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Master Thesis

The effects of a company's greenwashing practices on stock liquidity & stock price volatility: Evidence from the S&P 500

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Abstract

This study examines the relationship between greenwashing, stock liquidity and stock price volatility of S&P500 firms between the time frame 2013 and 2022. The results of this study have numerous applications for firms pursuing a greenwashing strategy. While some businesses may use greenwashing as a marketing strategy to improve their brand image, it can actually have a negative impact on a company's financial performance over time. Greenwashing increases information asymmetry between the firms pursuing such strategy and their shareholders and investors. The decreased trust levels between firms and stakeholders have serious implications for the stock traded by the firm. Stock liquidity and stock price volatility are critical stock characteristics strongly related to risk. The sample consists out of 2,113 company years for which a greenwashing score could be calculated. The effects of greenwashing on stock liquidity and stock price volatility are measured using two proxies: Amihud's illiquidity ratio (2002) and the standard deviation respectively. The outcomes of the statistical tests suggests that greenwashing firms experience lower levels of stock liquidity and higher levels of stock price volatility. Moreover, the results indicate that type of industry (environmental sensitive vs. non-environmental sensitive) and firm size moderate the effect of greenwashing on stock liquidity and stock price volatility.

Acknowledgement

I want to take this chance to express my gratitude to a few individuals that helped me when I was writing this thesis. First of all, I want to express my gratitude to Dr. Joris Kil for his constructive critique and encouragement to write a better work. Second, I want to express my gratitude to.... for reading and reviewing my master's thesis. Last but not least, I want to express my gratitude to Erasmus University Rotterdam for the invaluable teachings I acquired while pursuing my master's.

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1. Introduction

Over the past ten years, continuous climatic and environmental shocks have forced our society to move faster toward more sustainable growth and, ultimately, a green economy with no pollution. As the globe strives to address these pressing climate change and clean energy concerns while also recovering from the ongoing COVID-19 pandemic, sustainable finance is surging in favor across global markets to support the green shift financially. Marketers are concentrating on creating and providing green and sustainable goods and services to their customers to meet this current demand (Jaini et al., 2020; Li et al., 2020; Chua et al, 2016). This shift for a more sustainable economy gives rise to new sort of marketing strategy by firms. Consumer demand, investor demand, and competitive pressure are causing brown enterprises to "greenwash" in order to keep up with their green(er) counterparts due to non-market external forces like the absence of (monitoring) rules and market external drivers like these. (Delmas et al., 2011). Blome et al. (2017) described greenwashing as corporations' environmental claims regarding green products that are ambiguous and deceptive in order to create a positive "green" image without fulfilling the green promises. In 2015, a well-known instance of greenwashing occurred. Volkswagen (VW) was exposed in 2015 for deceiving customers with their purportedly "clean diesel" engines. Engineers at the automaker installed software in 11 million vehicles that fooled pollution tests into thinking the vehicle was environmentally benign. However, the vehicles were actually emitting up to 40 times the legal limit of nitrogen oxide emissions. Michael Horn, the company's then chief executive officer, responded by saying, "We have really fouled up." This demonstrates that the strategy to trick customers and boost sales was well thought out.

While some companies may employ greenwashing as a marketing technique to enhance their brand image, it can actually have a detrimental effect on a company's financial performance over time. Du's investigation on the Chinese stock market showed a positive link between corporate environmental performance and cumulative abnormal returns (CAR), while greenwashing had a negative relationship with CAR. Schmuck et al. (2018a) found evidence that incorrect greenwashing statements trigger cognitive persuasion in consumers, making them aware of these tactics. Wu and Shen (2013) also discovered a positive correlation between CSR and financial performance in a study of banks in 22 countries, but not for those institutions that engaged in greenwashing. The studies mentioned suggest that engaging in substantive environmental actions has no significant impact on financial performance, while greenwashing is negatively correlated with financial performance.

However, it is challenging to establish a direct relationship between financial and environmental success due to potential third factors like leadership and vision.

From an information asymmetry perspective, greenwashing increases information asymmetry in the stock market as it creates a gap between what a company claims to be doing to protect the environment and what it is actually doing. This lack of transparency makes it difficult for investors to accurately assess the environmental impact of a company's operations, as well as the associated financial risks of investing in a firms' stocks. Risks are highly correlated to important stock characteristic such as stock liquidity and stock price volatility. Increased risks have shown to decrease stock liquidity. This happens because investors could start to distrust the sustainability of the company's operations and grow doubtful of its claims. As a result, the volume and liquidity of trade are reduced since they are less likely to buy or sell the company's stock. Information asymmetry also have found to increase stock price volatility by stating that businesses increase uncertainty and risk for investors by greenwashing their CSR performance disclosure.

I have developed the following research question for this thesis in response to the request for additional study on the effects of greenwashing:

What are the effects of greenwashing on stock liquidity and stock price volatility levels?

In this thesis, the greenwashing score is formed by subtracting a firms ESG disclosure score by its ESG performance score. To measure the effect on stock liquidity and stock price volatility, this study uses to proxies: Amihud's illiquidity ratio (2002) and the standard deviation respectively. This study focuses it on firms included in the S&P500 over the years 2013-2022 as the proportion of S&P businesses reporting on ESG concerns increased from 20% in 2011 to 72% in 2013 due to the growing importance of transparency and ESG disclosures (Robinson et al., 2020). OLS regression models are used to test the impact of greenwashing on stock liquidity and stock price volatility. As the type of industry (environmental sensitive vs. non-environmental sensitive) and firm size tend to have a moderating impact on the effect of greenwashing on the researched metrics, interaction variables are included in the different models.

The findings show significant results on the impact of greenwashing on stock liquidity. The relationship between greenwashing and the Amihud illiquidity ratio is shown to have a significant positive relationship. As Amihud's illiquidity ratio is the inverse of stock liquidity, this supports the hypothesized effect that more greenwashing leads to less stock volatility. This result indicates that as firms increase their greenwashing practices, investors

could start to distrust the sustainability of the company's operations and grow doubtful of its claims. As a result, they are less inclined to purchase or sell the company's stock, which lowers the volume and liquidity of trading. However, the results of greenwashing on stock price volatility shows an insignificant positive relation. This indicates that greenwashing might make stock prices more volatile. Investors may react negatively and sell off their shares, which may lower the stock price when they learn that actual activities do not support a company's environmental statements. Thereby, if investors have unrealistic expectations of the company's environmental initiatives, the stock price may rise to unsustainable heights before collapsing. However, as the results are insignificant, this should be only considered as an indication.

While there is an extensive amount of research done on the drivers of greenwashing and its effect on investor behavior and sentiment, the impact of greenwashing and its idiosyncratic risks on stock is limited. Delmas et al. (2011) examined the institutional, market, organizational, and human drivers of greenwashing and shown that the phenomenon's alarming prevalence might have serious negative effects on consumers' and investors' confidence in environmentally friendly products. Greenwashing discourages consumers from purchasing a brand's goods, lowers trust levels, and raises levels of perceived risk, all of which have negative consequences on stakeholders, according to literature by Chang et al. (2014), Nyilasy (2014), Braga Junior (2019), and Walker (2012). In 2015, Du conducted research on the impact of greenwashing on financial performance, specifically in the form of cumulative abnormal returns (CAR). However, this research did not investigate the effect of greenwashing on stocks, which are a crucial component of investment strategies. As found by Chordia et al. (2002, 2005), Watanabe (2004), Jones et al. (1994), and Kyrölänen (2008), risk and trust levels have a significant impact on crucial stock features such stock liquidity and price volatility. Stock liquidity and stock price volatility are essential for companies because they impact how investors perceive a company's financial health and stability. Greenwashing is related to these metrics because it can impact how investors perceive a company's financial health and stability and, therefore, its stock liquidity and price volatility. If a company is found to be engaging in greenwashing, it can damage the company's reputation and lead to a loss of investor confidence. This can lead to a decrease in demand for the company's stock, which can, in turn, impact its stock liquidity and price volatility. Moreover, investors' increasing focus on environmental, social, and governance (ESG) factors has made greenwashing a more significant concern for companies, as investors increasingly consider a company's environmental practices and policies when making investment decisions.

Companies that engage in greenwashing may face a higher risk of negative investor reactions, which can impact their stock liquidity and price volatility.

By relating these many literary genres, a significant gap in the literature is shown that must be addressed. This paper tries to fill that gap by looking at the direct effects of greenwashing on stock liquidity and stock price volatility, focused especially on firms included in the S&P 500 between 2013-2022. Thereby, important characteristics including firm size and whether a firm is operating in an environmental sensitive industry are added as it influences the extent of a firm's greenwashing practices. The predictions of the different hypotheses are tested via OLS regressions using a fixed-effects model.

This paper is structured as follows. A review of previous findings, relationships, and theories that explain the relationship between greenwashing, stock liquidity, and stock price volatility is reviewed in the following section. The hypotheses are taken from this review. The third section describes the data and methodology that were utilized to test the hypothesis. Results from the empirical research are given in the fourth part. Finally, in part five, the findings are reviewed along with some restrictions and recommendations for future research.

2. Literature Review

The introduction of the three key ideas of greenwashing, stock liquidity, and market volatility, as well as how metrics can be defined and what models and variables are now in use and have been previously studied in the literature, will be the primary emphasis of the literature review. A discussion of academic articles that have previously examined the connection between greenwashing, stock liquidity, and stock volatility will come after this. The chapter finishes with the conceptual model employed in this study and the tested hypotheses after discussing a section of related theories.

2.1 Greenwashing

Greenwashing can be ascribed as corporations' environmental claims regarding green products that are ambiguous and deceptive in order to create a positive "green" image without fulfilling the green promises (Guo et al.,2018).

Claim greenwashing and executional greenwashing are the two categories the environmental marketing literature divides into. The first definition of claim greenwashing is "the use of textual arguments in the advertisement that create a misleading environmental claim" (Parguel et al., 2010). Previous studies examining greenwashing have primarily focused on cases of deceptive greenwashing claims made in advertisements. False greenwashing claims in advertising refer to misleading statements that can misguide consumers and are clearly contradicted by independent evidence, as defined by Schmuck et al. (2018a). Research conducted by Schmuck et al. (2018a) indicates that such misleading greenwashing claims can activate a rational cognitive persuasion system that raises consumer awareness about these tactics.

Second, research by Parguel et al. (2015) suggests that executional greenwashing can result in promoting incorrect perceptions of a brand's eco-friendliness, whether intentionally or unintentionally by the advertiser. Previous research has taken nature-invoking images into account to evaluate executional greenwashing. In order to communicate the ecological benefits of the offered product or business, commercials often use nature-inspired images that show settings that exemplify the beauty of the natural world (Schmuck et al., 2018b). When there is no mention of the advertised product or the brand's actual ecological attributes, images of lovely natural landscapes can lead consumers to believe that it is environmentally friendly when this is not the case (Schmuck et al., 2018a).

Thereby, greenwashing should be distinguished between firm-level and product-level greenwashing. According to Lyon and Maxwell (2011), greenwashing on firm-level is, in line with the stated definitions before, a sort of selective disclosure when companies disclose their good environmental efforts (CSR/ESG-efforts) while keeping quiet about their bad environmental effects. As a result, stakeholders may make erroneous assumptions about the company's overall environmental performance. Product-level greenwashing is a marketing strategy where companies use statements or logos to make a product seem more ecologically friendly in an effort to increase sales. A straightforward illustration would be to say that a product is "natural". In this paper, we investigate the effects of firm-level greenwashing.

Greenwashing can be seen as an exaggerated corporate sustainability communication strategy. This strategy overstates firms' sustainability achievements by engaging in excessive communication rather than making substantive efforts to improve environmental and social performance (Bowen et al., 2014; Kim et al., 2015; Delmas et al., 2011). In other words, greenwashing is intentionally creating a disclosure gap between real investments in CSR activities and the disclosed CSR investments. The foundation of Corporate Social Responsibility (CSR), according to Font et al. (2012), is the acknowledgement that businesses have responsibilities to society that go beyond shareholder wealth maximisation. Corporate actions in this field are often referred to as Environmental, Social and Governance (ESG).

Delmas and Burbano (2011) introduced a typology of organizations that employs two dimensions - environmental performance and communication about environmental performance - to depict diverse environmental and communication strategies. The two dimensions differentiate between "green" and "brown" organizations in terms of environmental performance and "vocal" and "silent" organizations in terms of communication about their environmental performance. A typology made up of four cells and these two dimensions (see Figure 1). "Vocal green" organizations are those that demonstrate robust environmental performance and engage in positive communication about their efforts, while "silent green" organizations do not publicly acknowledge their strong environmental performance. ‘Silent brown’ organizations have poor environmental performance and no communication about it. ‘Greenwashing’ organizations are the final group. As defined before, greenwashing firms have poor environmental performance and no communication about it. In this study, we focus on greenwashing firms.

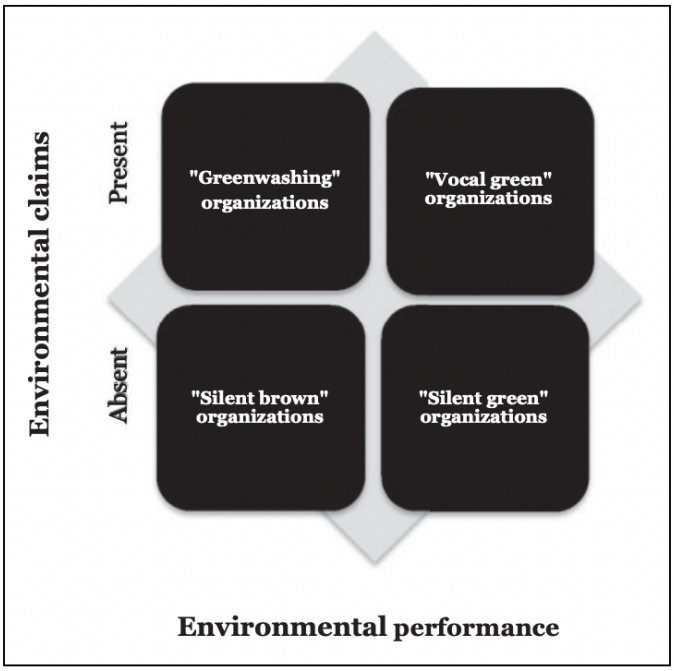

Figure 1. Typology of environmental strategies (Delmas & Burbano, 2011).

Previous literature

The literature on greenwashing distinguishes between macro-level studies focusing on the relationship between an organization's greenwashing strategies and its overall financial performance and micro-level studies examining greenwashed messages' impact on consumers.

According to macrolevel research, greenwashing does not improve an organization's key performance measures (De Jong et al, 2017). Du (2015) conducted a study on the Chinese stock market and found a significantly negative correlation between corporate environmental performance and cumulative abnormal returns (CAR), while greenwashing is positively correlated with CAR. Similarly, in their 2012 study, Walker and Wan examined the financial impacts of "greenwashing" versus substantive actions for Canadian businesses in polluting industries. They discovered that substantive action has no good nor negative financial ramifications while greenwashing is inversely correlated with financial performance. Wu and Shen (2013) also discovered a positive correlation between CSR and financial performance in a study of banks in 22 countries, but not for those institutions that engaged in greenwashing. These large-scale studies collectively suggest that greenwashing is not profitable for businesses, but it is challenging to deduce a direct relationship from the data. After all, a solid financial position might also influence how well the environmental

part performs, or a third factor, like leadership and vision, might influence financial and environmental success.

Weber (2018) researched the relationship between CSR performance, disclosure level and the cost of equity. By means of the data from the GRI Sustainability Disclosure Database, she predicted a negative association and that effective CSR performers will drive the association. However, Weber found that companies with poor CSR performance and high level of environmental disclosure, thus firms engaged in greenwashing, have higher cost of equity levels. This effect was confirmed by García-Sánchez et al. (2020).

On microlevel, some studies has focused on the effects of unsubstantiated green claims or green cues without disclosing to participants the greenwashing nature of those claims or cues. Chen et al. (2014) investigated the correlation between perceived greenwashing and a number of outcome characteristics in two non-experimental survey-based studies While Chen and Chang (2013) concentrated on the effects of greenwashing on consumer confusion, perceived risk, and trust, Chen, Lin, and Chang (2014) investigated the consequences of greenwashing on green perceived quality, green satisfaction, and green word of mouth. In order to answer questions, respondents had to think about a self-selected specific "information and electronics product" made by a Taiwanese company. Chen and Chang's (2013) research showed that perceived greenwashing has a detrimental impact on green trust, both directly and through confusion among consumers and perceived risk. Additionally, Chen et al. (2014) showed that perceived greenwashing is directly and indirectly associated with poor word-of-mouth regarding the environment via perceived green quality and satisfaction.

Thereby, Chang et al. (2014) and Nyilasy (2014) showed that when people believe that a company's products, services, or brand represents a significant environmental commitment while providing false information, a greenwashing perception is formed, which will discourage customers from purchasing the brand's goods, decreasing their level of trust (Braga Junior et al, 2019) and increasing his/her level of perceived risk (Chang et al, 2014; Nguyen et al, 2019). Scholars caution that greenwashing may indicate a negative signal to stakeholders and consequently impair the firms' profitability because the public perceives it as dishonest and misleading (Walker et al., 2012). These studies collectively imply that stakeholders may be harmed by greenwashing.

Moreover, In-depth interviews were used in a qualitative study by Lim et al. (2013) to examine how consumers respond to green claims and what happens when they find the claims are false. According to research by Lim et al., however, consumers are frequently unsure about green promises. However, once they learn about greenwashing, they may

become wary, suspicious, and eager to spread information about the tactics. However, a qualitative study by Atkinson and Kim (2014) revealed that consumers' responses to " greenwashed " communications were far less straightforward. Participants in focus groups appeared to use a variety of justification strategies to strike a balance between their skepticism and acceptance of environmental claims and between their aspirations to act sustainably and their nongreen behaviors.

However, greenwashing could also be useful to a firm ((Bowen & Aragon-Correa, 2014; Du & Swamy, 2014). The reason why is provided on hand of the legitimacy theory. According to legitimacy theory, firms can only survive if they operate in accordance with society's value system. In order to gain legitimacy in the eyes of society, firms disclose information that portrays their actions as desirable, proper, or appropriate (Hora & Subramanian, 2019). Legitimacy is crucial for companies as it leads to improved financial performance (Seele & Gatti, 2017). However, environmental disclosures are often made for strategic purposes and have little to do with corporate responsibilities or obligations (Laufer, 2003). When a firm's poor environmental performance threatens its legitimacy, it may resort to deception by publishing only positive aspects of its environmental performance to avoid a negative image (Laufer, 2003).

In addition, the incentives for greenwashing can also be explained by the signaling theory (Ross, 1977). The signaling theory suggests that firms use specific actions, such as disclosing information about their CSR performance, to signal to stakeholders that they are financially sound and well-managed. This reduces uncertainty and risk for investors, enhancing financial performance.

By enhancing a company's reputation, greenwashing can present a favorable image ((Tetrault-Sirsly & Lvina, 2019). A favorable reputation reduces risk and lowers the cost of capital and equity (Jo & Na, 2012; Hsu & Chen, 2015; Chollet & Sandwidi, 2018) and can improve employee engagement (Chaudhary, 2017). Thereby, García-Sánchez et al. (2020) found out that greenwashing has a positive effect on the cost of equity.

2.2 Stock Liquidity

A large amount of literature that discusses liquidity has been published recently. There is little doubt that liquidity is a complex and multifaceted notion, making it challenging to uncover causal links, identify drivers, and finally construct forecasting models. Liquidity refers to the ease with which a (financial) asset can be traded in the market quickly and

without significantly affecting the asset's price (O'Hara, 2004; Chordia et al., 2003b). Liu (2006) provided one of the most widely accepted definitions of liquidity, where liquid stocks are defined as stocks which are able to trade large volumes quickly at low cost with little price impact. Lui identified four aspects of in its definition of stock liquidity: trading quantity (how much a security can be traded for at a given price), trading speed (how quickly a security can be traded at a given price with a given quantity), trading costs (all costs associated with trading a given quantity of a security), and price impact (how simple it is to trade a security for at a given price with the least amount of price impact) (Le et al, 2020).

Stock market liquidity, defined as the ease of buying and selling stocks without affecting their prices, is a crucial aspect of a well-functioning economy. A liquid stock market facilitates efficient price discovery, which reduces volatility and provides investors with better information for informed investment decisions. It also promotes market participation by making it easier for investors to enter and exit positions, which spurs investment and contributes to economic growth. In addition, a liquid stock market can help absorb shocks and reduce the risk of financial instability, which supports the smooth functioning of the financial system. Furthermore, it encourages companies to raise capital through stock offerings, which can be utilized to invest in growth and development, thereby positively impacting the overall economy (Filis et al., 2014***).***

Stock market liquidity is a key market characteristic that, when present, helps the market run smoothly and, when absent, causes the market to become uneasy. Market liquidity is essential for a trader since it affects the magnitude of his returns and facilitates the development of efficient trading strategies. Besides, studies (Bradrania & Peat, 2014; Cao & Petrasek, 2014; K. H. Lee, 2011) have also addressed the crucial impact of changes in liquidity levels on investment decisions. Additionally, research (W. X. Li et al., 2012; Nadarajah et al., 2018) has shown that market liquidity affects business firms' costs of capital and company value by enhancing corporate governance mechanisms.

The role of stock market liquidity is crucial for the development of the economy. According to Ellington (2018), lower liquidity levels during a crisis can negatively impact economic growth. Apergis et al. (2015) also found that investor sentiment, which is influenced by stock market liquidity, has a significant impact on the future development of the economy. Nneji (2015) confirmed this by providing evidence that market liquidity indicates a market's ability to withstand economic shocks or crises. Research by Naes et al. (2011) and Smimou (2014) highlights the importance of stock market liquidity as a predictor of the future state of the economy.

As stated, stock liquidity is widely researched. From the broad range of literature, it can be suggested that having a thorough understanding of liquidity drivers from both a market-level and macrostructure viewpoint is crucial. Such market-level variables are examined by Chordia et al. (2005), who find that daily variations in return, trading volume, and volatility have a large impact on liquidity. They discover a high correlation between the two, which is consistent with the Ho and Stoll inventory model (1983). In a different study, Chordia et al. (2002) examine how trade volume affects stock liquidity. They contend that this measure hides some information since it is skewed by sizable one-sided trades or order imbalances. Watanabe (2004) examines the effects of trade volume as well, using share turnover as a proxy. The two main dominant perspectives on the microstructure dynamics of liquidity are brought together by Chordia et al. (2002) in the same study. They argue that the inventory model (Ho & Stoll, 1983) is more affected by market activity as a whole, whereas the asymmetric information (Glosten & Milgrom, 1985; Easley & O'Hara, 1987) is linked to individual trading activity.

Research in the area of liquidity began to progressively focus on common macroeconomic aspects in the early 2000s (Chordia et al., 2000 highlights this trend). According to Chordia, Sakar, and Subrahmanyam (2005), market liquidity varies with the business cycle, contains seasonal components, and is vulnerable to macroeconomic shocks. Since then, a great deal of research has examined this market-wide variation, most notably Acharya and Pedersen (2005), who contend that liquidity risk is a pricing factor. Hasbrouck and Seppi (2001) and Huberman and Halka (2001) were among the first to assess aggregate levels of liquidity, while Korajczyk and Sadka (2008) extracted the commonality trend by carrying out a time-series investigation, which was necessary to properly investigate the time-varying component of liquidity. It is possible to investigate liquidity across longer time periods by looking at overall market liquidity (Chordia et al., 2005).

The degree of stock market liquidity is crucial as existing research indicates that it is linked to a firm's lower cost of capital (Amihud and Mendelson, 1986; Diamond and Verrecchia, 1991), superior stock prices and firm value (Fang et al., 2009; Holmström and Tirole, 1993), as well as higher institutional and foreign ownership (Ferreira and Matos, 2008; Gompers and Metrick, 2001). Therefore, the development and growth of a company's financial position is closely related to stock market liquidity (Guiso et al., 2004; 2008). Stock liquidity is therefore an important factor in determining a company's financial performance and is important for both management and shareholders.

2.3 Stock Price Volatility

Generally speaking, volatility is the degree of variation of a trading price series over time as commonly measured by either standard deviation or logarithmic return. Stock price volatility is a manifestation of market efficiency, which is a response to the market's inadequate knowledge (i.e., uncertainty) (Hameed, 2006). There would be high market volatility present if stock values fluctuated sharply up and down. Low volatility is present if there are hardly any price movements. This unpredictability of returns makes the stock a more risky investment. Investors seek bigger returns because of the heightened risk. Companies with very volatile stock prices must either boost profitability while demonstrating a gradual growth in earnings and stock price or pay extremely high dividends. Some investors believe incorrectly that stock price volatility is based on the direction of the price trend. However, volatility is actually the degree of price variation (Malkiel & Xu, 1999). Therefore, stock price volatility is a commonly seen and used metric to measure risk associated with trading in financial securities.

According to Wang et al. (2020), accurate modeling and forecasting of the stock market volatility plays a crucial role in financial regulation, portfolio decisions, risk management, credit derivatives and other fields, which affect financial market participants' decision-making processes. Therefore, stock price volatility plays a great role in financial institutions, regulation authorities, portfolio- and fund managers and financial market participants. To illustrate, stock price volatility is closely monitored by financial regulatory agencies to prevent the volatility spillover impact, which is the transmission of market volatility from one financial market to another, of significant developments in the global financial markets and market investors even track the stock market volatility in real time to optimize portfolio strategy and avoid market risk. (Wang et al., 2020.)

Besides the stated importance for all participants of financial markets, stock volatility is widely researched in terms of its relationship with other financial market metrics. Schwert (1990) shows that there is a higher likelihood of significant stock price changes of either sign when stock market volatility (measured by the percentage change in prices or rates of return) increases. Jones et al. (1994) researched the relation between the effect of trade decomposed trading volume into two components, trade frequency and trade size.

Kyröläinen (2008) researched the relation between day trading and stock price volatility. According to Kyröläinen, the number of daily transactions made by individual investors is highly and positively correlated with the intraday stock price volatility. Nelson (1996) found that market volatility variations can be partially explained by *leverage effects*. When a

company's stock price declines, it becomes more leveraged, and the return is often more volatile. In addition, Fama et al (1977) and Christies (1982) demonstrated that high market volatility is correlated with high nominal interest rates.

2.4 Hypotheses development

As stated earlier, a lot of study has been done on the effects and relationships of the metrics being investigated. A company may experience both positive and negative effects from greenwashing. In this part, theories and links between greenwashing, stock market liquidity, and stock price volatility will be used to form hypotheses.

Theories behind greenwashing

The logics behind greenwashing were mostly explained by the signaling theory by Ross (1977). The signaling theory suggests that firms use specific actions, such as disclosing information about their CSR performance, to signal to stakeholders that they are financially sound and well-managed. This can lead to increases ins stock liquidity and a decrease in stock price volatility because it reduces uncertainty and risk for investors. When firms disclose their CSR performance, it provides stakeholders with information about the firm's social and environmental performance, which can be used as an indicator of the firm's overall financial health. This information can reduce the uncertainty and risk associated with investing in the firm, leading to a decrease in stock price volatility. Investors are more likely to invest in socially responsible firms, thus good CSR performance can lead to an increase in the demand for the company's stock, which in turn leads to a decrease in stock price volatility. Additionally, firms with good CSR performance are considered less risky and more stable. As a result, they are less likely to experience sudden and drastic changes in stock prices, leading to a decrease in volatility. Several benefits can be derived from this. A low stock price volatility is generally considered a good thing for a company because it indicates a level of stability in the stock price. This stability can make it easier for investors to predict the stock's future performance and make investment decisions based on that prediction. Thereby, a low stock price volatility can also help a company maintain investor confidence. If a stock is highly volatile, it can be difficult for investors to know when to buy or sell shares, and they may become hesitant to invest in the stock. A stable stock price can help investors feel more secure in their investments and may encourage them to hold onto their shares for longer periods of time. In addition, a low stock price volatility can benefit a company in

terms of its capital-raising activities. Suppose a company's stock price is highly volatile. In that case, it may be more difficult for the company to issue new shares or to raise capital through other means, as investors may be hesitant to invest in a company with an unstable stock price. In conclusion, the signaling theory suggests that firms that disclose information about their CSR performance can signal to stakeholders that they are financially sound and well-managed, which can increase stock liquidity and decrease stock price volatility by reducing uncertainty and risk for investors. This gives an incentive for firms to greenwash as the act of falsely disclosing a high CSR score will deceivingly boost stakeholder's confidence and falsely decrease uncertainty and decrease risk in the company's products and practices.

However, investor and customer sentiment has changed over the last years. Investors and customers no longer fall for greenwashing techniques for a number of reasons. First, there is more regulatory pressure, and authorities are paying closer attention to ESG disclosures. Investors are less willing to invest in companies that use greenwashing because they run the danger of facing legal and reputational repercussions. Investors now have more reliable and accurate information available thanks to the regulatory pressure forcing companies to be more open and truthful in their ESG disclosures (Delmas et al., 2011). Second, investors are becoming more knowledgeable about the effects of ESG issues on corporate performance and the dangers of greenwashing. Also, they are more likely to take ESG factors into account when making investment decisions and demand that businesses report accurate and trustworthy ESG data. Because of this raised knowledge, investors are less likely to believe greenwashing claims and are more likely to perform their own due diligence to verify the veracity of company information (Wu et al., 2020). Lastly, businesses are reporting on their sustainable activities and sharing ESG data in growing numbers. This makes it simpler for investors to assess a company's environmental performance and spot those who use greenwashing. Investors may choose companies to invest in more wisely and avoid those that use greenwashing techniques thanks to the improved openness (Robinson et al., 2020).

Therefore, this paper bases its hypotheses on the information asymmetry theory formed by Akerlof (1970). The information asymmetry theory states that when one party in a transaction has more information than the other, it can lead to market inefficiencies. In the case of greenwashing, the companies engaging in this practice have an informational advantage over investors, leading to mispricing and reduced trust in the market. It's effects on stock liquidity and stock price volatility are outlined while forming the hypotheses.

Greenwashing and stock liquidity

Greenwashing has significant effects on stock liquidity, which refers to the ease with which stocks can be bought and sold in the market at stable and fair prices. Greenwashing creates information asymmetry between firms and investors by making false or misleading claims about a company's environmental practices, leading to market mispricing (Stambauch et al., 2017), decreased trust in the market (Poortinga et al., 2004), and lower investment demand (Lambert et al., 2012). Low levels of trust have been shown to have a variety of negative effects, including increased monitoring requirements (Malhotra et al., 2002), higher transaction costs (Hau-siu, 2008), decreased loyalty (Shainesh, 2012), lower levels of commitment (Gargiulo and Ertug, 2006), and detrimental effects on purchase intentions (Hong and Cho, 2011). Furthermore, as investors become more aware of the potential for greenwashing, they may demand more accurate and transparent information, which can result in higher costs for firms and lower liquidity. Ultimately, greenwashing can contribute to a less efficient market and reduce the flow of capital to companies that are truly environmentally responsible. Therefore, information asymmetry, formed by greenwashing, is key in understanding a firm's stock market liquidity wherein firms with poor (better) disclosure and transparency should suffer from a lower (higher) level of stock market liquidity (Diamond and Verrecchia, 1991; Kurlat, 2018). As a result, greenwashing can result in reduced market liquidity and increased costs for companies to provide transparent information.

Therefore, taking everything into account, the first hypothesis tested in this thesis is:

H1: Greenwashing has a negative effect on stock liquidity.

Greenwashing and stock price volatility

In line with the information asymmetry theory, Xu and Liu's (2018) study explains how CSR disclosure successfully reduces stock price volatility and changes in consumer behavior after the disclosure. The line of reasoning is that giving stakeholders a more in-depth and accurate view of a firm's environmental disclosure will reduce information asymmetry levels and increase trust levels, decreasing stock price volatility levels.

In terms of the disclosure gap, which is the discrepancy between a company's actual investments in CSR initiatives and those that are publicly declared and a form of greenwashing, Yu et al. (2019) shows that a smaller disclosure gap in terms of ESG disclosures reduces information asymmetries and idiosyncratic risk, which in turn facilitates

capital attraction and has a beneficial impact on a firm's market value. As showed before, a decrease in risk and increase capital attraction leads to higher stock liquidity and lower stock price volatility.

On the other hand, S. Watson et al. (2002) contend that organizations can cut capital expenditures and uncertainty by demonstrating the value of more disclosure of information. A company gains a positive reputation when it is more transparent about its CSR endeavors. Because people choose to invest in socially conscious companies, shareholders are drawn to those businesses. In these situations, investors may withdraw their money from the market and penalize companies that do not act responsibly toward society, which could lead to an increase in the volatility of the stock price.

Therefore, the second hypothesis tested in this study is:

H2: greenwashing increases stock price volatility levels.

Industries

Environmental legitimacy has become a crucial concern for companies, particularly those operating in environmentally sensitive sectors, as they face external scrutiny from identifiable stakeholders who can grant or withdraw legitimacy (Barnett & King, 2008; Berrone & Gomez-Mejia, 2009). In the past, companies operating in such sectors often engaged in greenwashing, which involved making false or misleading claims about the environmental benefits of their products or services. However, increased consumer awareness and scrutiny have made greenwashing less prevalent. Consumers now research products and companies before making purchases and hold companies accountable for their environmental claims (Deegan & Gordon, 1996). According to Deegan and Gordon, firms operating in environmentally sensitive industries, especially larger ones with a more significant environmental impact, are more compelled by social demands to report more about the environment and are less likely to greenwash, reducing the chances of misrepresenting themselves as green. This outcome was further supported by Bowen (2000). According to Bowen (2000), industries with a significant environmental effect are linked to environmentally apparent problems like global warming and the possibility of oil spills. Recent studies highlight the visibility of environmental issues in determining environmental responsiveness, and environmental pressure groups closely monitor the operations of businesses in these areas (Bowen, 2000; Dutton et al., 1990). Due to the increased urgency of visible issues, the organization's association with environmental issues may encourage

environmental disclosure from the perspective of external groups like investors and regulators. According to empirical research, the sectors of metals, resources, paper and pulp, power generation, water, and chemicals have a substantial environmental impact (Bowen, 2000; Sharma, 1997; and Hoffman, 1999).

Additionally, many governments have implemented stricter regulations on advertising and marketing, making it more difficult for companies to make false or misleading claims. Furthermore, many organizations and third-party certifiers have developed standards and regulations that companies can use to verify their environmental performance, which makes it harder for companies to greenwash their products and services. (Delmas et al., 2011)

This suggests that firms operating in polluting industries are less likely to greenwash due to the higher probability of public scrutiny by environmental organizations and, therefore, experience superior financial performance (Walker et al., 2012).

By linking this finding to previous literature concerning stock liquidity (Akutran, 2018; Chen & Chang, 2013; Chen, Lin & Chang, 2014), which states that greenwashing is negatively related to stock market liquidity, I expect that firms in environmental sensitive industries are less participating in greenwashing activities and, therefore, have higher stock liquidity levels than firms operating in less environmental sensitive industries. Accordingly, the third hypothesis tested in this study is as follows:

H3: The negative effect of greenwashing on stock market liquidity is reduced for firms operating in an environmental sensitive industry, as they participate less in greenwashing activities.

Concerning stock price volatility, studies by Xu and Liu (2018) and Yu et al. (2019) show that CSR disclosure can reduce stock price volatility and change consumer behavior by reducing information asymmetry and increasing trust levels. S. Watson et al. (2002) argue that companies can reduce costs and uncertainty by being more transparent about their CSR endeavors, which can attract socially conscious shareholders and lead to a positive reputation.

By linking the findings concerning the effects of different types of industries on greenwashing to the previous literature regarding stock price volatility, we expect that in environmental sensitive industries companies participate less in greenwashing activities and therefore have lower CSR disclosure gaps, resulting in lower stock price volatility levels. Therefore, the fourth hypothesis tested becomes:

H4: The negative effect of greenwashing on stock price volatility is reduced for firms operating in an environmental sensitive industry, as they participate less in greenwashing activities.

Firm size

According to Christopher et al. (1998), a company's degree of environmental disclosure is positively correlated with the organization's size. As a company grows, shareholders and customers exert greater pressure on the firm to implement sustainable initiatives. This increased pressure can make environmental reporting a more salient issue for larger companies, as they are at a higher risk of reputational damage if perceived as unsustainable. Furthermore, as larger companies are subject to greater scrutiny, the likelihood of being caught engaging in "greenwashing" increases, which can serve as a deterrent to such behavior. Therefore, it can be reasonably inferred that the size of a company is a significant determinant of the level of environmental disclosure and that larger companies are less likely to engage in greenwashing.

As previous research (Akutran, 2018; Chen & Chang, 2013; Chen, Lin & Chang, 2014) showed that greenwashing is positively related to stock market liquidity, the next hypothesis is formed as follows:

H5: The negative effect of greenwashing on stock liquidity is reduced by firm size, as firm size is positively related with stock liquidity.

Chueng et al. al (1992) found that firm size can have a significant impact on stock price volatility. Due to their limited size and resources, smaller firms may have less diversified business operations and may be more vulnerable to market fluctuations, which can result in more volatile stock prices. In contrast, larger firms tend to have more diversified business operations and greater access to financial resources, which can help to stabilize their stock prices. As a result, larger firms typically exhibit less volatile stock prices compared to smaller firms.

Following the research conducted by Ross (1970), Xu et al. (2018), Yu et al. (2019) and Watson (2002), we expect that greenwashing has a positive relation with stock price

volatility. As firm size is predicted to have a negative relation with greenwashing, we expect that bigger companies are less engaged in greenwashing practices and, therefore, have lower stock price volatility levels. The last hypothesis becomes:

H6: The negative effect of greenwashing on stock price volatility is reduced by firm size.

2.5 Conceptual model

In the previous paragraph hypotheses are formed on basis of previous literature. To visualize this research design, I made a conceptual model presented in Figure 2. The independent variable, greenwashing, is centered between the two dependent variables, stock liquidity and stock price volatility. The control variables, type of industry and firm size, are standing on both sides of the graph.

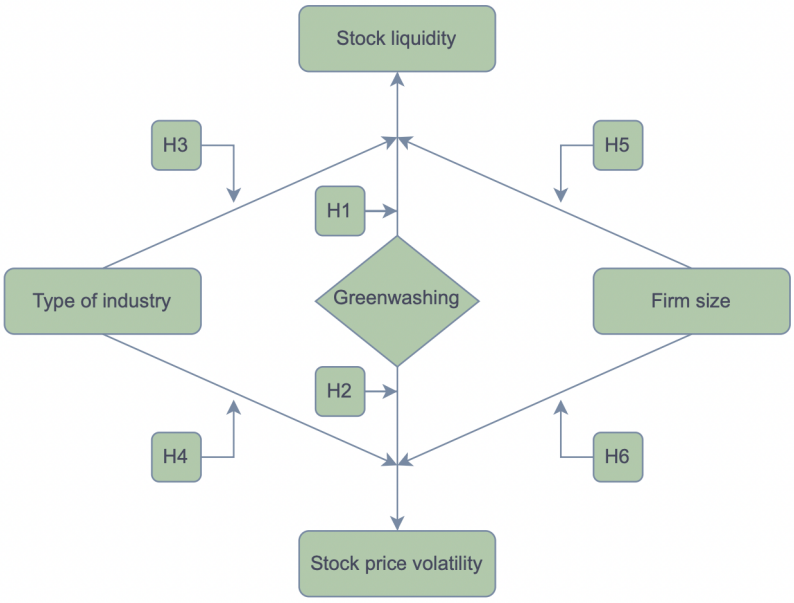

Figure 2. Conceptual model.

The expected relationships between greenwashing and the control variables, type of industry and firm size, on stock liquidity and stock price volatility are presented in the table below.

Dependent variables	***Stock liquidity***	***Stock price volatility***	***Based on***
Direct effect of independent variable: Greenwashing	-	+	(Akerlof, 1970; Akutran, 2018; Chen & Chang, 2013; Chen, Lin & Chang, 2014; Ross, 1977; Xu & Liu's 2018; Yu et al., 2019; Watson et al., 2002)
Indirect effect: Type of industry (environment sensitive vs. environment non-sensitive)	+	-	(Deegan et al., 1996; Bowen, 2000; Dutton et al., 1990; Sharma, 1997; and Hoffman, 1999)
Indirect effect: Firm size	+	-	Christopher et al. (1998), Akutran, 2018; Chen & Chang, 2013; Chen, Lin & Chang, 2014; Cheung et al. (1992).

Table 3. The relationships between greenwashing, stock price liquidity and stock price volatility

3. Data & Methodology

In this section, we will discuss the databases used to gather the relevant data. We will then explain the process for creating a well greenwashing score and its application in this study. Additionally, we will provide details on how the stock liquidity and stock price volatility measurements were formed and used in this paper. The control variables used in the empirical model will also be discussed, including their connections to the dependent, independent, and control variables. Finally, we will outline the statistical methods utilized to test the hypotheses,

3.1 Data

Research sample

The sample of this research is consisting of all firms that have been index constituents in the S&P 500 index from 2013 until 2023. A Deloitte study found that the proportion of S&P businesses reporting on ESG concerns increased from 20% in 2011 to 72% in 2013 due to the growing importance of transparency and ESG disclosures (Robinson et al., 2020). Also, as we get closer to the current year, the information in these reports has grown and become more valuable (Governance & Accountability Institute, 2020). As a result, I have decided to focus on the years post-2013, where more ESG information is available to contribute to the scoring of companies. As previous studies have done (Cooper & Uzun, 2015; García-Sánchez et al., 2020; Hawn & Ioannou, 2015), ESG scores are lagged by one year because the impact is not expected until at least the following year. Moreover, S&P500 firms were chosen

because larger companies usually lead in sustainability reporting and often set trends that others follow later (Threlfall et al., 2020).

To test the hypotheses if greenwashing practices of corporation's effects stock liquidity and stock price volatility, different databases were needed and merged. All data is obtained through the Bloomberg and Eikon Refinitiv databases, access granted by the Erasmus University Rotterdam. The datasets were merged through ISIN identifiers, both offered by the different datasets.

A greenwashing proxy is formed with normalized ESG disclosure scores and normalized ESG performance scores. I compile the ESG disclosure scores from the Bloomberg database, as was done in earlier research on greenwashing (Tamimi et al, 2017; Yu et al., 2018, 2020; GarcíaSánchez et al., 2020). Then, any missing observations are removed while keeping any firm that has a disclosure score for one or more years.

In accordance with earlier research, I compared the ESG performance scores from Thomson Reuters Asset 4 scores, now implemented in the Eikon Refinitiv database, with Bloomberg ESG disclosure scores (Pinnuck et al., 2020; Yu et al., 2018, 2020; Mittelbach-Hörmanseder et al., 2021). The Eikon scores have a range from 0.1 to 100, just like the Bloomberg ESG disclosure scores. I reiterate that I only save observations corroborating with the Bloomberg dataset.

The yearly stock trading data of firms is retrieved from the Eikon Refinitiv database, the access is granted through the Erasmus University. This database offers yearly data on stocks of listed companies in the United States of America, traded on the NYSE and the Nasdaq. In order to use Amihud's (2002) illiquidity ratio for this research, the following data is extracted from Eikon Refinitiv: the daily opening stock prices, the daily closing stock prices and the daily turnover by volume. To get a representative illiquidity ratio, I included only companies having at least 2 months of trading data per year. In addition, the daily trade volume must be greater than 0, the minimum stock price above $0,50 cents as the returns will be biased and days when there was no data available were removed from the dataset.

The yearly stock price volatility data is also subtracted from the Eikon Refinitiv database. All data concerning stock price volatility for S&P 500 listed firms is included and therefore easily obtained through the database.

3.2 Variable description

Independent variable: Greenwashing

The independent variable researched in this paper is greenwashing score. The definition of a *greenwashing company* is one that discloses much data to appear transparent while failing to perform well in ESG areas.

The amount of ESG data that a company discloses is measured by the disclosure scores offered by Bloomberg. The scores only consider transparency and do not account for ESG performance. A little over 900 non-financial ESG factors, including political donations, employee training expenses, and environmental spills, are used to calculate the score. By reflecting how transparent the company is, the scoring system aids stakeholders and investors in evaluating risks and opportunities.

The Asset4 scores rank listed firms in ten distinct categories, such as emissions, CSR strategy, and human rights, to indicate the ESG performance. The weighting of each category gives categories with more difficulties a higher weight in the final score (Huber & Comstock, 2017). The scores are derived from more than 400 different pieces of data. Additionally, Asset4 considers country- and industry-specific elements, and the evaluation is related to the Asset4 universe.

Based on earlier studies in the field (Garca-Sánchez et al., 2020; Hawn & Ioannou, 2015; Izzo & Magnanelli, 2012; Yu et al., 2018, 2020), the greenwashing variable is calculated as follows:

Greenwashing score = a company's normalized disclosure score as reported by Bloomberg – the company's normalized ESG performance score as reported by Asset 4

The ESG and disclosure scores are divided by 100. The total sample scores are then normalized by subtracting the mean and dividing by the standard deviation. The score for greenwashing is determined as depicted above. There are, in essence, three results. In the first place, the company may have a high score, indicating that it is greenwashing. Second, a score of 0 would mean that the company's ESG performance and transparency scores are equal. Last but not least, a negative score denotes that the company is revealing too little data on its ESG performance and, therefore, is not engaging in greenwashing practices.

The impact of greenwashing on stock liquidity and volatility will be measured using a continuous Greenwashing metric based on the calculation described above. A multiple regression analysis will examine the relationship between the Greenwashing metric and stock market outcomes. The Greenwashing metric will be referred to as such throughout the study.

Dependent variable: stock liquidity

This research uses the Amihud (2002) illiquidity measure, one of the most widely used liquidity substitutes in the finance field, to analyze the effects of greenwashing on stock liquidity.

The Amihud illiquidity measure is used to assess how greenwashing affects the stock liquidity of S&P 500 companies because it shows whether there is a correlation between a company's ESG performance and its stock liquidity. In particular, if greenwashing increases stock investments in a company, it may also increase demand for the stock and trading volume, which could lower liquidity and raise the cost of immediacy, which is what the Amihud illiquidity metric can measure.

It is possible to determine whether there is a substantial difference in liquidity between the groups assessed by comparing the Amihud illiquidity score for companies with high greenwashing scores to those with lower greenwashing scores. If there is a significant difference, this would indicate that ESG-focused investors are increasing demand for shares of high-rated ESG companies, which might encourage greenwashing and reduce stock liquidity.

The Amihud (2002) metric offers two advantages compared to many other liquidity measures Firstly, the Amihud metric is created in a straightforward method by using the daily return-to-volume ratio's absolute value as a proxy for price impact.. This design is highly suitable for evaluating a time frame of companies from the S&P500, as all relevant data is readily available in the public domain and easily accessible from databases. Secondly, Hasbrouck (2009) compared various price impact measures, which were constructed from daily and microstructure data. He concluded that the Amihud illiquidity ratio displays the strongest correlation with microstructure-based price impact measures, thus making it a highly effective measure to utilize in this research.

Our research contributes to a deeper understanding of the liquidity measure introduced by Amihud in 2002, which is often utilized in financial literature. As the Amihud measure has a strong correlation with the high-frequency price impact benchmark, we can affirm that it does a good job of capturing stock liquidity and price impact. Since stock illiquidity may be measured, the Amihud measure is useful.

$$A_{iy} = \frac{1}{D_{iy}} \sum_{t=1}^{Diy} \frac{|r_{it}|}{Dvol_{it}}, \tag{2}$$

where A_{iy} is the Amihud measure of firm i estimated in year y; r_{it} and $Dvol_{it}$ are daily return and daily dollar trading volume for stock i on day t; D_{iy} is the number of days with available ratio in year y. Everything else equal, higher trading volume will lead to a lower Amihud illiquidity measure. This linkage is particularly strong because the trading volume component has a much greater crosssectional variation than the stock return component. For example, the 75th percentile cutoff of the trading volume component is over 100 times its 25th percentile cutoff, but the 75th percentile cutoff of the return component is just two times its 25th percentile cutoff (Lou et al., 2014).

A greater (lower) Amihud ratio denotes less (more) stock market liquidity since the prices of illiquid equities are more (less) susceptible to trading. Since it is proven to be closely connected with other benchmark proxies that evaluate stock market liquidity, previous studies imply that Amihud's (2002) measure is among the best price-impact proxies (Fong et al, 2017; Goyenko et al, 2009; Marshall et al, 2012).

Dependent variable: stock price volatility

The second dependent variable researched is stock price volatility. The standard deviation, which measures the spread or dispersion of a set of data from its mean or average, is an effective way to test the volatility of stock prices connected to greenwashing. The standard deviation can be used to evaluate the volatility of a stock's price movement over time in the context of stock pricing. As this research focuses on the effects of greenwashing on stock price volatility of S&P 500 firms, this metric fits perfectly.

Using the standard deviation to measure the volatility of a stock's price movement, investors can gauge the degree of change in risk associated with investing in a company that engages in greenwashing practices. The standard deviation should be interpreted as follows: if a stock has a high standard deviation of stock prices it is more likely to experience significant price swings, and its price is less predictable over time. This implies a higher degree of risk for investors. On the other hand, a stock with a low standard deviation is less likely to experience large price swings, and its price is more predictable over time, indicating lower risk for investors. Therefore, the standard deviation can be a valuable tool for investors who want to assess the potential impact of greenwashing on a company's stock price volatility.

Firm size

Firm size is one of the traits that might affect environmental disclosure and, consequently, greenwashing. According to Soutar et al. (1998), the amount of environmental disclosure depends on firm size. According to them, when a company grows, shareholders and customers will put more pressure on it to improve its sustainability efforts. It makes it reasonable that environmental reporting would become a more serious concern as larger companies suffer greater reputational risk if considered a highly unsustainable corporation. As larger companies are examined more frequently and the chance of "getting caught" of greenwashing increases, this results in less greenwashing and, in the end, will affect idiosyncratic stock market liquidity and stock price volatility. Firm size is based on the market capitalization of the firms included in this research.

Industry

Another topic that authors suggest influences greenwashing is the industry in which a firm is active. Deegan and Gordon (1996) suggest that firm industry background plays a much larger role in the level of sustainable disclosure than expected. They suggested that firms operating in environmentally sensitive industries (such as the mining industry) are more subject to social pressures and thus provide more environmental reporting, especially if they were larger (since their environmental impact would also be larger). Their theory would suggest that firms who have a more severe impact on the environment are less likely to greenwash. This result was also found by Brammer and Pavelin, 2006.

The present study draws on previous research by Cowen et al. (1987) and Patten (1997; 2002), to categorize industries that exhibit a higher degree of environmental sensitivity based on primary SIC codes (i.e., Standard Industrial Classification codes). Industries (and their SIC codes) often classified as environmentally sensitive include mining (10xx, 12xx), oil and gas (13xx, 29xx), paper (26xx), chemical (28xx), excluding pharmaceuticals (283x), metals (33xx), and utilities (49xx). A dummy variable (i.e., 1 or 0) is utilized to operationalize this categorization to distinguish companies operating in these industries.

3.3 Control variables

The literature on greenwashing has primarily examined its direct effects on stock market liquidity and stock price volatility. However, a growing body of research has investigated the

relationship between firm and industry characteristics on greenwashing, stock market liquidity, and stock price volatility. This line of inquiry focuses primarily on financial attributes such as profitability, market-to-book ratio, and leverage. Additionally, some studies have found that firms operating in certain industries are more likely to engage in environmental reporting and perform better in this regard. These findings contribute to a better understanding of the complex interplay between greenwashing, financial performance, and industry-specific factors in the stock market.

Financial control variables

Stock liquidity and stock price volatility may be influenced by additional firm-specific factors. By leaving out factors that potentially affect the studied dependent variables, results could be skewed. Because they have a significant impact on stock liquidity and stock price volatility, leverage, market to book value, dividend yield, and return on assets are included in this study as control variables, which is consistent with other studies (Benlemlih et al., 2018; Chollet and Sandwidi, 2018; Shakil et al., 2019).

Leverage

A body of scholarly literature has examined the relationship between stock liquidity and capital structure. Notable studies in this field include Lipson et al. (2005), Lesmond et al. (2008), and Frieder et al. (2006). However, the findings from these studies have generated controversy, as they reveal a degree of inconsistency across countries. Specifically, some studies have indicated that higher financial leverage positively affects stock liquidity, while others suggest a negative impact of financial leverage on liquidity. In addition, Figlewski et al (2000) predicted that stock market volatility increases with financial leverage. As leverage has both influences stock liquidity and stock volatility, a control variable of leverage is included in the regressions.

Market-to-book

According to Gutierrez and Pirinsky's 2007 research, institutional investors frequently purchase cross-sectional return winners while chasing relative returns. They demonstrate how these stocks frequently have high market-to-book ratios on average. Such transactions boost stock liquidity by deepening the market. High corporate performance hence increases demand from institutional investors, which in turn creates liquidity. In its research on stock price

volatility of US banks, Tasnia et al. (2021) found a significant negative relationship between market-to-book ratio and stock price volatility. Reasons could be that a high market-to-book ratio indicates stable earnings, higher quality of assets, lower leverage, and better growth prospects.

Dividend yield

Agarwal (2007) researched the relationships between institutional ownership and the liquidity of stock, taking along the effect of dividend yield on stock liquidity. His research found that dividend yield is positively related to stock liquidity. This because a high dividend yield increases investor demand, signals market confidence and price support for their stocks during periods of economic uncertainty.

Huddsunry et al. (2011) found a negative significant relationship between dividend yield and stock price volatility, consistent with prior of Allen and Rachim (1996). This because dividend-paying stocks tend to be viewed more positively by investors, leading to increased price support, reduced trading activity, and lower volatility. Additionally, the steady income stream provided by dividends can help reduce the impact of price fluctuations on overall returns, which can further reduce volatility.

Allen and Rachim (1996) Huddsunry et al. (2011)

Return on Assets

Khan et al. (2019) found that return on assets and liquidity are positively related. This positive relationship between ROA and stock liquidity comes from the fact that companies with high ROA tend to be viewed more positively by investors, which can lead to increased demand and price support for their stock. This, in turn, promotes a more active trading environment and higher liquidity.

Return on assets is also correlated with stock price volatility. Nguyen et al (2020) found that a high ROA could lead to lower stock price volatility, as investors may view the company as more stable and less risky. This perception of lower risk could lead to lower uncertainty and volatility in the stock price. However, this relationship is only sometimes true and can be influenced by factors such as market conditions, industry trends, company management, and investor sentiment.

All the variables mentioned above are described in the table below by definition and computation (Table 2).

Main variables:	Description
Greenwashing	*Independent variable that is computed as company's normalized disclosure score as reported by Bloomberg – the company's normalized ESG performance score as reported by Asset 4*
Stock liquidity	*Independent variable which is computated as following Amihud's Illiquidity measure:* $A_{iy} = \frac{1}{D_{iy}} \sum_{t=1}^{Diy} \frac{\lvert r_{it} \rvert}{Dvol_{it}},$
Stock price volatility	*Independent variable which is computated as the standard deviation of stocks.*
Second degree independent variables	
Environmental sensitive industries	*Distinguished in the panel data through SIC-codes. Environmental sensitive industries SIC-codes (10xx, 12xx, 13xx, 26xx, 28xx (excluding pharmaceuticals 283x), 29xx, 33xx, 49xx).*
Firm size	*Independent variable computed as the market capitalization, which is the total dollar value of a company's outstanding stock.*
Financial control variables:	
Leverage	Size variable is computed by taking the natural logarithm of total assets: ln(Total Assets)
Market-to-book ratio	Growth opportunity measure that is computed by 1/ (Total Market Value / Total Assets)
Dividend	
Return on Assets	Profitability measure that is computed by EBITDA/Average Total Assets

Table 2: The following table provides the description and measurement approach for the dependent, independent and control variables used in this study.

Descriptive statistics and correlation of variables

The descriptive statistics of the control and sample variables are displayed in Table 3 on the following page. First, Residual versus Fitted (RVF) test was done to assess for linearity across the independent and dependent variables. The RVF plot is used to assess linearity, with random scattering of residuals around zero, indicating a linear relationship between independent and dependent variables. In order to validate our dependent and independent

variables for this research, several transformations had to be made. The Amihuds illiquidity ratio was found to be non-linear related with firm size, measured in market capitalization. The scatterplots can be found in appendix A. The Amihuds illiquidity ratio is therefore transformed in a square root Amihud illiquidity ratio throughout this study following Hasbrouck (2009) and Chelly-Steely (2015). They even state that the square root transformation may perform better empirically.

The second adjustment that had to be made was a log transformation for firm size, measured in market capitalization. As can be seen from table 3, firm size, measured in market capitalization, is highly non-normal distributed. This can be seen as the kurtoisis has a value of 198,53 and a skewness of 11,554. Kurtosis measures the degree of peakedness and heaviness of the tails of the distribution. A value of 198,53 indicates that the distribution has extremely heavy tails and is highly peaked, which means that extreme values are more likely to occur than in a normal distribution. The skewness value of 11,554 suggests that the distribution is highly skewed to the right, with a long tail extending in that direction. Therefore, a log transformation is made of market capitalization. This stabilizes the variance of the variable and reduces the impact of extreme values. This changes the kurtosis to 3,197 and the skewness to 0,143.

The mean of stock price volatility of the sample is stated in percentages. This indicates that the mean of the stock's annual high and low price has shown a historical variation of +20,967% to -20,967% from its annual average price.

The continuous greenwashing variable has a mean of -0.051. This implies that over the sample including S&P 500 firms from over de last ten years, companies disclose too little over their ESG performance score, indicating that they are in fact more CSR and, therefore, ESG oriented than they are sharing with their shareholders and stakeholders. This is in line with the works of Soutar et al. (1998), which predicted that large firms greenwash less than their smaller counterparts, as S&P 500 firms are the largest firms in market cap in the U.S. market.

For the dummy greenwashing variable, the average greenwashing score is 0,45. This means that firms which are greenwashing, have an average gap of 0,45 on a score based on ESG disclosure scores and ESG performance scores, which should lie between -1 and +1. Therefore, we could say that firms which are greenwashing are….

The mean of firms operating in environmental sensitive industry is 0.266. This implies that from the 2140 firm years were data is available, 26.6% were operating in

environmental sensitive industries. This comes down to 483 firm years' operating in environmental sensitive industries and 1657 in non-environmental industries.

The average firm size, measured in Ln market cap, has an average of 17.21 thousand of millions dollars. This comes down to $17 billion dollars average for each firm.

Variable	N	Mean	Std. Dev.	min	p5	p25	Median	p75	p95	max	kurtosis	skewness
A	2140	.079	.087	.001	.008	.026	.052	.091	.266	.448	9.871	2.512
sqrtA	2140	.25	.127	.028	.09	.163	.228	.302	.516	.67	4.746	1.239
vol	2140	20.967	6.487	9.75	12.525	16.445	19.88	24.425	33.105	49.58	4.87	1.149
greenwashing	2140	-.051	.774	-2.578	-1.247	-.613	-.092	.46	1.253	3.458	3.043	.196
dGreenwashing	2140	.45	.498	0	0	0	0	1	1	1	1.04	.199
env sens	2140	.226	.418	0	0	0	0	0	1	1	2.722	1.312
Mcap	2140	62856739	1.346e+08	672448	443672	138366	273934	634890	2.282e+08	2.917e+09	198.53	11.554
lnMcap	2140	17.21	1.18	13.419	15.305	16.443	17.126	17.966	19.246	21.794	3.197	.143
leverage	2140	126.60	122.81	0	0	46.87	86.39	155.98	497.15	497.15	5.517	1.748
mb	2140	4.644	4.612	.46	.46	1.68	2.99	5.4	18.64	18.64	5.634	1.837
dividend	2140	2.246	1.252	0	0	1.4	2.23	3.05	4.703	4.705	2.428	.086
ROA	2140	6.96	5.204	-1.11	-1.11	3.19	6.2	10.05	18.02	18.02	2.513	.541

Table 3. This table shows the descriptive statistics of the dependent and independent variables. Secondly, it shows the descriptive statistics of the firm-specific variables. The sample consists out of 2140 company years where both Bloomberg ESG-disclosure score and Eikon Refinitiv's ESG performance score were available.

In addition to the RVT test for linearity, as done earlier, tests for heteroscedasticity and multicollinearity must be done to ensure the data is suitable for this research.

To address the violation of the homoscedasticity assumption, a robust standard error analysis is utilized following Breusch and Pagan (1979) with extensions from Cook and Weisberg (1983)**.** Results indicate a preference for the fixed effects model, as evidenced by a significant test statistic exceeding the critical value derived from the chi-square distribution. Thus, the fixed effects model, in combination with the robust standard error analysis, is employed for the regressions. The results of the Breusch-Pagan and Cook-Weisberg are in appendix B.

Multicollinearity can be assessed using the VIF test, which helps identify high levels of correlation among independent variables. Table 4 displays the correlation between the variables used in our empirical model. As per Pallant's (2005) criteria, correlations exceeding -0.5 or 0.5 suggest moderate multicollinearity and correlations beyond -0.7 or 0.7 indicate high correlation. While the greenwashing variables exhibit high correlation due to their shared inputs, it is inconsequential as they are distinct, independent variables and will not be used together in a single regression. The results of the correlation matrix show no serious

issues of correlation, therefore the variables are all included in the regression.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) sqrtA	1.000									
(2) vol	0.394***	1.000								
(3) Greenwashing	0.077***	0.014	1.000							
(4) dGreenwashing	0.096***	0.034	0.807***	1.000						
(5) env_sens	0.079***	-0.024	0.305***	0.259***	1.000					
(6) ln_mcap	-0.476***	-0.412***	-0.075***	-0.106***	-0.131***	1.000				
(7) leverage	0.086***	0.016	0.060***	0.049**	0.077***	-0.063***	1.000			
(8) mb	-0.097***	-0.136***	-0.022	-0.018	-0.152***	0.164***	0.518***	1.000		
(9) dividend	-0.096***	-0.342***	0.078***	0.073***	0.256***	0.029	0.109***	-0.118***	1.000	
(10) ROA	-0.211***	-0.164***	-0.076***	-0.082***	-0.213***	0.213***	-0.043**	0.453***	-0.101***	1.000

***Table 4**. This table shows the Pearson's correlation matrix between all variables used in the analysis. *** p<0.01, ** p<0.05, * p<0.1*

3.4 Methodology

Model

This study built statistical models to test the hypothesis regarding the link between greenwashing, stock liquidity and stock price volatility of the S&P 500 firms over the time period of 2013-2022. Thereby looking at the moderating role of firm size and the type of industry, while controlling for leverage, market-to-book ration, dividend and return on assets

To see the effects of greenwashing on liquidity and volatility levels, this study will perform Pooled Ordinary Least Squares (OLS) panel regressions since the models will analyze one dependent variable at the time, stock market liquidity and stock price volatility, and one or more independent variables, of which greenwashing is the main variable analyzed. Moreover, panel regressions, using a fixed-effects model, will be performed because the dependent variable and independent variables are most likely to vary over time for each firm. Lastly, OLS regression models with panel data are the most appropriate method because the data contains repeated observations on the same units.

Tabel 5 shows the models used per hypothesis tested.

Hypothesis	Model
H1	$LIQ_{it} = \alpha_o + \beta_1 \text{Greenwashing score} + \beta_2 LNSIZE + \beta_3 PROF + \beta_4 LVG + \beta_5 MVB + \beta_6 ROA + \varepsilon_{it}$

H2	$VOL_{it} = \alpha_o + \beta_1$Greenwashing score$+ \beta_2$LNSIZE $+ \beta_3$PROF$+ \beta_4$LVG $+ \beta_6$MVB $+ \beta_7$ ROA $+ \varepsilon_{it}$
H3	$LIQ_{it} = \alpha_o + \beta_1$Greenwashing score$+ \beta_2$ LNSIZE $+ \beta$3dIND $+ \beta_4$PROF$+ \beta_5$LVG $+ \beta_6$MVB $+ \beta_7$ ROA $+ \varepsilon_{it}$
H4	$VOL_{it} = \alpha_o + \beta_1$Greenwashing score$+ \beta_2$LNSIZE $+ \beta$3dIND $+ \beta_4$PROF$+ \beta_5$LVG $+ \beta_6$MVB $+ \beta_7$ ROA $+ \varepsilon_{it}$
H5	$LIQ_{it} = \alpha_o + \beta_1$Greenwashing score $+ \beta_2$ LNSIZE $+ \beta_3$PROF$+ \beta_4$LVG $+ \beta_5$MVB $+ \beta_6$ROA $+ \beta_7$ Greenwashing* LNSIZE $+ \varepsilon_{it}$
H6	$VOL_{it} = \alpha_o + \beta_1$Greenwashing score $+ \beta_2$LNSIZE $+ \beta_3$PROF$+ \beta_4$LVG $+ \beta_5$MVB $+ \beta_6$ROA $+ \beta_7$ Greenwashing* LNSIZE $+ \varepsilon_{it}$

Table 5. *This table shows the models used per hypothesis in this research. The variables used in these models are Amihuds illiquidity measure denoted by LIQ, Greenwashing denoted by greenwashing score, Firm size denoted by LNSIZE, profitability denoted by PROF, leverage dentoted by LVG, market-to-book ratio denoted by MVB. return on assets denoted by ROA, a dummy variable dIND is included to see the effect of different types of industries and the error term denoted bu* ε.

4. Results

The following section presents the results of regression analyses used to test the hypotheses. The first part examines the findings of multivariate regression models that investigate the impact of greenwashing on stock liquidity, while the second part delves into the results of multivariate regression models examining the effects of greenwashing on stock price volatility. Lastly, robustness checks are presented to validate the results.

4.1 Regression results

To test hypotheses 1, 3, and 5, which examine the relationship between greenwashing and stock liquidity levels of S&P 500 firms from 2013-2022, various OLS regression models were utilized. Financial control variables were incorporated to counteract potential biases that could affect the results. Table 6 displays the results of the regression, along with the standard errors for each variable.3

Dependent variable: *Stock liquidity*	(1)	(2)	(3)
Independent variable:			

Greenwashing	0.00355**	0.00370**	0.00954
	(0.00143)	(0.00166)	(0.0264)
Moderating variables:			
env_sens	-0.00565*	-0.00548*	
	(0.00318)	(0.00322)	
Ln Firm size	-0.0961***	-0.0961***	-0.0959***
	(0.00124)	(0.00124)	(0.00123)
Greenwashing*Environmental sensitive		-0.000694	
		(0.00313)	
Greenwashing*Ln Firm size			-0.000436
			(0.00153)
Financial control variables			
Leverage	-1.36e-05	-1.34e-05	-1.48e-05
	(1.29e-05)	(1.29e-05)	(1.29e-05)
Market-to-Book	0.00157***	0.00156***	0.00161***
	(0.000391)	(0.000390)	(0.000392)
Dividend Yield	-0.00656***	-0.00656***	-0.00696***
	(0.00120)	(0.00120)	(0.00114)
Return on Assets	-0.00136***	-0.00136***	-0.00131***
	(0.000296)	(0.000296)	(0.000294)
Constant	1.904***	1.904***	1.899***
	(0.0219)	(0.0219)	(0.0218)
Observations	2,113	2,113	2,113
R-squared	0.828	0.828	0.827
Adjusted R-squared	0.827	0.827	0.827
F	1043	928.5	928.5
p	0	0	0
rmse	0.0524	0.0524	0.0524

Table 6. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.

The first column in Table 1 presents the direct impact of greenwashing on stock liquidity while controlling for financial control variables. The coefficient reveals a slightly positive correlation between greenwashing and the Amihud illiquidity ratio, indicating that increased greenwashing results in reduced stock liquidity. The result is statistically significant at a 5% level, consistent with hypothesis 1, which is based on previous research by Malhotra et al. (2002), Hau-siu (2008), Shainesh (2012), (Gargiulo & Ertug, 2006), and Hong and Cho (2011). These findings align with those of Velte (2022), who observed that decreased greenwashing enhances stock liquidity levels.

Column 2 presents the findings for the third hypothesis, which proposes that environmentally sensitive firms engaging in less greenwashing which reduces the direct effect of greenwashing on stock liquidity. To analyze this, a dummy variable is used for firms with SIC codes related to mining (10xx, 12xx), oil and gas (13xx, 29xx), paper (26xx), and chemicals (28xx), excluding pharmaceuticals (283x), metals (33xx), and utilities (49xx) (Cowen et al.,1987); Patten (1997; 2002). The moderating term shows an insignificant negative relationship (-0.000694) between greenwashing and stock liquidity. This result indicates that we the direction of the effect is in line with prior research by Deegan and Gordon (1996), Walker et al. (2012), Akutran (2018), Chen & Chang (2013), and Chen, Lin & Chang (2014), which found that firms operating in environmental sensitive industries greenwash less due to factors such as public scrutiny, government regulations, and stakeholder pressure. However, as the results show insignificant results, the results should be seen as an indication.

The third model shows the interaction effect of greenwashing and firm size on stock liquidity, again, measure by Amihud's illiquidity measure. Interesting is that the direct effect of greenwashing on the Amihud illiquidity measure is insignificantly positive (0,0954) while the interaction effect (Greenwashing*Ln Firm size) is slightly negative but not significant (-0,000436). This means that the effect of greenwashing which increases the illiquidity is offset by firm size. This is in line with Soutar et al. (1998), who found that larger firms face greater pressure from shareholders and customers to improve sustainability efforts, leading to increased environmental disclosure. This is due to the higher reputational risk for larger companies perceived as highly unsustainable. As scrutiny on larger companies increases, greenwashing is reduced, affecting stock market liquidity. However, as this finding is not significant, this can only be seen as an indication.

The third model shows the interaction effect of greenwashing and firm size on stock liquidity, again, measure by Amihud's illiquidity measure. Interesting is that the direct effect of greenwashing on the Amihud illiquidity measure is insignificantly positive (0,0954) while the interaction effect (Greenwashing*Ln Firm size) is slightly negative but not significant (-0,000436). This means that the effect of greenwashing which increases the illiquidity is offset by firm size. This is in line with Soutar et al. (1998), who found that larger firms face greater pressure from shareholders and customers to improve sustainability efforts, leading to increased environmental disclosure. This is due to the higher reputational risk for larger companies perceived as highly unsustainable. As scrutiny on larger companies increases,

greenwashing is reduced, affecting stock market liquidity. However, as this finding is not significant, this can only be seen as an indication.

While all financial control variables are significant, the leverage metric has a very small, negative, and insignificant coefficient. Due to the conflicting findings among Lipson et al. (2005), Lesmond et al. (2008), and Frieder et al. (2006), we cannot draw definitive conclusions based solely on this, and it should be seen as an indication from the sample. The Market-to-Book value is significantly positive at the 1% level (0.00156-0.00161). This contrasts with Gutierrez and Pirinsky's (2007) findings that institutional investors tend to buy cross-sectional return winners with high market-to-book ratios, which can increase market depth and stock liquidity. Their results suggest that high firm performance generates liquidity through institutional investor demand. As we are looking at the inverse of a liquidity function, we were looking for a negative coefficient. The dividend yield metric shows an significant negative relation with the Amihud's illiquidity measure throughout all models (-0,00656 - -0,00696). This is in line with the findings of Agarwal (2007). His research found that dividend yield is positively related to stock liquidity. This because a high dividend yield increases investor demand, signals market confidence and price support for their stocks during periods of economic uncertainty. Lastly, the return on assets (ROA) metric shows significant negative coefficients throughout all models (-0,00131 - -0,00136). This supports the findings of Khan et al. (2019), who found that return on assets and liquidity are positively related.

The regression results for the second, fourth and sixth hypotheses, concerning the effects of on the stock price volatility of stocks, are shown in table 7 on the next page.

The first column shows the direct effect of greenwashing on the stock price volatility of S&P500 firms over the years 2013-2022. The coefficient shows an insignificant positive relation between greenwashing and stock price volatility (0,0362). The direction of this finding is in line with the works of Yu et al. (2019). They suggested that less greenwashing reduces information asymmetries and idiosyncratic risk, which in turn facilitates capital attraction and has a beneficial impact on a firm's market value. This decrease in risk and increase capital attraction leads to lower stock price volatility. However, as the coefficient is insignificant, this can only be seen as an indication.

The fifth model, shown in column 4, examines the impact of greenwashing on stock price volatility for firms operating in environmentally sensitive industries. The results show a significant negative coefficient (-0.866) at a 5% significance level for the interaction effect of greenwashing and the dummy variable for environmentally sensitive industries. This

indicates that firms in these industries that engage in greenwashing have lower levels of stock price volatility compared to their counterparts in non-environmental industries. These findings support our fourth hypothesis, which posited lower stock price volatility for environmentally sensitive firms, as they engage in less greenwashing. This is consistent with the works of Barnett et al. (2008) and Berrone et al. (2009), who stated that companies operating in environmentally sensitive industries face increased scrutiny to demonstrate environmental legitimacy. As a result, these companies are more likely to report accurately on their CSR practices and less likely to engage in greenwashing, which helps reduce information asymmetry and therefore stock price volatility levels.

The last column shows the interaction term between firm size and greenwashing. The coefficient is significantly negative (-0,353), indicating that the effect of greenwashing decreases with firm size on stock price volatility at a 1% significance level. This supports the sixth hypothesis, which stated that the negative effect of greenwashing on stock price volatility is reduced by firm size. Thereby, this is line with Christopher et al. (1998), who stated that as a company grows, shareholders and customers exert greater pressure on the firm to implement sustainable initiatives. This increased pressure can make environmental reporting a more salient issue for larger companies, as they are at a higher risk of reputational damage if perceived as unsustainable. Thereby, as larger companies are subject to greater scrutiny, the likelihood of being caught engaging in "greenwashing" increases, which can serve as a deterrent to greenwashing behavior.

In models 4-6, the control variables are similar to those in models 1-3, and leverage is again the only variable with insignificant results. The positive results are very similar to each other (0.00471-0.00490) and in line with Figlewski et al.'s (2000) finding that stock price volatility increases with leverage. However, since the leverage coefficient is insignificant, it can only serve as an indicator. The Market-to-book ratio is significant and negatively related with stock price volatility with a coefficient varying over the models between -0,218 and -0,223 This is consistent with research by Tasnia et al. (2021), who discovered a substantial inverse link between stock price volatility and market-to-book ratio. Some explanations include that a high market-to-book ratio suggests steady profitability, greater asset quality, less debt, and better growth prospects. Additionally, dividend yield is significantly and highly

Dependent variable: *Stock price volatility*	(4)	(5)	(6)
Greenwashing	0.0362	0.227	-6.295***

	(0.156)	(0.171)	(2.155)
env_sens	-0.167	0.0438	
	(0.342)	(0.357)	
ln_mcap	-2.088***	-2.093***	-2.020***
	(0.101)	(0.101)	(0.103)
ln_mcap2	0.694***	0.691***	0.734***
	(0.0548)	(0.0548)	(0.0562)
1.env_sens#c.greenwashing		-0.866**	
		(0.397)	
c.greenwashing#c.ln_mcap			-0.353***
			(0.125)
c.greenwashing#c.ln_mcap2			-0.191***
			(0.0734)
leverage	0.00471***	0.00490***	0.00473***
	(0.00125)	(0.00125)	(0.00124)
mb	-0.218***	-0.223***	-0.218***
	(0.0408)	(0.0409)	(0.0408)
dividend	-1.858***	-1.858***	-1.879***
	(0.115)	(0.115)	(0.113)
ROA	-0.0601*	-0.0594*	-0.0608*
	(0.0312)	(0.0312)	(0.0312)
			-
Constant	60.94***	61.07***	59.76***
	(1.733)	(1.733)	(1.782)
Observations	2,113	2,113	2,113
R-squared	0.352	0.353	0.356
r2_a	0.349	0.351	0.353
F	121.8	109.0	113.4
p	0	0	0
rmse	5.225	5.219	5.210

Table 7. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

negatively correlated with stock price volatility at the 1% significance level, which is consistent with the findings of Allen et al. (1996) and Huddsunry et al. (2011). They found that dividend-paying stocks tend to be viewed more positively by investors, leading to increased price support, reduced trading activity, and lower volatility. Lastly, return on assets also shows a negative relationship with stock price volatility, significant at a 10% significance level.

4.2 Robustness checks

To check for robustness, the sample will be partitioned into four categories based on the sample's mean. The first category consists of firms exhibiting low greenwashing, representing the lowest 25% of the sample. The second category includes firms with a greenwashing score below the mean, falling within the 25%-50% percentile range. The third category comprises firms with a greenwashing score above the mean, representing the 50%-75% percentile range. Lastly, the fourth category encompasses firms with a high greenwashing score, falling within the 75%-100% percentile range. The regressions are run with respect to the lowest greenwashing group of this research. This categorization strategy enables a clear evaluation of the effects of greenwashing on the dependent variables of stock liquidity and stock price volatility across different levels of greenwashing intensity. The results can be found in appendix F.

For hypothesis 1, observed is that the second and the fourth group, referring to the 25%-50% and 75%-100% quarters, have significant positive coefficients with respect to the lowest percentile range group. This means that if companies use more greenwashing techniques, their stock will become less liquid. This supports the positive linear effect and is consistent with the findings of Malhotra et al. (2002), Hau-siu (2008), Shainesh (2012), Gargiulo & Ertug (2006), and Hong & Cho. It was also detected in the primary regression models (2011).

For the second hypothesis, the insignificant positive effect of greenwashing on stock price volatility remains. However, as we dive deeper into the results, we see that the third group, indicating the 50%-75% greenwashing group, has as the only group a significant positive effect on stock price volatility. In order to check if the overall effect of these three parameters is significant or not, a Wald-test is performed following De Santgi's (1997). The results, shown in appendix G. The results of the Wald-test shows that the parameters are overall insignificant. This eventually supports the findings found in our regression models.

According to the third hypothesis, companies that operate in environmentally sensitive sectors experience less of a negative impact from greenwashing on stock liquidity. The primary regressions' initial insignificant negative results turn out to be significant negative for the second and fourth quarter groups. Once more, a Wald-test is used to determine whether the three characteristics taken together are also significant. The Appendix H contains the Wald-test results. The parameters are once again insignificant at a 5%

significance level. This demonstrates that the results of the primary regression were reliable and simply needed to be taken as an indication because they are not statistically significant.

We discovered a significant adverse effect for the fourth hypothesis, which proposed that the influence of greenwashing on stock volatility is diminished for enterprises working in an environmentally sensitive industry. However, the findings of the robustness regressions demonstrate a comparable detrimental effect, albeit insignificantly. Therefore, a small part of the statistical power is lost, but only slightly.

The fifth hypothesis stated that the effect of greenwashing on stock liquidity is reduced by firm size. The insignificant negative effect of firm size on the effect of greenwashing remains in the robustness check.

Lastly, the significant negative effect of firm size on the effect of greenwashing on stock liquidity remains for all percentile quarters. This analysis therefore provides robust findings that larger companies engaging in greenwashing practices have lower stock price volatility levels than their smaller counterparts.

5. Conclusion

Discussion

While a lot of research has been done on the causes of greenwashing and how it affects investor sentiment and behavior, less is known about how it affects stock prices and the idiosyncratic risks it poses. Delmas et al. (2011) examined the institutional, market, organizational, and human drivers of greenwashing and shown that the phenomenon's alarming prevalence might have serious negative effects on consumers' and investors' confidence in environmentally friendly products. Greenwashing discourages consumers from purchasing a brand's goods, lowers trust levels, and raises levels of perceived risk, all of which have negative consequences on stakeholders, according to literature by Chang et al. (2014), Nyilasy (2014), Braga Junior (2019), and Walker (2012). In 2015, Du conducted research on the impact of greenwashing on financial performance, specifically in the form of cumulative abnormal returns (CAR). However, this research did not investigate the effect of greenwashing on stocks, which are a crucial component of investment strategies. As found by Chordia et al. (2002, 2005), Watanabe (2004), Jones et al. (1994), and Kyrölänen (2008), risk and trust levels have a significant impact on crucial stock features such stock liquidity and price volatility. By relating these many literary genres, a significant gap in the literature is shown that must be addressed. This paper tries to fill that gap by looking at the direct effects

of greenwashing on stock liquidity and stock price volatility, focused especially on firms included in the S&P 500 between 2013-2022. Thereby, important characteristics including firm size and whether a firm is operating in an environmental sensitive industry are added as it influences the extent of a firm's greenwashing practices. The predictions of the different hypotheses are tested via OLS regressions using a fixed-effects model.

Next to the broad extent of literature, the hypotheses of this research are based primary on the information asymmetry theory of Akerlof (1970). The theory suggests that greenwashing creates information asymmetry between firms and investors by making false or misleading claims about a company's environmental practices, leading to market mispricing, decreased trust in the market, and lower investment demand. The inefficiency created by greenwashing of these markets showed to have an idiosyncratic impact on stock liquidity and stock price volatility. As greenwashing causes an increased need for monitoring (Malhotra et al., 2002), increased transactions costs (Hau-siu, 2008), decreased loyalty (Shainesh, 2012), lower levels of commitment (Gargiulo and Ertug, 2006) and negative effects on intention to purchase (Hong and Cho, 2011), the first hypothesis expected that greenwashing has a negative effect on the liquidity of stocks. Furthermore, as fewer greenwashing decreases information asymmetries, idiosyncratic risks and facilitates capital attraction, this paper hypothesized that greenwashing will increases stock price volatility levels. According to prior research, business size and the kind of industry were included in the remaining hypotheses since it was anticipated that they would moderate the effects of greenwashing. The impacts of greenwashing on stock liquidity and stock price volatility, as proposed in hypotheses 3 and 5, are hypothesized to be negatively moderated by firm size. Lastly, the type of industry entails whether a firm is operating in an environmental sensitive industry or not. Firms operating in environmental industries tend to participate less in greenwashing practice and therefore moderates the effect of greenwashing on stock liquidity and stock price volatility, projected in hypotheses 4 and 6 respectively. The following findings regarding the preceeding hypothesis are presented in this paper:

In case of hypothesis 1, this paper finds a significant positive relationship between greenwashing and the inverse of stock liquidity, measured in Amihud's illiquidity ratio. This indicates that the market reacts negatively to greenwashing firms, making the stocks more illiquid. This means that it becomes harder to sell the stocks fast and at low costs with little price impact. This was in line with earlier research by Malhotra et al. (2002), Hau-siu (2008), Shainesh (2012), Gargiulo & Ertug (2006), Hong & Cho (2011), and Velte (2022), which demonstrated that greenwashing causes low trust levels, an increased need for monitoring,

higher transaction costs, lower levels of commitments, negative effects on purchase intentions, and lower stock liquidity in the end. The robustness assessment provided additional support for the findings, which added significancd to the body of knowledge on greenwashing.

For the second hypothesis, this paper finds an insignificant positive relation between greenwashing and stock price volatility. This positive but insignificant effect was also found during the robustness checks. The direction of this finding is in line with the works of Yu et al. (2019), who found that less greenwashing, in form of a smaller ESG disclosure and ESG performance gap, results in less stock price volatility. The line of reasoning is that giving stakeholders a more in-depth and accurate view of a firm's environmental disclosure will reduce information asymmetry levels and increase trust levels, decreasing stock price volatility levels. Thereby, the market associates information asymmetry with a higher level of risk and may demand a higher return to compensate for that risk. This can lead to higher fluctuations in the stock price as investors adjust their expectations of the company's future earnings and growth prospects (Brennan et al., 2001). As the results were insignificant, we cannot make hard conclusions for the found relationship between greenwashing and stock price volatility, but the direction is of the effect is clearly visible.

The third hypothesis stated that firms operating in environmental sensitive industries engage in less greenwashing which reduces the direct effect of greenwashing on stock liquidity. The findings show an insignificant negative effect, indicating that the effect of greenwashing on stock liquidity is indeed lower for firms operating in environmental sensitive industries. This in line with prior research by Deegan and Gordon (1996), Walker et al. (2012), Akutran (2018), Chen & Chang (2013), and Chen, Lin & Chang (2014), which found that firms operating in environmental sensitive industries greenwash less due to factors such as public scrutiny, government regulations, and stakeholder pressure.

The fourth hypothesis stated that the positive relationship between greenwashing and stock price volatility is reduced for companies operating in environmental sensitive industry. As we saw in the second hypothesis, greenwashing increases stock price volatility due to the perceived risk the information asymmetry brings on the stakeholders and investors. This information asymmetry is decreased as firms operating in environmental industries are faced with increased scrutiny to demonstrate environmental legitimacy This is consistent with the works of Barnett et al. (2008) and Berrone et al. (2009). As a result, these companies are more likely to report accurately on their CSR practices and less likely to engage in

greenwashing, which helps reduce information asymmetry and therefore stock price volatility levels.

The OLS regression for the fifth hypothesis showed an insignificant negative effect for the interaction term of greenwashing and firm size. This means that the decreased stock liquidity caused by greenwashing is reduced by firm size. This is in line with Soutar et al. (1998), who found that larger firms face greater pressure from shareholders and customers to improve sustainability efforts, leading to increased environmental disclosure. This is due to the higher reputational risk for larger companies perceived as highly unsustainable. As scrutiny on larger companies increases, greenwashing is reduced, affecting stock market liquidity. The robustness checks showed similar results for hypothesis 5. However, as these findings are not significant, this can only be seen as an indication.

Lastly, this paper found a significant negative moderating role for firm size on the effect of greenwashing on stock price volatility levels. As the robustness check showed similar results, it can be concluded that firm size indeed has an moderating effect on the greenwashing-stock price volatility relationship.

The results of this study have multiple practical uses for businesses using a greenwashing strategy. While some businesses may use greenwashing as a marketing strategy to improve their brand image, it can actually have a negative impact on a company's financial performance over time. Decreased stock liquidity is one way how greenwashing has a detrimental effect on a company's financial success. This happens because investors could start to distrust the sustainability of the company's operations and grow doubtful of its claims. As a result, the volume and liquidity of trade are reduced since they are less likely to buy or sell the company's stock. Moreover, greenwashing might make stock prices more volatile. Investors may react negatively and sell off their shares, which may lower the stock price when they learn that actual activities do not support a company's environmental statements. On the other hand, if investors have unrealistic expectations of the company's environmental initiatives, the stock price may rise to unsustainable heights before collapsing. Finally, this study also highlights how firm size and enterprises working in environmentally sensitive sectors might moderate the impact of greenwashing on stock liquidity and volatility levels. Due to their environmental impact, businesses in environmentally sensitive industries may be subject to additional scrutiny and regulation when operating in a sensitive area. As a result, greenwashing becomes more complex and has more severe effects. As a result, businesses engaged in polluting industries use greenwashing less, which reduces the adverse impact on stock liquidity and price volatility. The correlation between greenwashing, stock liquidity,

and volatility is moderated by the size of a corporation. As companies expand, there is increased pressure from shareholders and customers to improve sustainability efforts. Therefore, larger companies face greater reputational risk as highly unsustainable corporations, making environmental reporting a more pressing concern. Companies are therefore more reluctant to engage in greenwashing practices, which reduces the effects on stock liquidity and stock price volatility.

Limitations

This paper examines the relationship between stock liquidity, stock price volatility, and greenwashing. There are some limitations that should be taken into account, even though the results may suggest a particular relationship between these three variables.

The greenwashing variable is the result of two different types of ESG scoring systems. The greenwashing score is determined by comparing the ESG disclosure scores of Bloomberg by the ESG performance scores of Eikon Refinitiv. It is possible that distinct procedures and criteria will be used to produce ESG performance scores and ESG disclosure scores, which could make the obtained greenwashing score biased. The ESG performance score provided by Eikon Refinitiv, for instance, may be based on quantitative measures like diversity statistics or greenhouse gas emissions, as opposed to the ESG disclosure score provided by Bloomberg, which may be based on how thoroughly a company reports on ESG issues. Thereby, a lot of ESG disclosure scores and ESG performance scores were not available for in the dataset. This could be the case as ESG reporting is not legally obliged and companies could influence their sustainable activities or communications in their favor. For instance, a business may use greenwashing by highlighting its beneficial ESG practices in marketing materials while concealing unfavorable effects in its ESG reporting.

Additionally, this analysis is only based on a limited number of public corporations operating in the same market, namely the S&P500 firms over the years 2013-2022. This is a limitation as it represents a comparatively small subset of businesses operating in the world market. Therefore, as this research misses out on other businesses that might be adopting greenwashing, this must be taken into consideration when making conclusions on the findings. Thereby, S&P 500 corporations are sizable, well-established businesses with the capital to fund sustainability programs. As a result, given that they have a more prominent reputation to uphold, these companies may be less likely to engage in greenwashing. This may lead to a biased sample and, therefore, not representative of all businesses.

Further research

The foundation for additional study is covered in the limitations section. This research examined how greenwashing, stock liquidity, and stock price volatility relate to S&P500 firms between 2013 and 2022. Further studies could expand on this by comparing different markets and countries using a multinational sample. Since the S&P500 only includes U.S. stock market companies, which have their own laws, rules, and market responses to factors such as ESG reporting, greenwash penalties, and stock consequences, it would be useful to explore possible differences between markets.

Thereby, the Bloomberg ESG disclosure score focuses solely on the quantity of disclosure, neglecting the quality of the information provided. To obtain a more accurate evaluation, future research could explore the impact of greenwashing while also considering disclosure quality. Although the Bloomberg disclosure scores are authoritative, supplementing them with primary data on the quality of nonfinancial disclosures would provide a more comprehensive assessment. Given the rapidly evolving nature of ESG disclosures, conducting this research in the future, when regulations have had time to take root and make a significant impact, could yield more significant results.

Lastly, while greenwashing has received significant attention in the literature, brownwashing has received comparatively little. Brownwashing refers to companies that make similar claims as greenwashing companies about their social responsibility practices but engage in harmful or unethical practices that contradict their stated values. This is surprising given the potential impact that brownwashing can have on stock liquidity and stock price volatility, particularly given the increasing importance that investors place on social responsibility and ethical practices. These are all gaps in the literature that could be interesting for future researchers to further understand the effects of greenwashing on stock characteristics.

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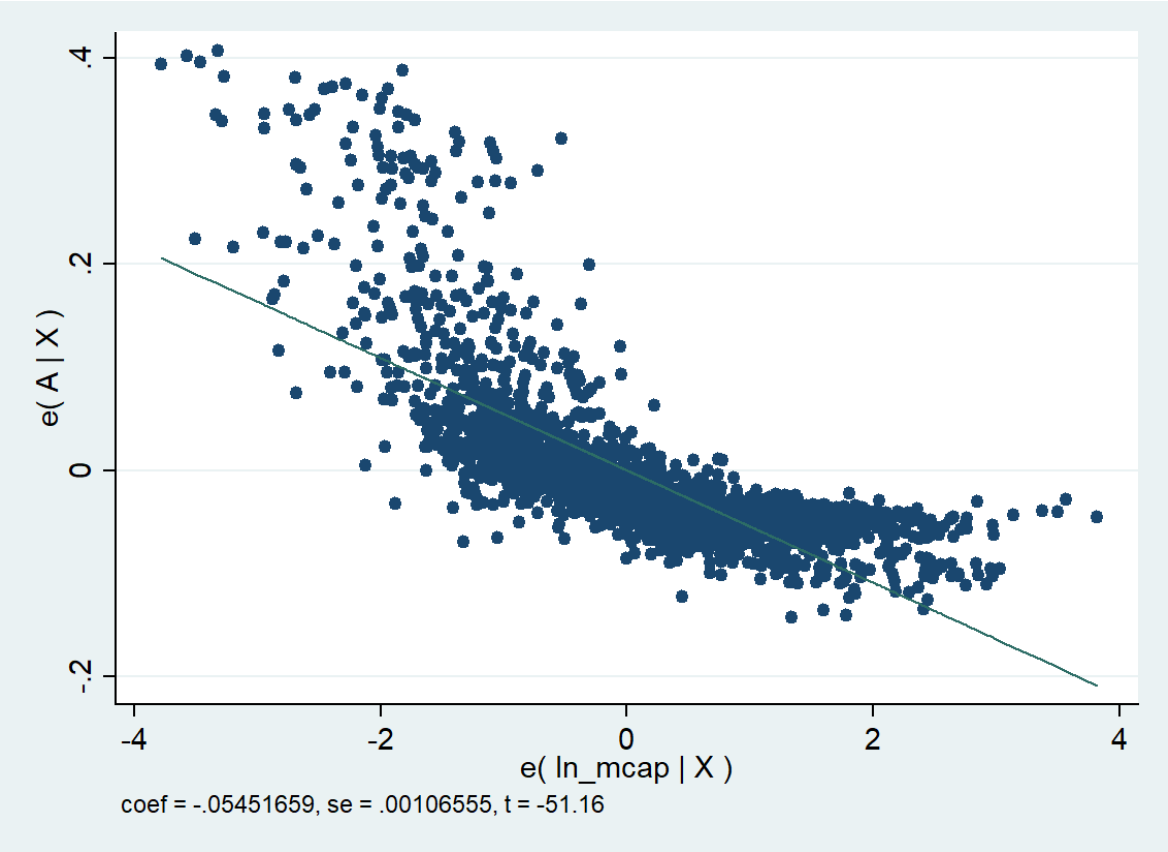
Appendix

Appendix A – Result Linearity



Appendix B – Results Breusch-Pagan/Cook-Weisberg test for heteroskedasticity

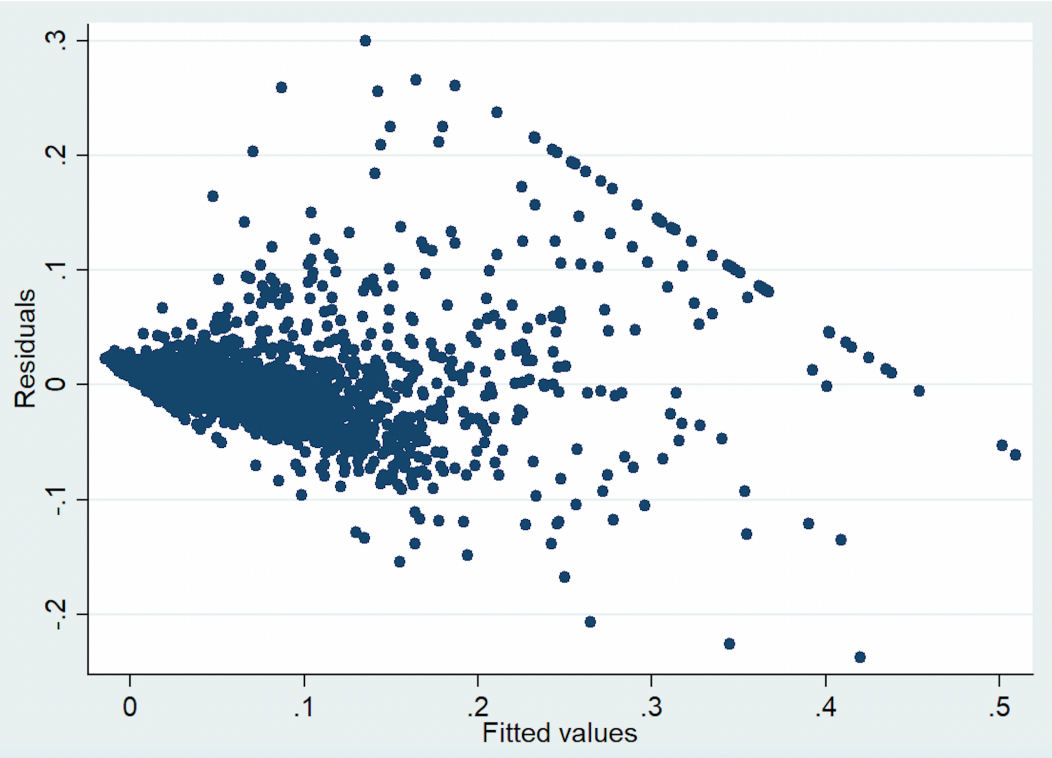
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
Ho: Constant variance
Variables: fitted values of sqrtA
chi2(1) = 885.01
Prob > chi2 = 0.0000
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
Ho: Constant variance
Variables: fitted values of vol
chi2(1) = 94.91
Prob > chi2 = 0.0000

Appendix C – Results Variance Inflation Factor test for Multicollinearity

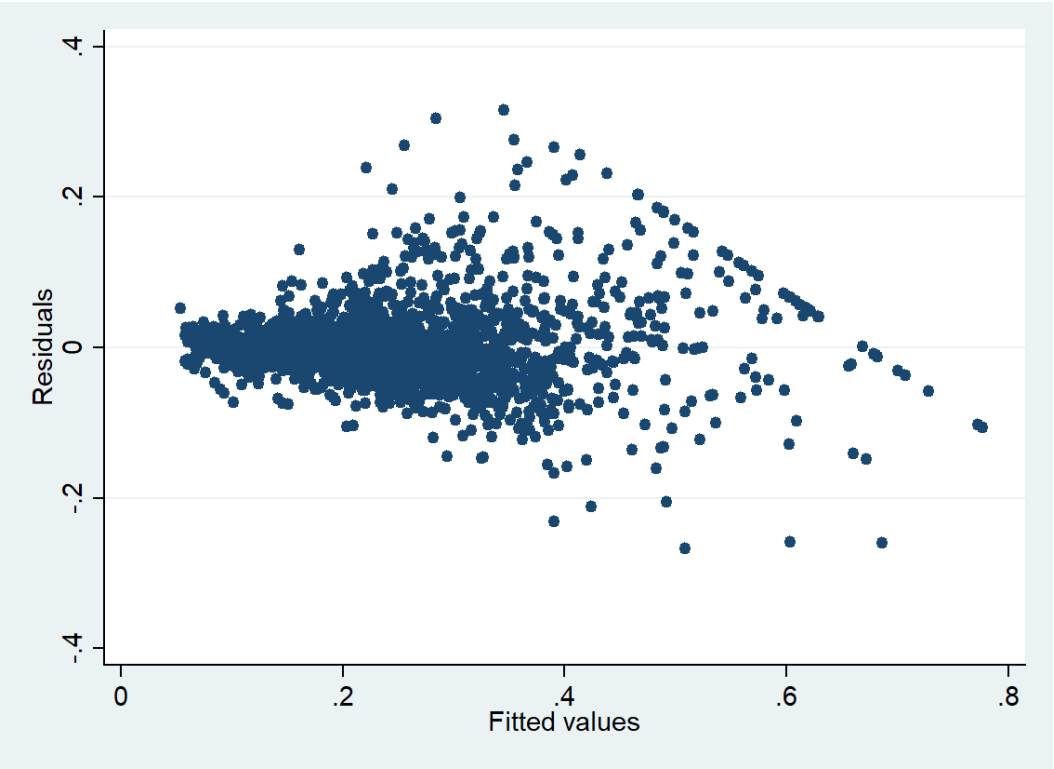
```
Multicollinearity

    Variable |       VIF       1/VIF
-------------+----------------------
          mb |      2.13    0.468490
    leverage |      1.72    0.582940
         ROA |      1.49    0.672389
    env_sens |      1.25    0.800742
    dividend |      1.13    0.882661
greenwashing |      1.11    0.899859
     ln_mcap |      1.11    0.901934
    ln_mcap2 |      1.02    0.979381
-------------+----------------------
    Mean VIF |      1.37
```

Appendix D – RVF test plot without square root transformation of Amihud illiquidity measure vs quadratic effect of size



Appendix E - test plot with square root transformation of Amihud illiquidity measure vs quadratic effect of size.



Appendix F – Robustness check

VARIABLES	(1) sqrtA	(2) sqrtA	(3) sqrtA	(4) vol	(5) vol	(6) vol
2.cGreenwashing	0.00861***	0.0111***	0.0257	0.211	0.286	-7.451*
	(0.00313)	(0.00335)	(0.0692)	(0.283)	(0.288)	(4.527)
3.cGreenwashing	0.00517	0.00462	-0.0224	0.766**	0.617*	4.481
	(0.00315)	(0.00351)	(0.0605)	(0.307)	(0.319)	(4.412)
4.cGreenwashing	0.00929***	0.0109***	-0.000934	0.252	0.530	-15.03***
	(0.00324)	(0.00376)	(0.0576)	(0.343)	(0.383)	(4.691)
env_sens	-0.00560*	0.00619		-0.235	0.273	
	(0.00319)	(0.00594)		(0.340)	(0.943)	
ln_mcap	-0.0961***	-0.0961***	-0.0962***	-2.074***	-2.077***	-2.284***
	(0.00125)	(0.00125)	(0.00259)	(0.101)	(0.101)	(0.161)
ln_mcap2	0.0140***	0.0140***	0.0148***	0.693***	0.691***	0.605***
	(0.000731)	(0.000729)	(0.00131)	(0.0547)	(0.0549)	(0.0764)
25%-50%Greenwashing*environemtnal sensitive		-0.0220**			-0.743	
		(0.00866)			(1.160)	
3.cGreenwashing#1.env_sens		-0.00650			-0.185	
		(0.00778)			(1.129)	
4.cGreenwashing#1.env_sens		-0.0137*			-1.086	
		(0.00742)			(1.084)	
2.cGreenwashing#c.ln_mcap			-0.000819			-0.435*
			(0.00399)			(0.262)
3.cGreenwashing#c.ln_mcap			-0.00150			-0.228
			(0.00350)			(0.255)
4.cGreenwashing#c.ln_mcap			-0.000560			-0.859***
			(0.00331)			(0.271)
leverage	-1.30e-05	-1.27e-05	-1.55e-05	0.00471***	0.00485***	0.00492***
	(1.29e-05)	(1.30e-05)	(1.29e-05)	(0.00124)	(0.00125)	(0.00124)
mb	0.00154**	0.00153**	0.00162**	-	-	-0.225***

	*	*	*	0.220***	0.224***	
	(0.000390)	(0.000390)	(0.000388)	(0.0406)	(0.0408)	(0.0405)
dividend	-0.00650***	-0.00651***	-0.00688***	-1.854***	-1.857***	-1.874***
	(0.00121)	(0.00120)	(0.00115)	(0.115)	(0.115)	(0.112)
ROA	-0.00135***	-0.00134***	-0.00133***	-0.0593*	-0.0574*	-0.0535*
	(0.000295)	(0.000296)	(0.000292)	(0.0311)	(0.0313)	(0.0311)
Constant	1.898***	1.898***	1.898***	60.41***	60.42***	64.16***
	(0.0221)	(0.0221)	(0.0451)	(1.743)	(1.745)	(2.809)
Observations	2,113	2,113	2,113	2,113	2,113	2,113
R-squared	0.828	0.829	0.828	0.354	0.355	0.360
r2_a	0.827	0.828	0.827	0.350	0.351	0.355
F	828.5	640.4	580.9	97.54	75.57	68.64
p	0	0	0	0	0	0
rmse	0.0524	0.0523	0.0524	5.220	5.219	5.200

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Appendix G – Wald-tests parameters

Wald-test for the effect of greenwashing on stock price volatility
(1) 25%-50% Greenwashing = 0
(2) 50%-75% Greenwashing = 0
(3) 75%-100% Greenwashing = 0
F(3, 2102) = 2.12
Prob > F = 0.0962
Wald-test for the moderating effect of type of industry of greenwashing on stock liquidty
(1) 25%-50% Greenwashing#1.env_sens = 0
(2) 50%-75% Greenwashing#1.env_sens = 0
(3) 75%-100% Greenwashing#1.env_sens = 0
F(3, 2099) = 2.51
Prob > F = 0.0569