950	0,4130	0,0035	1	1														
(9) CRD Physical	0,2776	0,4074	0,0508	0,0950	0,4130	0,0035	1	1	1													
(10) CRD Misc.	0,2776	0,4074	0,0508	0,0950	0,4130	0,0035	1	1	1	1												
(11) Analysts x CRD	0,3807	0,5581	0,0460	0,0968	0,4693	-0,0004	0,8961	0,8961	0,8961	0,8961	1											
(12) Analysts x CRDREGU	0,3701	0,5366	0,0460	0,0870	0,4484	-0,0037	0,8660	0,8660	0,8660	0,8660	0,9636	1										
(13) Analysts x CRDPHYS	0,3611	0,5285	0,0420	0,0940	0,4511	-0,0018	0,8365	0,8365	0,8365	0,8365	0,9412	0,9079	1									
(14) Analysts x CRDMISC	0,3658	0,5078	0,0410	0,0867	0,4294	-0,0025	0,7906	0,7906	0,7906	0,7906	0,8980	0,8919	0,9007	1								
(15) Share price	0,0571	0,1091	0,0973	-0,0138	0,0538	0,0073	0,1980	0,1980	0,1980	0,1980	0,1583	0,1600	0,1558	0,1555	1							
(16) Free float	0,0734	0,1408	0,0253	0,0549	0,0987	-0,0027	0,0792	0,0792	0,0792	0,0792	0,0977	0,0913	0,0921	0,0849	0,0476	1						
(17) Information asymmetry	-0,0211	-0,0694	-0,0928	-0,0069	-0,0830	-0,0020	-0,0292	-0,0292	-0,0292	-0,0292	-0,0302	-0,0288	-0,0296	-0,0273	-0,0171	-0,0416	1					
(18) Country Bid-Ask	-0,0458	0,0073	0,0245	-0,0210	-0,0628	-0,0108	-0,0498	-0,0498	-0,0498	-0,0498	-0,0312	-0,0330	-0,0398	-0,0332	-0,0653	0,0129	0,0725	1				
(19) Volatility	-0,1294	-0,1027	-0,2560	-0,0141	-0,2542	-0,0452	-0,1316	-0,1316	-0,1316	-0,1316	-0,1233	-0,1174	-0,1188	-0,1144	-0,0780	-0,1058	0,0576	0,0191	1			
(20) Year	0,0360	-0,0416	-0,0484	0,0359	0,0368	0,0071	0,0055	0,0055	0,0055	0,0055	-0,0186	-0,0130	-0,0018	-0,0006	0,0475	0,0123	-0,0413	-0,5593	-0,0304	1		
(21) Industry	0,0294	-0,0174	-0,0554	-0,0414	-0,0531	-0,0122	0,0115	0,0115	0,0115	0,0155	0,0122	0,0121	0,0066	0,0067	-0,0533	0,0392	-0,0019	-0,0113	-0,0481	0,0021	1	
(22) Country	-0,0287	-0,1714	-0,0670	0,0252	-0,1279	-0,0080	-0,2903	-0,2903	-0,2903	-0,2903	-0,2560	-0,2540	-0,2358	-0,2378	-0,2873	0,2140	-0,0203	0,0807	0,0552	0,0183	0,0187	1

4.2 Regression results

As described in the introduction, four relationships will be analysed. First, the relationship between analyst following and information asymmetry, and between analyst following and market value. Secondly, carbon risk disclosure[3] will be added as an interaction variable in both relationships, to see whether it has an effect on the strength and/or direction of the relationships. In this chapter, the results of each relationship will be presented and further elaborated upon.

4.2.1 Information asymmetry and analyst following

As described in chapter 2.1.1, the expectation is that analyst following is negatively associated with information asymmetry. When looking at the results in table 4.3, a negative significant effect is found (z = -2,05, p = < 0,05). This means there is support for the first hypothesis. Of the control variables, firm size, profitability and free float have a negative significant effect on information asymmetry (z = -6,19, p = < 0,01, z = -7,30, p = < 0,01, z = -3,32, p = < 0,01, respectively). As expected, the average information asymmetry per country (country bid-ask spread) and share price volatility both have a positive significant effect on information asymmetry (z = 6,10, p = < 0,01 and z = 4,61, p = < 0,01, respectively). In contrast to Schiemann & Sakhel (2018), no negative significant effect of share price on information asymmetry could be found. However, when looking at European firms only, indeed a negative significant relationship can be found. This will be further discussed in the robustness tests section in paragraph 4.3.

Table 4.3 Information asymmetry and analyst following

Variables	
Analyst following	-0,0537** (-2,07)
Firm size	-0,8586*** (-6,19)
Profitability	-6,7276*** (-7,30)
Share price	0,00005 (0,11)

[3] This includes carbon risk disclosure in general, regulatory carbon risk disclosure, physical carbon risk disclosure and miscellaneous carbon risk disclosure.

Free float	-2,2998** (-3,32)
Country bid-ask	594,58*** (6,10)
Share price volatility	7,4107*** (4,61)
Year controls	*Yes*
Country controls	*Yes*
Industry controls	*Yes*
R-squared	0,0548
Obs.	21.491

*Notes: The numbers displayed are the coefficients. The z-values can be found in the brackets. *, ** and *** symbolise the significance levels of 0,10, 0,05 and < 0,01, respectively. For variable definitions, see table 3.3.*

As described in chapter 2.2.4, the expectation is that carbon risk disclosure positively moderates the relationship between analyst following and information asymmetry. As can be seen in the results in table 4.4, carbon risk disclosure in general has a negative but insignificant effect on information asymmetry. However, the interaction variable between analysts and carbon risk disclosure is positive and significant (z = 2,58, p = < 0,05). This indicates that the negative relationship between analyst following and information asymmetry is less strong when a firm discloses its carbon risks. As a result, support is found for the third hypothesis. Looking at the three different forms of carbon risk disclosure separately, the interaction variables between analyst following and regulatory-, physical- and miscellaneous carbon risk disclosure are positive and significant (z = 2,49, p = < 0,05, z = 2,27, p = < 0,05 and z = 2,11, p = < 0,05, respectively). This indicates that each of the three risks, independently, weakens the negative relationship between analyst following and information asymmetry. There is a small difference in the strength of the effects. Regulatory carbon risk disclosure has the largest effect (0,1120) and miscellaneous carbon risk disclosure the weakest (0,0996). A potential reason why the relationship between analyst following and information asymmetry becomes less strong when a firm discloses its carbon risks, is that more information about the firm becomes available to the public. As a result, investors are less dependent on analysts, who were one of the few groups who could have information about firms' carbon risks. Hence, the effect of analysts on information asymmetry decreases.

Table 4.4 Information asymmetry and analyst following, with carbon risk disclosure

	CRD	CRD Regulatory	CRD Physical	CRD Misc.
Analyst following	-0,0848** (-3,04)	-0,0819** (-2,96)	-0,0796*** (-2,89)	-0,0765*** (-2,80)
Firm size	-0,9085*** (-6,47)	-0,9052*** (-6,46)	-0,9017*** (-6,43)	-0,8990*** (-6,44)
Profitability	-6,6388*** (-7,20)	-6,6466*** (-7,21)	-6,6448*** (-7,21)	-6,6450*** (-7,21)
Share price	0,000006 (0,13)	0,000006 (0,12)	0,000006 (0,12)	0,000006 (0,12)
Free float	-2,3417** (-3,38)	-2,3401** (-3,38)	-2,3335*** (-3,37)	-2,3358*** (-3,37)
Country bid-ask	597,6386*** (6,13)	598,0749*** (6,14)	595,4278*** (6,11)	593,4989*** (6,09)
Share price volatility	7,4659*** (4,64)	7,4589*** (4,63	7,4666*** (4,64)	7,4555*** (4,63)
CRD	-1,1309 (-1,25)			
CRD Regulatory		-1,0992 (-1,19)		
CRD Physical			-0,9842 (-1,03)	
CRD Misc.				-0,9142 (-0,93)
Analysts x CRD	0,1145** (2,58)			
Analysts x CRDREGU		0,1120** (2,49)		
Analysts x CRDPHYS			0,1039** (2,27)	
Analysts x CRDMISC				0,0996** (2,11)
Year controls	*Yes*	*Yes*	*Yes*	*Yes*
Country controls	*Yes*	*Yes*	*Yes*	*Yes*
Industry controls	*Yes*	*Yes*	*Yes*	*Yes*
R-squared	0,0565	0,0563	0,0563	0,0561
Obs.	21.491	21.491	21.491	21.491

*Notes: The numbers displayed are the coefficients. The z-values can be found in the brackets. *, ** and *** symbolise the significance levels of 0,10, 0,05 and < 0,01, respectively. For variable definitions, see table 3.3.*

4.2.2 Market value and analyst following

The expectation is, as described in chapter 2.1.1, that analyst following is positively associated with the market value of firms. When looking at the results in table 4.5, a positive significant relationship exists between the number of analysts following a firm and the market value of a firm (z = 4,32, p = < 0,01). As a result, the second hypothesis is supported. Of the control variables, profitability and firm size have a positive significant effect on market value as well (z = 3,59, p = < 0,01 and z = 21,50, p = < 0,01, respectively). This is in accordance with the consulted literature. However, unlike Rajan & Zingales (1994) and Lee & Lee (2019), no significant effect of leverage on market value could be found. In contrast to Lee & Lee (2019), a significant relationship between firm growth and market value is not found either.

Table 4.5 Market value and analyst following

Variables	
Analyst following	0,1812*** (4,32)
Profitability	4,5853*** (3,59)
Leverage	-1,2778 (-1,33)
Firm size	6,0994*** (21,50)
Growth	-0,0173 (-0,17)
Year controls	*Yes*
Country controls	*Yes*
Industry controls	*Yes*
R-squared	0,6653
Obs.	20.764

*Notes: The numbers displayed are the coefficients. The z-values can be found in the brackets. *, ** and *** symbolise the significance levels of 0,10, 0,05 and < 0,01, respectively. For variable definitions, see table 3.3.*

As described in chapter 2.2.4, the expectation is that carbon risk disclosure will positively moderate the relationship between analyst following and the market value of firms. The results in table 4.6 indicate that carbon risk disclosure, in general, has a negative significant effect on the market value of firms ($z = -4,96$, $p = < 0,01$). When looking at the interaction variables, the results show that the effect is positive and significant ($z = 8,22$, $p = < 0,01$). This indicates that carbon risk disclosure further strengthens the relationship between analyst following and the market value of firms. In practical terms, when a firm starts disclosing its carbon risks, the positive effect of analyst following on the market value of that firm, will be higher. In this way, support is found for the fourth hypothesis. Regarding the three different forms of carbon risk disclosure, regulatory, physical and miscellaneous, the interaction variable with analysts is positive and significant for all three risks ($z = 8,99$, $p = < 0,01$, $z = 7,48$, $p = < 0,01$ and $z = 7,97$, $p = < 0,01$, respectively). This indicates that each of the three risks, independently, strengthens the positive relationship between analyst following and market value. There is a small difference in the strength of the effects. Regulatory carbon risk disclosure has the strongest effect (0,5145) and physical carbon risk disclosure the weakest (0,4273).

Table 4.6 Market value and analyst following, with carbon risk disclosure

Variables	CRD	CRD Regulatory	CRD Physical	CRD Misc.
Analyst following	0,0672 (1,52)	0,0612 (1,40)	0,0875** (2,00)	0,0874** (2,01)
Profitability	4,5286*** (3,55)	4,5203*** (3,54)	4,5446*** (3,56)	4,5757*** (3,59)
Leverage	-1,5852 (-1,65)	-1,6001* (-1,66)	-1,5533 (-1,61)	-1,5886* (-1,65)
Firm size	6,0994* (21,50)	6,0785*** (21,51)	6,1138*** (21,63)	6,0967*** (21,61)
Growth	-0,018 (-0,18)	-0,0157 (-0,15)	-0,0118 (-0,11)	-0,0137 (-0,13)
CRD	-5,6080*** (-4,96)			
CRD Regulatory		-6,0924*** (-5,34)		
CRD Physical			-5,3799*** (-4,61)	
CRD Misc.				-5,6293*** (-4,69)
Analysts x CRD	0,4635*** (8,22)			
Analysts x CRDREGU		0,5145*** (8,99)		
Analysts x CRDPHYS			0,4273*** (7,48)	
Analysts x CRDMISC				0,4703*** (7,97)
Year controls	*Yes*	*Yes*	*Yes*	*Yes*
Country controls	*Yes*	*Yes*	*Yes*	*Yes*
Industry controls	*Yes*	*Yes*	*Yes*	*Yes*
R-squared	0,6723	0,6726	0,6712	0,6723
Obs.	20.764	20.764	20.764	20.764

*Notes: The numbers displayed are the coefficients. The z-values can be found in the brackets. *, ** and *** symbolise the significance levels of 0,10, 0,05 and < 0,01, respectively. For variable definitions, see table 3.3.*

4.3 Robustness tests

In this research, four robustness tests will be conducted. First of all, Tobin's q will be used as an alternative for the market value of a firm (e.g. Chung & Jo, 1996; Nekhili et al., 2017; Ararat et al., 2017). Tobin's q can be calculated by dividing the market value of the equity and liabilities, by the book value of equity and liabilities (Finabase, 2019). As can be seen in table 4.7, analyst following has a positive significant effect on Tobin's q (z = 16,67, p = < 0,01). This is in accordance with the relationship between analyst following and market value. When looking at the control variables, leverage is significant (z = 10,37, p = < 0,01), in contrast to the model which has market value as dependent variable. However, firm size has obtained a negative significant effect (z = -35,69, p = < 0,01).

Table 4.7: Tobin's q and analyst following

Analyst following	0,0338*** (16,67)
Profitability	1,0665*** (16,14)
Leverage	0,5049*** (10,37)
Firm size	-0,4712*** (-35,69)
Growth	0,0123** (2,31)
Year controls	*Yes*
Country controls	*Yes*
Industry controls	*Yes*
R-squared	0,3062
Obs.	21.196

*Notes: The numbers displayed are the coefficients. The z-values can be found in the brackets. *, ** and *** symbolise the significance levels of 0,10, 0,05 and < 0,01, respectively. For variable definitions, see table 3.3.*

In table 4.8 the results for the relationship between analyst following and Tobin's q, with carbon risk disclosure, can be found. In accordance with the relationship between analyst following and market value, carbon risk disclosure in general has a positive significant effect on Tobin's q. In addition, however, no significant effects are found for the interaction variables. This implicates that carbon risk disclosure has no effect on the strength and/or direction of the relationship between analyst following and Tobin's q.

Table 4.8 Tobin's q and analyst following, with carbon risk disclosure

Variables	CRD	CRD Regulatory	CRD Physical	CRD Misc.
Analyst following	0,0347*** (16,22)	0,0344*** (16,40)	0,0342*** (16,42)	0,0336*** (16,26)
Profitability	1,0669*** (16,16)	1,0667*** (16,16)	1,0664*** (16,16)	1,0662*** (16,15)
Leverage	0,5054*** (10,37)	0,5050*** (10,37)	0,5047*** (10,36)	0,5038*** (10,34)
Firm size	-0,4744*** (-35,67)	-0,4741*** (-35,65)	-0,4741*** (-35,65)	-0,4740*** (-35,64)
Growth	0,0125** (2,33)	0,0124** (2,32)	0,0124** (2,32)	0,0124** (2,33)
CRD	0,1298** (2,22)			
CRD Regulatory		0,1078** (2,23)		
CRD Physical			0,0884** (2,08)	
CRD Misc.				0,0477 (1,28)
Analysts x CRD	-0,0045 (-1,56)			
Analysts x CRDREGU		-0,0036 (-1,48)		
Analysts x CRDPHYS			-0,0025 (-1,21)	
Analysts x CRDMISC				0,0002 (0,13)
Year controls	*Yes*	*Yes*	*Yes*	*Yes*
Country controls	*Yes*	*Yes*	*Yes*	*Yes*
Industry controls	*Yes*	*Yes*	*Yes*	*Yes*
R-squared	0,3071	0,3069	0,3069	0,3073
Obs.	21.196	21.196	21.196	21.196

*Notes: The numbers displayed are the coefficients. The z-values can be found in the brackets. *, ** and *** symbolise the significance levels of 0,10, 0,05 and < 0,01, respectively. For variable definitions, see table 3.3.*

Secondly, R&D will be used as an additional control variable in the relationship between analyst following and market value (e.g. Chauvin & Hirschey, 1993). Information about a firm's Research and Development, which is measured as the R&D expenditures of firm *i* in year *t*, is not widely available. If this variable would be added in the original models, the number of observations would drop to 8.629 (compared to 20.764 without the variable). When including R&D as control variable, analyst following still has a positive significant effect on the market value of a firm (z = 1,98, p = < 0,05). Of the control variables, R&D has a very small but positive significant effect on the market value of firms (z = 47,66, p = < 0,01). Leverage and firm size obtain a negative significant effect on market value (z = -1,73, p = 0,10 and z = -0,46, p = < 0,01). The interaction variable between carbon risk disclosure and analysts remains positive and significant (z = 5,00, p = < 0,01). This is also the case for the three sorts of carbon risk disclosure, regulatory, physical and miscellaneous, separately (z = 6,15, p = < 0,01, z = 4,22, p = < 0,01, z = 5,07, p = < 0,01, respectively).

Table 4.9: Market value and analyst following including R&D

Analyst following	0,0104*** (1,98)
Profitability	0,3500*** (2,61)
Leverage	-0,2000* (-1,73)
Firm size	-0,4650*** (-0,46)
Growth	-0,0060 (13,08)
R&D	0,000015*** (47,66)
Year controls	*Yes*
Country controls	*Yes*
Industry controls	*Yes*
R-squared	0,6301
Obs.	8.629

*Notes: The numbers displayed are the coefficients. The z-values can be found in the brackets. *, ** and *** symbolise the significance levels of 0,10, 0,05 and < 0,01, respectively. For variable definitions, see table 3.3.*

Table 4.10 Market value and analyst following including R&D, with carbon risk disclosure

Variables	CRD	CRD Regulatory	CRD Physical	CRD Misc.
Analyst following	0,0147 (0,26)	0,0007 (0,01)	0,0370 (0,67)	0,0311 (0,57)
Profitability	3,5017*** (2,60)	3,5034*** (2,61)	3,4856** (2,59)	3,5346*** (2,63)
Leverage	-2,1570* (-1,87)	-2,1723* (-1,89)	-2,1203* (-1,84)	-2,1437* (-1,86)
Firm size	4,7096*** (13,23)	4,6879*** (13,18)	4,7241*** (13,27)	4,7186*** (13,31)
Growth	-0,0623 (-0,48)	-0,0590 (-0,46)	-0,0579 (-0,45)	-0,0539 (-0,42)
R&D	0,00001*** (47,20)	0,00001*** (47,03)	0,00001*** (47,26)	0,00001*** (47,12)
CRD	-4,8469*** (-3,31)			
CRD Regulatory		-5,7783*** (-3,94)		
CRD Physical			-4,3403*** (-2,89)	
CRD Misc.				-4,8621*** (-3,13)
Analysts x CRD	0,3622*** (5,00)			
Analysts x CRDREGU		0,4460*** (6,15)		
Analysts x CRDPHYS			0,3022*** (4,22)	
Analysts x CRDMISC				0,3711*** (5,07)
Year controls	*Yes*	*Yes*	*Yes*	*Yes*
Country controls	*Yes*	*Yes*	*Yes*	*Yes*
Industry controls	*Yes*	*Yes*	*Yes*	*Yes*
R-squared	0,6362	0,6377	0,6346	0,6372
Obs.	8.629	8.629	8.629	8.629

*Notes: The numbers displayed are the coefficients. The z-values can be found in the brackets. *, ** and *** symbolise the significance levels of 0,10, 0,05 and < 0,01, respectively. For variable definitions, see table 3.3.*

Thirdly, 66,89% of the firms in the sample are US firms. To ensure that the main effects are not caused by US firms only, US firms are left out of the sample. For the relationship between analyst following and information asymmetry, the total number of observations is 6.928 (compared to 21.491 with US firms). For the relationship between analyst following and market value, the total number of observations is 6.751 (compared to 20.764 with US firms). As can be seen in table 4.11 and 4.12, analyst following keeps having a negative significant effect on information asymmetry and a positive significant effect on market value (z = -5,04, p = < 0,01 and z = 2,41, p = < 0,05, respectively). When looking at the control variables for information asymmetry, profitability has become insignificant when examining European firms only. Share price, in accordance with Schiemann & Sakhel (2018), has become negative and significant. The other control variables have remained the same, with the exception of some small differences in the coefficients. Of the control variables for market value, profitability and firm size remain positive and significant, while leverage and growth remain negative and insignificant.

Table 4.11 Information asymmetry and analyst following, without US

Variables	Information asymmetry
Analyst following	-0,0723*** (-5,04)
Profitability	-0,8293 (-1,40)
Firm size	-0,6061*** (-7,96)
Share price	-0,0001** (-3,34)
Free float	-1,4883*** (-4,25)
Country bid-ask	580,8619*** (21,20)
Share price volatility	6,7776*** (9,69)
Year controls	*Yes*
Country controls	*Yes*
Industry controls	*Yes*
R-squared	0,2810
Obs.	6.928

*Notes: The numbers displayed are the coefficients. The z-values can be found in the brackets. *, ** and *** symbolise the significance levels of 0,10, 0,05 and < 0,01, respectively. For variable definitions, see table 3.3.*

Table 4.12 Market value and analyst following, without US

Variables	Market value
Analyst following	0,2693** (2,41)
Profitability	13,1197** (3,27)
Leverage	-4,7533 (-1,44)
Firm size	6,7418*** (8,70)
Growth	-0,000005 (0,00)
Year controls	*Yes*
Country controls	*Yes*
Industry controls	*Yes*
R-squared	0,7497
Obs.	6.751

*Notes: The numbers displayed are the coefficients. The z-values can be found in the brackets. *, ** and *** symbolise the significance levels of 0,10, 0,05 and < 0,01, respectively. For variable definitions, see table 3.3.*

When looking at the relationship between analyst following and information asymmetry in table 4.13, the interaction variable between analysts and carbon risk disclosure remains positive and significant for the European firms (z = 4,01, p = < 0,01). This is also the case for regulatory-, physical-, and miscellaneous carbon risk disclosure (z = 3,75, p = < 0,01, z = 3,41, p = < 0,01 and z = 3,21, p = < 0,01, respectively). Without the US firms, the interaction variable between carbon risk disclosure and analyst following remains positive and significant in table 4.14 (z = 2,64, p = < 0,01). So also for European firms only, the results indicate that carbon risk disclosure strengthens the positive relationship between analyst following and market value. This is also the case for the three sorts of carbon risk disclosure, regulatory, physical and miscellaneous (z = 3,14, p = < 0,01, z = 2,00, p = < 0,05 and z = 2,71, p = < 0,01, respectively).

Table 4.13 Information asymmetry and analyst following with carbon risk disclosure, without US

	CRD	CRD Regulatory	CRD Physical	CRD Misc.
Analyst following	-0,1005*** (-6,26)	-0,0981*** (-6,18)	-0,0936*** (-5,96)	-0,0925*** (-5,94)
Firm size	-0,6048*** (-7,88)	-0,6111*** (-7,97)	-0,6021*** (-7,87)	-0,6135*** (-8,00)
Profitability	-0,8759 (-1,48)	-0,8736 (-1,48)	-0,8705 (-1,47)	-0,8511 (-1,44)
Share price	-0,0001*** (-3,24)	-0,0001*** (-3,24)	-0,0001*** (-3,25)	-0,0001*** (-3,25)
Free float	-1,4383*** (-4,12)	-1,4502*** (-4,16)	-1,4517*** (-4,16)	-1,4690*** (-4,21)
Country bid-ask	582,7779*** (21,24)	582,4988*** (21,22)	581,3101*** (21,18)	580,9848*** (21,17)
Share price volatility	6,7360*** (9,63)	6,7470*** (9,65)	6,7647*** (9,67)	6,7509*** (9,65)
CRD	-1,3182*** (-3,84)			
CRD Regulatory		-1,1506*** (-3,33)		
CRD Physical			-1,1411*** (-3,23)	
CRD Misc.				-0,9736*** (-2,69)
Analysts x CRD	0,0757*** (4,01)			
Analysts x CRDREGU		0,0705*** (3,75)		
Analysts x CRDPHYS			0,0638*** (3,41)	
Analysts x CRDMISC				0,0611*** (3,21)
Year controls	*Yes*	*Yes*	*Yes*	*Yes*
Country controls	*Yes*	*Yes*	*Yes*	*Yes*
Industry controls	*Yes*	*Yes*	*Yes*	*Yes*
R-squared	0,2982	0,2970	0,2950	0,2938
Obs.	6.928	6.928	6.928	6.928

*Notes: The numbers displayed are the coefficients. The z-values can be found in the brackets. *, ** and *** symbolise the significance levels of 0,10, 0,05 and < 0,01, respectively. For variable definitions, see table 3.3.*

Table 4.14 Market value and analyst following with carbon risk disclosure, without US

Variables	CRD	CRD Regulatory	CRD Physical	CRD Misc.
Analyst following	0,1375 (1,11)	0,1168 (0,95)	0,1866 (1,54)	0,1507 (1,25)
Profitability	12,9774*** (3,23)	12,9644*** (3,23)	12,9478*** (3,23)	13,0531*** (3,25)
Leverage	-4,9997 (-1,52)	-4,9943 (-1,52)	-4,9439 (-1,50)	-5,1254 (-1,56)
Firm size	6,7857*** (8,73)	6,7317*** (8,65)	6,8381*** (8,80)	6,7364*** (21,61)
Growth	-0,0105 (-0,04)	-0,0094 (-0,03)	-4,7978** (-0,01)	-0,0012 (-0,00)
CRD	-5,4224** (-2,34)			
CRD Regulatory		-5,8494** (-2,52)		
CRD Physical			-4,7978** (-2,06)	
CRD Misc.				-4,9992** (-2,09)
Analysts x CRD	0,3418*** (2,64)			
Analysts x CRDREGU		0,4032*** (3,14)		
Analysts x CRDPHYS			0,2489** (2,00)	
Analysts x CRDMISC				0,3455*** (2,71)
Year controls	*Yes*	*Yes*	*Yes*	*Yes*
Country controls	*Yes*	*Yes*	*Yes*	*Yes*
Industry controls	*Yes*	*Yes*	*Yes*	*Yes*
R-squared	0,7518	0,7519	0,7510	0,7515
Obs.	6.751	6.751	6.751	6.751

*Notes: The numbers displayed are the coefficients. The z-values can be found in the brackets. *, ** and *** symbolise the significance levels of 0,10, 0,05 and < 0,01, respectively. For variable definitions, see table 3.3.*

Lastly, the major part of the sample (24,79%) consists of firms which are active in the financial industry. This could have an effect on the external validity of the results. Therefore, the regressions are replicated using a sample without firms from the financial industry. For the relationship between analyst following and information asymmetry, the number of observations is 16.449 (compared to 21.419 without the variable). For the relationship between analyst following and market value, the number of observations is 15.907 (compared to 20.764 without the variable). As the results in table 4.15 and 4.16 show, analyst following obtains a negative but insignificant[4] effect on information asymmetry. The control variables, however, maintain their direction and significance, except for some small difference in the coefficients. Analyst following maintains its positive significant effect on market value (z = 2,89, p = < 0,01). Also the control variables for market value hold their significance and direction when leaving out financial firms.

Table 4.15 Information asymmetry and analyst following, without financials

Variables	Information asymmetry
Analyst following	-0,0465
	(-1,53)
Profitability	-6,0603***
	(-6,21)
Firm size	-1,0147***
	(-5,86)
Share price	-0,00005
	(-0,32)
Free float	-2,1997***
	(-2,73)
Country bid-ask	574,5261***
	(5,19)
Share price volatility	7,9119***
	(4,50)
Year controls	*Yes*
Country controls	*Yes*
Industry controls	*Yes*
R-squared	0,0578
Obs.	16.499

*Notes: The numbers displayed are the coefficients. The z-values can be found in the brackets. *, ** and *** symbolise the significance levels of 0,10, 0,05 and < 0,01, respectively. For variable definitions, see table 3.3.*

[4] Insignificant with a p-value of 0,126.

Table 4.16 Market value and analyst following, without financials

Variables	Market value
Analyst following	0,1237*** (2,89)
Profitability	4,0838*** (3,44)
Leverage	-0,7782 (-0,82)
Firm size	6,5316*** (20,64)
Growth	-0,0512 (-0,48)
Year controls	*Yes*
Country controls	*Yes*
Industry controls	*Yes*
R-squared	0,5895
Obs.	15.907

*Notes: The numbers displayed are the coefficients. The z-values can be found in the brackets. *, ** and *** symbolise the significance levels of 0,10, 0,05 and < 0,01, respectively. For variable definitions, see table 3.3.*

In table 4.17, the results are presented for the relationship between analyst following and information asymmetry, including carbon risk disclosure. The interaction variable between analyst following and carbon risk disclosure maintains positive and significant (z = 2,18, p = < 0,01). This means that carbon risk disclosure strengthens the positive relationship between analyst following and information asymmetry, also without financial firms in the sample. This is also the case for the three forms of carbon risk disclosure: regulatory, physical and miscellaneous (z = 9,24, p = < 0,01, z = 1,88, p = < 0,01 and z = 1,73, p = < 0,01, respectively). When looking at table 4.18, the results for the relationship between analyst following and market value, including carbon risk disclosure, are presented. Again, the interaction variable between analyst following and carbon risk disclosure remains positive and significant (z = 7,94, p = < 0,01). This also goes for the three sorts of carbon risks: regulatory, physical and miscellaneous (z = 9,24, p = < 0,01, z = 7,11, p = < 0,01 and z = 8,36, p = < 0,01). This means that each risk, independently, strengthens the positive relationship between analyst following and market value.

Table 4.17 Information asymmetry and analysts with carbon risk disclosure, without financials

	CRD	CRD Regulatory	CRD Physical	CRD Misc.
Analyst following	-0,0764** (-2,34)	-0,0740** (-2,28)	-0,0708** (-2,19)	-0,0680** (-2,12)
Firm size	-1,0783*** (-6,08)	-1,0806*** (-6,10)	-1,0668*** (-6,04)	-1,0685*** (-6,07)
Profitability	-5,9707*** (-6,12)	-5,9697*** (-6,12)	-5,9830*** (-6,13)	-5,9764*** (-6,12)
Share price	-0,00005 (-0,31)	-0,00001 (-0,32)	-0,00001 (-0,32)	-0,00001 (-0,33)
Free float	-2,2456*** (-2,78)	-2,2513*** (-2,79)	-2,2360*** (-2,77)	-2,2433*** (-2,78)
Country bid-ask	577,8953*** (5,22)	577,8474*** (5,22)	575,8099*** (5,20)	572,2774*** (5,16)
Share price volatility	7,9932*** (4,54)	7,9831*** (4,54)	8,0034*** (4,55)	7,9934*** (4,54)
CRD	-1,0378 (-0,99)			
CRD Regulatory		-0,9596 (-0,90)		
CRD Physical			-0,8782 (-0,80)	
CRD Misc.				-0,7603 (-0,66)
Analysts x CRD	0,1119** (2,18)			
Analysts x CRDREGU		0,1089** (2,11)		
Analysts x CRDPHYS			0,0996* (1,88)	
Analysts x CRDMISC				0,0947* (1,73)
Year controls	*Yes*	*Yes*	*Yes*	*Yes*
Country controls	*Yes*	*Yes*	*Yes*	*Yes*
Industry controls	*Yes*	*Yes*	*Yes*	*Yes*
R-squared	0,0594	0,0593	0,0592	0,0590
Obs.	16.449	16.449	16.449	16.449

*Notes: The numbers displayed are the coefficients. The z-values can be found in the brackets. *, ** and *** symbolise the significance levels of 0,10, 0,05 and < 0,01, respectively. For variable definitions, see table 3.3.*

Table 4.18 Market value and analyst following with carbon risk disclosure, without financials

Variables	CRD	CRD Regulatory	CRD Physical	CRD Misc.
Analyst following	0,0089 (0,20)	-0,0041 (-0,09)	0,0311 (0,70)	0,0230 (0,52)
Profitability	3,9689*** (3,34)	3,9459*** (3,33)	3,9871*** (3,36)	4,0114*** (3,38)
Leverage	-1,0695 (-1,13)	-1,1059 (-1,17)	-1,0289 (-1,09)	-1,1025 (-1,16)
Firm size	6,6065*** (20,92)	6,5823*** (20,86)	6,6167*** (20,96)	6,6023*** (20,97)
Growth	-0,0501 (-0,47)	-0,0470 (-0,44)	-0,0463 (-0,43)	-0,0413 (-0,39)
CRD	-5,6063*** (-4,92)			
CRD Regulatory		-6,4139*** (-5,61)		
CRD Physical			-5,2965*** (-4,51)	
CRD Misc.				-6,1493*** (-5,07)
Analysts x CRD	0,4529*** (7,94)			
Analysts x CRDREGU		0,5274*** (9,24)		
Analysts x CRDPHYS			0,4087*** (7,11)	
Analysts x CRDMISC				0,4953*** (8,36)
Year controls	*Yes*	*Yes*	*Yes*	*Yes*
Country controls	*Yes*	*Yes*	*Yes*	*Yes*
Industry controls	*Yes*	*Yes*	*Yes*	*Yes*
R-squared	0,5981	0,5991	0,5965	0,5989
Obs.	15.907	15.907	15.907	15.907

*Notes: The numbers displayed are the coefficients. The z-values can be found in the brackets. *, ** and *** symbolise the significance levels of 0,10, 0,05 and < 0,01, respectively. For variable definitions, see table 3.3.*

5. Conclusion and discussion

In times when environmental disclosure by firms becomes more and more important, this research investigates to what extent carbon risk disclosure moderates the relationship between analyst following and market value, for 3.715 European and US firms in the period 2011-2017. Although the effect of analyst following on market value has been researched before, there are indications in the consulted literature that carbon risk disclosure could have a moderating effect on this relationship. By disclosing carbon risks, information asymmetry between firms and outside investors can be further reduced, through which agency- and transaction costs decrease and market value increases (Jensen & Meckling, 1976; Akerlof, 1970; Healy & Palepu, 2001). In order to investigate this, four relationships are analysed in particular. First of all, the relationship between analyst following and information asymmetry. Secondly, the relationship between analyst following and market value. Lastly, carbon risk disclosure will be added as an interaction variable in both relationships, to see if it has an effect on the strength and/or direction of the relationships. To be noted, the first two relationships are analysed for the completeness of this research, i.e. to compare the results in this research with prior research.

In accordance with the literature consulted, the results indicate that there is a negative relationship between analyst following and information asymmetry. So, more analysts following a firm leads to lower information asymmetry between the firm and the outside investors. When carbon risk disclosure is added as a moderator, a positive effect is found. This means that when a firm discloses its carbon risks, the negative relationship between analyst following and information asymmetry becomes less strong. This positive effect is also found for regulatory-, physical-, and miscellaneous carbon risk disclosure. Therefore, disclosing one of these carbon risks would already weaken the negative effect of analyst following on information asymmetry. However, there are some small differences in the effects. Regulatory carbon risk disclosure has the strongest effect and miscellaneous carbon risk disclosure the weakest. A possible reason why carbon risk disclosure can weaken the negative effect between analyst following and information asymmetry is the increased publicly available information about the firm's carbon risks. As a result, investors become less dependent on the investigation, knowledge and recommendations of analysts, who are

one of the few groups which could have information about a firm's carbon risks. Hence, the effect of analysts on information asymmetry decreases.

The results also indicate, in accordance with previous literature, that there is a positive effect between analyst following and market value. In other words, more analysts following a firm leads to a higher market value. When adding carbon risk disclosure as a moderator in this relationship, a positive effect is found. This implicates that when a firm discloses its carbon risks, the effect of analysts following on market value is higher. Regulatory-, physical-, and miscellaneous carbon risk disclosure all, independently, have a positive effect on the relationship between analyst following and market value. So disclosing one of these carbon risks would already strengthen the positive effect of analysts on market value. However, again, there are small differences in the strengths of the effects. Regulatory carbon risk disclosure has the strongest effect and physical carbon risk disclosure the weakest.

This research has theoretical, practical and societal contributions. The theoretical contribution is that this research has given insights in a relative new and under researched phenomenon: carbon risk disclosure. Previous research in the literature mainly focused on non-financial disclosure, like corporate social responsibility (CSR) disclosure. The main theoretical insights gained from this research is that carbon risk disclosure weakens the negative relationship between analyst following and information asymmetry, but strengthens the positive relationship between analyst following and market value. In practice, firms could face a decision whether or not to disclose their carbon risks. Disclosing carbon risk could on the one hand lead to lower information asymmetry and thus lower agency- and transaction costs. But on the other hand could the disclosed information lead to uncertainty among investors as well, through which the company could be penalised on the market. With the insights from this research, firms which are followed by analysts, know now that they can increase their market value by disclosing carbon risks. The societal contribution of the research is that it could lead to more carbon risk disclosure by firms followed by analysts. More carbon risk disclosure, in turn, could lead to better management of carbon risks, which is beneficial to both the firm and society in general.

A limitation of this research is, first of all, that it does not take into account the content of the disclosed information. As a result, no conclusions can be made about to what extent high or low carbon risks would moderate the relationship between analyst following and market value. Investors, for example, could be penalised on the market when they would disclose severe carbon risks. A second limitation is the relatively low R-squared of 0,057 for the models between analyst following and information asymmetry (with and without the carbon risk disclosure interaction variables). Based on this, the negative effect that is found between analyst following and information asymmetry and the positive moderating effect of carbon risk disclosure on the negative relationship between analyst following and information asymmetry, could be questioned. However, this low R-squared was found when using the sample of both US and European firms. When using the sample with European firms only, the R-squared was approximately 0,30 for these models. Because the same results were found, the negative relationship between analyst following and information asymmetry and the positive moderation effect are less questionable. A third limitation is that a relatively small part of the firms in the sample, 16,69%, discloses its carbon risks. The external validity of the results would be higher if more firms in the sample had reported carbon risks to the CDP questionnaire.

As mentioned earlier, carbon risk disclosure is a relative under-researched phenomenon. In this research, the effect of analyst following on information asymmetry and market value has been researched. In future research, carbon risk disclosure itself can be used in a more diversified way. A distinction, for example, could be made in high and low regulatory-, physical and miscellaneous carbon risk disclosure. In addition, more aspects of the disclosed carbon risks could be analysed, like the impact on business activity, likelihood of occurrence and timeframe of the risk, as in Schiemann & Sakhel (2018). Secondly, the influence of carbon risk disclosure on frequently researched finance topics, like analyst recommendations, mergers and acquisitions or capital structure decisions, could give interesting new insights. Furthermore, it would be interesting to know whether the results could also be generalised to other continents, like Asia. Lastly, carbon performance and carbon risk disclosure could be combined in an analysis. Mae Matsumura et al. (2014) find that carbon emissions have a negative effect on firm value. Is this, for example, also the case when a firm discloses its carbon risks? Or does the effect of carbon risk disclosure on market value change when a firm discloses its carbon emissions? This are questions which future research has to answer.

References

Akerlof, G. A. (1970). The Market for" Lemons": Quality Uncertainty and the Market Mechanism, 84Q. *J. ECON*, *488*, 489-90.

Ararat, M., Black, B. S., & Yurtoglu, B. B. (2017). The effect of corporate governance on firm market value and profitability: time-series evidence from turkey. *Emerging Markets Review*, *30*, 13-19.

Bae Choi, B., Lee, D., & Psaros, J. (2013). An analysis of Australian company carbon emission disclosures. *Pacific Accounting Review*, *25*(1), 58-79.

Barth, M. E., Kasznik, R., & McNichols, M. F. (2001). Analyst coverage and intangible assets. *Journal of accounting research*, *39*(1), 1-34.

Bowen, R. M., Chen, X., & Cheng, Q. (2008). Analyst coverage and the cost of raising equity capital: Evidence from underpricing of seasoned equity offerings. *Contemporary Accounting Research*, *25*(3), 657-700.

Cambridge Dictionary (2019). Financial Analyst. Accessed on April 2, 2019: https://dictionary.cambridge.org/dictionary/english/financial-analyst

Chauvin, K. W., & Hirschey, M. (1993). Advertising, R&D expenditures and the market value of the firm. *Financial management*, 128-140.

Cho, H. J., & Pucik, V. (2005). Relationship between innovativeness, quality, growth, profitability, and market value. *Strategic management journal*, *26*(6), 555-575.

Cho, S. Y., Lee, C., & Pfeiffer Jr, R. J. (2013). Corporate social responsibility performance and information asymmetry. *Journal of Accounting and Public Policy*, *32*(1), 71-83.

Chung, K. H., & Jo, H. (1996). The impact of security analysts' monitoring and marketing functions on the market value of firms. *Journal of Financial and Quantitative analysis*, *31*(4), 493-512.

Clarkson, P. M., Li, Y., Richardson, G. D., & Vasvari, F. P. (2008). Revisiting the relation between environmental performance and environmental disclosure: An empirical analysis. *Accounting, organizations and society*, *33*(4-5), 303-327.

Cotter, J., & Najah, M. M. (2012). Institutional investor influence on global climate change disclosure practices. *Australian journal of management*, *37*(2), 169-187.

Derrien, F., & Kecskés, A. (2013). The real effects of financial shocks: Evidence from exogenous changes in analyst coverage. *The Journal of Finance, 68*(4), 1407-1440.

Dhaliwal, D., Li, O., Tsang, A., & Yang, Y. (2011). Voluntary Nonfinancial Disclosure and the Cost of Equity Capital: The Initiation of Corporate Social Responsibility Reporting. The Accounting Review, 86(1), 59-100.

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

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

EPA (2019). Greenhouse Gas Emissions - Overview of Greenhouse Gases. Accessed on March 26, 2019: https://www.epa.gov/ghgemissions/overview-greenhouse-gases

Finabase (2019). Databaser: on financial databases - Tobin's Q Ratio. What is and where can I find it? Accessed on May 20, 2019: http://finabase.blogspot.com/2013/05/tobins-q-ratio-what-is-and-where-can-i.html

Fuhrmann, S., Ott, C., Looks, E., & Guenther, T. W. (2017). The contents of assurance statements for sustainability reports and information asymmetry. *Accounting and Business Research*, *47*(4), 369-400.

Fuller, J., and M. Jensen. 2002. "Just Say No to Wall Street: Putting a Stop to the Earnings Game" *Journal of Applied Corporate Finance* 14 (4): 41-46.

Görgen, M., Jacob, A., Nerlinger, M., Riordan, R., Rohleder, M., & Wilkens, M. (2018). Carbon Risk.

Hahn, R., & Lülfs, R. (2014). Legitimizing negative aspects in GRI-oriented sustainability reporting: A qualitative analysis of corporate disclosure strategies. *Journal of business ethics*, *123*(3), 401-420.

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

Hsiao, C. (2014). *Analysis of panel data* (No. 54). Cambridge university press.

He, J. J., & Tian, X. (2013). The dark side of analyst coverage: The case of innovation. *Journal of Financial Economics*, *109*(3), 856-878.

Healy, P. M., & Palepu, K. G. (2001). Information asymmetry, corporate disclosure, and the capital markets: A review of the empirical disclosure literature. *Journal of accounting and economics*, *31*(1-3), 405-440.

Hoffmann, V. H., & Busch, T. (2008). Corporate carbon performance indicators: Carbon intensity, dependency, exposure, and risk. *Journal of Industrial Ecology*, *12*(4), 505-520.

Jensen, M. C., & Meckling, W. H. (1976). Theory of the firm: Managerial behavior, agency costs and ownership structure. *Journal of financial economics*, *3*(4), 305-360.

Johnston, J. S. (2005). Signaling social responsibility: On the law and economics of market incentives for corporate environmental performance. *U of Penn, Inst for Law & Econ Research Paper*, 05-16.

Joo, B. A., & Hussanie, I. (2017). Selecting the right variable as a proxy for profitability-A propitious beginning for researchers. Accessed on May 15, 2019: https://bit.ly/2w1qGqF

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

Jung, B., Sun, K. J., & Yang, Y. S. (2012). Do financial analysts add value by facilitating more effective monitoring of firms' activities?. *Journal of Accounting, Auditing & Finance*, *27*(1), 61-99.

Kothari, S. P., Li, X., & Short, J. E. (2009). 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), 1639-1670.

Labatt, S., & White, R. R. (2011). Carbon finance: the financial implications of climate change (Vol. 362). John Wiley & Sons.

Lee, K., & Lee, H. (2019). How Does CSR Activity Affect Sustainable Growth and Value of Corporations? Evidence from Korea. *Sustainability*, *11*(2), 508.

Lehavy, R., Li, F., & Merkley, K. (2011). The effect of annual report readability on analyst following and the properties of their earnings forecasts. *The Accounting Review*, *86*(3), 1087-1115.

Luo, X., Wang, H., Raithel, S., & Zheng, Q. (2015). Corporate social performance, analyst stock recommendations, and firm future returns. Strategic Management Journal, 36(1), 123-136.

Matisoff, D. C. (2013). Different rays of sunlight: Understanding information disclosure and carbon transparency. *Energy Policy*, *55*, 579-592.

Mae Matsumura, E., Prakash, R., & Vera-Munoz, S. (2014). Firm-value effects of carbon emissions and carbon disclosures. *The Accounting Review, 89*(2), 695-724.

Michaely, R., & Womack, K. L. (1999). Conflict of interest and the credibility of underwriter analyst recommendations. *The Review of Financial Studies*, *12*(4), 653-686.

Milgrom, P. R. 1981. Good news and bad news: Representation theorems and applications. Bell Journal of Economics (Autumn): 380–391.

Moore, D. S., & Kirkland, S. (2012). The basic practice of statistics. New York: WH Freeman.

Muller III, K. A., Riedl, E. J., & Sellhorn, T. (2011). Mandatory fair value accounting and information asymmetry: Evidence from the European real estate industry. *Management Science*, *57*(6), 1138-1153.

Nekhili, M., Nagati, H., Chtioui, T., & Rebolledo, C. (2017). Corporate social responsibility disclosure and market value: Family versus nonfamily firms. *Journal of Business Research*, *77*, 41-52.

Rajan, R. G., & Zingales, L. (1995). What do we know about capital structure? Some evidence from international data. *The journal of Finance*, *50*(5), 1421-1460.

Refinitiv (2019). Institutional Brokers Estimate System - I/B/E/S Estimates. Accessed on May, 7, 2019: https://www.refinitiv.com/en/financial-data/company-data/institutional-brokers-estimate-system-ibes

Romilly, P. (2007). Business and climate change risk: A regional time series analysis. *Journal of International Business Studies*, *38*(3), 474-480.

Roulstone, D. T. (2003). Analyst following and market liquidity. *Contemporary accounting research*, *20*(3), 552-578.

Schiemann, F., & Sakhel, A. (2018). Carbon Disclosure, Contextual Factors, and Information Asymmetry: The Case of Physical Risk Reporting. *European Accounting Review*, 1-28.

Stoll, H. R. (1978). The pricing of security dealer services: An empirical study of NASDAQ stocks. *The journal of finance*, *33*(4), 1153-1172.

Thomas Reuters (2019). Thomson Reuters ESG Scores. Accessed on May 7, 2019: https://www.refinitiv.com/content/dam/marketing/en_us/documents/methodology/esg-scores-methodology.pdf

Torres-Reyna, O. (2007). Panel data analysis fixed and random effects using Stata (v. 4.2). *Data & Statistical Services, Priceton University*.

Verrecchia, R. E. (2001). Essays on disclosure. *Journal of accounting and economics*, *32*(1-3), 97-180.

Zhou, Z., Zhang, T., Wen, K., Zeng, H., & 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*, *27*(8), 1131-1144.

Appendix

1. Fixed vs Random effects model — market value and analyst following[5]

Variables	Fixed	Random
Analyst following	-0,0388 (-0,83)	0,1812*** (4,32)
Profitability	4,6055*** (3,46)	4,5853*** (3,59)
Leverage	-0,6116 (-0,58)	-1,2778 (-1,33)
Firm size	3,0038*** (7,39)	6,0994*** (21,50)
Growth	0,0160 (0,15)	-0,0173 (-0,17)
Year controls	*Yes*	*Yes*
Country controls	*No*	*Yes*
Industry controls	*No*	*Yes*
R-squared	0,1268	0,5895
Obs.	20.786	20.764

[5] The Hausman Test gave some conflicting results. Therefore, the decision is made based on the R-squared.

2. Fixed vs Random effects model — information asymmetry and analyst following

Variables	Fixed	Random
Analyst following	-0,1107** (-2,29)	-0,0537** (-2,07)
Firm size	-4,1099*** (-9,79)	-0,8506*** (-6,19)
Profitability	-0,6236 (-0,50)	-6,7276*** (-7,30)
Share price	-0,00002 (-0,20)	0,00001 (0,11)
Free float	-3,9255*** (-4,21)	-2,2998*** (-3,32)
Country bid-ask spread	577,7124*** (5,82)	594,58*** (6,10)
Share price volatility	5,9970*** (3,28)	7,4107*** (4,61)
Year controls	*Yes*	*Yes*
Country controls	*No*	*Yes*
Industry controls	*No*	*Yes*
R-squared	0,0272	0,0548
Obs.	21.521	21.491