

Grahn, Aline

Article — Published Version

Greenhouse Gas Disclosure: Evidence from Private Firms

Journal of Business Ethics

Provided in Cooperation with:

Springer Nature

Suggested Citation: Grahn, Aline (2024) : Greenhouse Gas Disclosure: Evidence from Private Firms, Journal of Business Ethics, ISSN 1573-0697, Springer Netherlands, Dordrecht, Vol. 197, Iss. 1, pp. 177-194,
<https://doi.org/10.1007/s10551-024-05697-w>

This Version is available at:

<https://hdl.handle.net/10419/319167>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.



<http://creativecommons.org/licenses/by/4.0/>



Greenhouse Gas Disclosure: Evidence from Private Firms

Aline Grahn¹

Received: 6 June 2023 / Accepted: 14 April 2024 / Published online: 22 May 2024
© The Author(s) 2024

Abstract

Existing literature on greenhouse gas (GHG) emissions disclosure has paid little attention to private firms, despite the fact that this type of firm is responsible for significant GHG emissions. This study empirically analyzes the GHG disclosure of German private firms. The results suggest that more pronounced information asymmetries due to a more dispersed ownership structure and/or multiple bank relationships are associated with more extensive GHG disclosure. This aligns with arguments from agency and stakeholder theory. While this result is not new for public firms, it is for private firms. Given the specific characteristics of this type of firms (no separation of ownership and control, private communication channels, close bank–borrower relationships), it is not a straightforward assumption that observations from public firms can be transferred to private firms one-to-one. Moreover, higher levels of actual GHG emissions are also associated with more GHG disclosure, indicating that legitimacy theory arguments hold for private firms as well.

Keywords GHG disclosure · Environmental disclosure · Private firms · GHG emissions · EU ETS · ESG

JEL Classification M14 · M41 · Q54

Introduction

Several initiatives are attempting to promote the reduction of greenhouse gas (GHG) emissions and mitigate global warming (e.g., the United Nations (UN) Sustainable Development Goals (SDGs), the Paris Agreement, and the C40 Cities initiative). However, in analyzing progress on SDG 13, the UN believes that the world is “*on the brink of a climate catastrophe and current actions and plans to address the crisis are insufficient.*” (UN, 2023).

Recent literature has emphasized that the real effects of sustainability disclosures (Christensen et al., 2017; Fiechter et al., 2022) and of disclosures on GHG emissions (Dowmar et al., 2021; Tomar, 2023) are significant. Capital markets react to firms’ GHG disclosures (Griffin et al., 2017;

Matsumura et al., 2014), and banks also take information on firms’ GHG awareness into account when making lending decisions (Jung et al., 2018).

However, the existing literature has focused almost exclusively on public firms. That is not surprising, given the higher visibility of this type of firms and the better data availability. Nevertheless, the vast majority of firms all over the world are not listed on a stock exchange.¹ Prior literature has shown that private and public firms exhibit different characteristics when it comes to financial disclosure (Ball & Shivakumar, 2005; Burgstahler et al., 2006; Hope et al., 2013). However, there are a very few studies that analyze and find such differences with respect to non-financial disclosure (Carmo & Miguéis, 2022; Fernandez-Feijoo et al., 2014; Hickman, 2020), and none that specifically analyze GHG disclosure of private firms. Given the

✉ Aline Grahn
aline.grahn@fu-berlin.de

¹ Freie Universität Berlin, Thielallee 73, 14195 Berlin, Germany

¹ Worldwide, there were only 43,248 listed firms in 2019, and the trend has been slightly decreasing over time (World Bank, 2023). In 2020, only 438 firms in Germany were publicly listed companies, out of a total of more than 3 million firms (Statista, 2021, 2022).

major impact that private firms have on the economy² and the major impact that the private economy has on GHG emissions,³ understanding the GHG disclosures of private firms is an important step toward integrating these firms into global efforts to fight climate change.

The purpose of this paper is therefore to shed light on why private firms decide to voluntarily disclose GHG emissions information. What are the drivers of private firms' GHG disclosures? Which patterns that we know about from public firms are transferable to private firms, and which are not? I conduct an empirical analysis on German private firms that are covered by the European Union Emission Trading System (EU ETS). The EU ETS is a key domestic policy to achieve the EU's GHG emission reduction targets (see, e.g., the update of the Nationally Determined Contribution (NDC) of the EU and its Member States from 2023). This setting is especially suited to address these research questions for several reasons: First, there is no mandatory GHG disclosure in Germany for the period of analysis, for private or for public firms. As a consequence, it is possible to rule out disclosure incentives induced by the regulatory framework. Second, annual reports from private firms are publicly available in Germany, in contrast to many other large economies in the world. This is not only necessary for data collection, but it also sets up a communication channel for private firms with their stakeholders. Third, from an ecological point of view, it is worth analyzing the German setting because Germany is the largest GHG emitter within the EU.⁴ Last, analyzing firms covered by the EU ETS comes with some advantages: on one hand, the business model of these firms is associated with high GHG emissions levels; therefore, if there were any private firms (and their stakeholders) that were aware of their own GHG emissions and the potential consequences, it should be the ones covered by the EU ETS. On the other hand, since firms covered by the EU ETS are obliged to report facility-level GHG emissions to the relevant authority, it is possible to track their GHG emissions with a bit of effort. These firms do not necessarily disclose their GHG emissions in their annual reports. Nevertheless, the GHG emissions information I gathered by analyzing the EU ETS data proxies actual GHG emissions of all sample firms independent of their decision to disclose

this information in their annual (or comparable) reports. I can therefore overcome the self-selection problem that studies dealing with voluntary disclosure usually suffer from (Christensen et al., 2021).

I find a robust positive effect of ownership dispersion, and a negative effect of having a single bank relationship on a given firm's GHG disclosure level. Both results are in line with arguments from principal–agent theory and stakeholder theory: When information asymmetries with capital providers (as important stakeholders) are more likely, i.e., when there is a dispersed ownership structure and multiple bank relationships, sample firms tend to disclose more GHG emissions information. Moreover, I find a robust and significant positive association between a firm's actual GHG emissions level and the GHG Disclosure Index. This indicates that insights from legitimacy theory that have already been shown to apply for public firms could hold for private firms as well. The local anchoring of a firm is supposed to account for a potentially important stakeholder group of private firms, namely, the local community the firm is embedded in. Nevertheless, my results do not suggest a significant association between a firm's local anchoring and its level of GHG disclosure.

Although some results are not new for public firms, they are for private firms. It is not obvious that private firms have similar GHG disclosure incentives *ex ante* as public firms. Private firms are often assumed to face fewer information asymmetries compared to their public counterparts (Beatty & Harris, 1998), and hence, it is not straightforward to assume that the information demands of capital providers would qualify as relevant determinants of GHG disclosures for them. Moreover, for arguments related to legitimacy theory to be effective, it is necessary that a given firm trying to seek or maintain legitimacy be recognized by the corresponding audience (Suchman, 1995). Since private firms can be rather small (Burgstahler et al., 2006), and hence are potentially less exposed to public attention than public firms, this precondition might not be valid. Hence, it is again not straightforward that legitimacy concerns play a role for private firms' GHG disclosure decisions *ex ante*.

This study makes three major contributions: First, it adds to the growing body of literature on (voluntary) GHG disclosure. It shows that some mechanisms that are relevant for public firms' GHG disclosure also apply for private firms. Second, from a methodological point of view, I have been able to conduct a voluntary disclosure study without the typical problem of self-selection bias. Third, because it is the first study to specifically address the determinants of GHG disclosure of private firms, it has implications for both practitioners and policymakers: A careful consideration of the determinants of voluntary disclosure is a cornerstone for any further ambitions to standardize and regulate (corporate) reporting. This is especially relevant considering the expansion of mandatory sustainability

² According to Eurostat, SMEs, which are likely to be private firms in most cases, account for 99.8% of all enterprises in the EU, employ 64.4% of the EU's non-financial business economy workforce, and contribute to more than half of value-added wealth (52.6%) in 2019 (Eurostat, 2022).

³ In 2019, more than half of worldwide GHG emissions were caused by the sectors of energy supply (34%) and industry (24%) (IPCC, 2022).

⁴ In 2019, Germany emitted 809,799 kilotons of CO₂ equivalent, which is almost 20% of total EU GHG emissions (European Parliament, 2023).

reporting requirements as laid down in the European Union's "Corporate Sustainability Reporting Directive" and its potential indirect effects on non-listed small and medium-sized entities (SMEs). Initiatives such as the C40 Cities that seek to promote GHG emission reductions can also benefit from a deeper understanding of the motivations of private firms, as getting these types of firms on board could be critical to their success in meeting their reduction targets. In addition, these cities shape the environment of the private firms that operate in their vicinity, and thus the ability of these firms to reduce their GHG emissions.

This study is structured as follows: "The Institutional Background" Section provides an overview of the study's institutional framework. "Literature and Hypotheses" Section summarizes the existing literature and develops the hypotheses. The research design is described in "Research Design" Section. "Regression Results" Section discusses descriptive statistics as well as the results of multivariate regressions and endogeneity issues. "Conclusion" Section concludes.

The Institutional Background

European Directive 2003/87/EC introduced a trading scheme for GHG emission allowances in the European Union. The main goal was "*to promote reductions of greenhouse gas emissions in a cost-effective and economically efficient manner*" (European Parliament & the Council, 2003). Firms that operate facilities which perform (at least) one of the activities covered by the Directive, or aircraft operators, need to hold a permit issued by a "competent authority." This permit is only granted if the operator "*is capable of monitoring and reporting emissions*" (2003/87/EC, Art. 6). According to Article 14, each operator of an installation has to report the emissions from that installation during each calendar year to the competent authority. The competent authority must then make emissions reports available to the public (2003/87/EC, Art. 17), which takes place in the Union Registry. GHG disclosure at the Union Registry website is rather opaque, however: facility-level GHG emission data are only disclosed using an internal ID number. An additional table is necessary to trace this ID number to the account holder, which is usually the firm that owns the installation. To determine firm-level GHG emissions, all facilities that belong to this firm have to be collected manually. Therefore, although GHG emissions information is publicly available on the Union Registry website, determining a specific firm's GHG emissions is time consuming and hence costly.

Reporting requirements regarding firms' annual reports are untouched by the EU ETS Directive. It is incumbent on firms to decide whether they wish to additionally disclose GHG emissions information in their annual reports or even publish stand-alone reports.

Literature and Hypotheses

Related Literature

Literature on the determinants and consequences of GHG disclosure is already exhaustive when it comes to public firms (e.g., Luo et al., 2012; Matisoff et al., 2013; Prado-Lorenzo et al., 2009).

Considering the broader concept of CSR, (public) firms with a dispersed ownership structure seem to exhibit more extensive CSR disclosure (Cormier et al., 2005; Gamerschlag et al., 2011; Lu & Abeysekera, 2014). The reduction of information asymmetries between a firm's management and its owners by more extensive disclosure corresponds to the ideas of principal-agent theory, but can also be explained by stakeholder theory. Building on the latter, Guenther et al. (2016) identified government, general public, media, employees, and customers as relevant stakeholders for firms' decisions to disclose information on their GHG emissions.

Studies on the market value effects of GHG disclosures have also underscored the relevance of information related to GHG emissions to investors (e.g., Griffin et al., 2017; Matsumura et al., 2014).

Moreover, there are several studies that have analyzed the association between a firm's cost of capital and its GHG disclosure and/or performance. Most of the studies have found a negative association between the cost of equity and (more extensive) GHG disclosure (e.g., Lemma et al., 2019). Jung et al. (2018) found a positive association between the amount of GHG emissions and the cost of debt. Furthermore, they found that this effect could be mitigated by showing "carbon awareness," which they measured as GHG disclosure.

The link between a firm's GHG disclosure and its actual GHG emissions has also gained attention, but the results are ambiguous. Some studies found a positive association (e.g., Giannarakis et al., 2017; Guenther et al., 2016), indicating that well-performing firms try to signal their type by more extensive disclosure, which therefore suggests that signaling arguments also apply for GHG concerns. On the contrary, other studies have identified highly selective GHG disclosure behavior (Kim & Lyon, 2011) or a negative association between GHG disclosure and performance (Luo et al., 2018); this suggests legitimacy considerations as a potential motivation for firms' decisions to disclose GHG information. More recently, analyses of the particular strategies used to gain or maintain legitimacy have attracted attention in the literature. These strategies often go back to Lindblom (2010): While one of them refers to substantive changes in firms' actions and their disclosure, others reflect a more symbolic disclosure that is not associated with an underlying change in actions. Current empirical evidence supports the

existence of both substantive and symbolic intentions with respect to environmental/GHG disclosure (e.g., Borgstedt et al., 2019; Crossley et al., 2021; Liesen et al., 2017).

Moreover, recent literature has underscored the idea that there are real effects of sustainability (Christensen et al., 2017; Fiechter et al., 2022) and GHG disclosures (Downar et al., 2021; Tomar, 2023) in mandatory reporting settings.

Taken together, a comprehensive picture of determinants and potential consequences of corporate GHG disclosures can be drawn from the existing literature. However, the findings rely exclusively on analyses of public—or at least very large—firms. There are a very few studies that explicitly consider private firms. Freedman and Stagliano (2002) analyze the environmental disclosures of firms that are about to go public, but find no higher levels of such disclosures compared to the control group of firms that are already publicly listed. Fernandez-Feijoo et al. (2014) use a sample consisting of private and public firms and show that stakeholder pressure is associated with more transparent sustainability reports. The analysis of large Portuguese firms by da Silva Monteiro and Aibar-Guzmán (2010) shows that listing status is positively related to the level of environmental disclosure. Chi et al. (2020) examined differences in the CSR reporting behavior of Taiwanese public and private firms and found public firms to be more likely to publish a CSR report. Hickman (2020) comes to a similar conclusion for US firms and also finds out that they are more likely to follow the GRI guidelines. Private firms facing greater information asymmetry, e.g., due to a large number of shareholders, show a similar reporting behavior as public firms. In a sub-sample analysis she finds that non-owner stakeholders motivate private firms to publish CSR reports. Carmo and Miguéis (2022) performed a case study on five non-listed Portuguese firms. They found information demands of stakeholders such as the local community to be one main reason for initiating CSR reporting among the firms they analyzed. Apart from these studies, the closest other analyses have come to this are studies on SMEs.

Russo and Perrini (2010) view CSR in SMEs as an outcome of socially responsible behavior to build up social capital. For larger firms, they rather considered CSR as an antecedent of good stakeholder relationships in line with stakeholder theory. Baumann-Pauly et al. (2013) presented another approach: since the relative costs of external CSR communication are rather high for smaller firms and low for larger firms, but the relative organizational costs of integrating CSR practices are low for small firms and high for larger ones, two gaps result: a reporting gap for SMEs that implement CSR practices but do not report them, and an implementation gap for larger firms that communicate about CSR but have difficulties when implementing CSR strategies.

These studies solely draw on differences in the size of the firm. While this can be an important difference between

private and public firms, there are additional differences that might also affect their decisions on GHG disclosure.

First, private firms show very heterogeneous ownership characteristics (Hope et al., 2012). While public firms usually have only limited managerial ownership, private firms range from large multinational entities closely resembling public firms (Bonacchi et al., 2019) to small companies run by a manager-owner (Berger & Udell, 1998). With significant managerial ownership, the manager-owner agency conflict should be less relevant. A manager-owner typically has a substantial share of her wealth and of human capital tied to the firm. According to principal-agent theory, that should reduce managerial myopia. Second, private firms typically have little access to capital markets, which is associated with lower financial reporting quality (Burgstahler et al., 2006). Third, private firms (may) have a far more concentrated ownership structure than their public counterparts. With concentrated ownership, private communication becomes more likely, reducing the need for high financial reporting quality (Ball & Shivakumar, 2005). Fourth, private firms are typically assumed to rely more on debt than public firms, and tend to have close relationships with their lending banks (Santikian, 2014). Such close relationships facilitate private communication and in turn reduce the need for high financial reporting quality (Bigus & Hillebrand, 2017). Fifth, due to their smaller size and their non-listed status, private firms can be considered to be less visible than public firms. Different stakeholders might therefore be relevant for them compared to those of public firms.

Taken together, there are several differences between public and private firms that have the potential to affect their reporting decisions. In an auditing context, Langli and Svanström (2014) conclude that “*differences that exist between private and public companies are so large and fundamental that without careful consideration we cannot rely on findings for public companies*” (2014, p. 149). I therefore postulate that insights into the determinants of GHG disclosure that are drawn from studies on public firms cannot be transposed *ex ante* to private firms. For this reason, I discuss the potential determinants of private firms’ GHG disclosure based on (a.) insights from public firms’ GHG disclosure, but (b.) in the light of private firms’ characteristics.

Development of Hypotheses

Ownership Dispersion

Investors in public firms seem to consider information concerning a firm’s GHG emissions as important (Griffin et al., 2017; Matsumura et al., 2014). Financial risks arising from extensive environmental pollution could also play a role for owners of private firms, rendering information on GHG

emissions relevant to them as well. The long-term survival of the firm is especially important to owners of private firms, who typically have a non-diversified portfolio. On the other hand, especially for owners of firms with financial constraints, environmentally related topics might be perceived to be less relevant, because these firms need to focus their limited resources on the survival of the firm.

Even if we assume the GHG emissions information is relevant to owners of private firms, a second point still has to be considered: Where ownership is concentrated and there is no separation of ownership and control, disclosure of GHG emissions information in publicly available documents may not be necessary due to private communications. However, research on public firms (with their dispersed ownership structure) has shown that information asymmetries between owners and managers can be reduced by more and better CSR reporting (e.g., Cormier et al., 2005; Gamerschlag et al., 2011; Lu & Abeysekera, 2014). Private firms may have a concentrated ownership structure with, *in extremum*, owner-managers, but they may also have a dispersed and complex ownership structure comparable to public firms (Bonacchi et al., 2019). The information asymmetry-reducing effect of official GHG disclosure might therefore also be observed for private firms (Hickman, 2020). The possible variation in ownership concentration makes the private firm setting especially interesting for analysis.

Taken together, it is not clear *ex ante* whether the demand for information with respect to GHG emissions exists among private firms' owners. If it does exist, I assume arguments from principal-agent theory to hold for private firms as well, and therefore expect to observe increased GHG disclosure with a more dispersed ownership structure. This would also be consistent with stakeholder theory, which assumes that owners are important stakeholders whose information needs must be fulfilled. However, since private communication could play an important role for private firms, I posit H1 as a null hypothesis:

Hypothesis 1 For private firms, a firm's ownership dispersion is not associated with its disclosure levels on GHG emissions.

Bank Relationships

Current research suggests that creditors also incorporate GHG emissions information into their lending decisions (Jung et al., 2018). Since bank financing is a primary source of external capital (Berger & Udell, 1998; Santikian, 2014), one could conclude that private firms are likely to disclose information on their GHG emissions voluntarily in order to fulfill the information demands of this especially important type of stakeholder. Above all, when the relationship between the bank and the firm is close because the bank is

the firm's sole provider of debt, its information demands are especially relevant to the firm. Such close bank-borrower relationships are of major importance in Germany's bank-based financial system (Ongena et al., 2012). On the other hand, in such cases, private communication becomes more likely. Consequently, prior research has shown that close bank-borrower relationships are associated with lower financial reporting quality (Bigus & Hillebrand, 2017). The same could apply for GHG reporting: Interested lenders could request information on GHG emissions via private communication channels, in part to ensure an information advantage over competing banks.

Having the information demand of an especially important stakeholder on one hand, and the possibility of private communication on the other, I formulate H2 without a direction:

Hypothesis 2 For private firms, a firm's close bank relationship is associated with its disclosure levels on GHG emissions.

Local Anchoring

Prior research has identified several stakeholders that shape the GHG disclosure behavior of public firms (e.g., Guenther et al., 2016; Prado-Lorenzo et al., 2009). Again, these studies focus on large and public firms. As Prado-Lorenzo et al. (2009) argued, those firms tend to be more visible. With smaller, non-listed, and less visible firms, other stakeholders might become more relevant. Investigations of stakeholder relations and CSR reporting have identified the local community as an important stakeholder (Cooper & Owen, 2007; Jamali, 2008). Marquis and Battilana defined local communities as "*institutional arenas that have an enduring influence on organizational behavior through regulative, normative, and cultural-cognitive processes*" (2009, p. 294). The extent of this influence on a firm's behavior is what I refer to as a firm's "local anchoring." While public firms are more likely to be multinationally operating corporations with a decentralized structure and numerous sites, the variation of local anchoring can be much wider among private firms, ranging from similarly decentralized firms to highly centralized, locally operating firms with *in extremum* a single site and extremely narrowly defined markets for their products and labor.

On the one hand, local communities might be especially interested in information on firms' polluting activities as they might perceive themselves as the first ones affected. On the other hand, for a locally anchored firm, the local community serves two important functions. First, from a stakeholder theory perspective, it is an important stakeholder, because its suppliers, customers, or (potential) employees are all part of the same local community. Second, from a

legitimacy theory perspective, locally based firms are less visible to society at large, which means that society at large may not be particularly interested in that particular firm. Thus, a locally anchored firm may instead desire the legitimacy that its immediate local community can provide. In this vein, I follow the literature which suggests that stakeholder theory and legitimacy theory are not two entirely distinct approaches, but overlap (Gray et al., 1995). Both theories help explain the rationale for a firm's actions with respect to its GHG disclosure, albeit from slightly different perspectives.

Therefore, assuming that the local community is interested in the GHG emissions of a locally anchored firm, both theoretical approaches suggest that the firm should respond to this information demand. What remains questionable is the "how." If GHG emissions are considered to be of major importance to the local community, the firm may want to have this information clearly stated in its formal reporting. However, if it is simply concerned about informing interested people living close by, there may be other ways to disclose GHG emissions information, such as common billboards and local newspapers. Moreover, monitoring becomes easier if the firm only operates in a locally restricted area and, thus, reporting in official documents might be less necessary.

Altogether, it is worth analyzing the effect of a private firm's local anchoring on its GHG disclosure behavior, because it is an attribute that is potentially particularly important to private firms, and it is not *ex ante* clear what prevails: the use of official documents to inform the local community about GHG emissions or the use of private communication. Hence, again, H3 is stated without a direction:

Hypothesis 3 For private firms, a firm's local anchoring is associated with its disclosure level on GHG emissions.

Actual GHG Emissions

For public firms, two explanatory approaches prevail in explaining how a firm's actual GHG performance and its disclosure about it are related: Disclosure theory suggests that firms voluntarily disclose sufficiently favorable information to increase the value of the firm, but withhold unfavorable information. There is evidence that investors punish public firms with lower share prices for high GHG emissions (e.g., Griffin et al., 2017; Matsumura et al., 2014). Thus, firms voluntarily disclose their environmental performance only when it is good (Clarkson et al., 2008; Giannarakis et al., 2017; Hummel & Schlick, 2016). A "substantive" legitimacy strategy would lead to the same outcome, because this concept describes how firms change their actions and communicate them in order to ensure legitimacy (Borgstedt

et al., 2019). On the other hand, other legitimacy strategies are symbolic and do not involve actual changes in behavior (Lindblom, 2010). In these cases, better GHG disclosure serves as a tool to maintain legitimacy despite the fact that actual behavior is not changed for the better (i.e., GHG emissions are not reduced). This is consistent with the prior literature finding that higher levels of environmental disclosure seek to repair negative effects on legitimacy (e.g., Braam et al., 2016; Deegan et al., 2002; Stanny, 2013).

There are a number of problems in transferring these argumentation patterns to private firms. For disclosure theory, the capital market mechanism is lacking for private firms. For legitimacy theory, it is necessary to discuss whose legitimacy a private firm seeks. For large, multinationally operating private firms, that legitimacy may come from a national or global society, similarly to public firms. But for small and less visible firms, the target audience is probably not the (global) society but rather the (local) community. As discussed for H3, there may therefore be other instruments to ensure legitimacy.

Hence, in a setting of private firms, other approaches to explain the association between a firm's actual GHG emissions and its disclosure about it may be needed. Transferring the approaches of Russo and Perrini (2010) and Baumann-Pauly et al. (2013) for CSR practices of SMEs suggests that smaller firms may find it easier to behave in an environmentally friendly manner, but harder to properly report that behavior. Therefore, a positive association between GHG disclosure and the actual GHG emissions level could result.

Since not only the existing empirical evidence but also the theoretical arguments point in different directions, I again formulate the hypothesis without a predicting direction:

Hypothesis 4 For private firms, a firm's actual level of GHG emissions is associated with its disclosure on GHG emissions.

Research Design

Sample Description

The sample comprises German private firms covered by the EU ETS from 2013 to 2015. The homogeneous regulatory framework in Germany at that time is especially suited for this analysis because there was no comprehensive GHG reporting requirement at that time. The observation period starts with the beginning of the third EU ETS trading period in 2013. In April 2017, the German Parliament passed the CSR Directive Implementation Act. To rule out any possible biases from this later regulatory intervention, I restrict the observation period to between 2013 and 2015.

Table 1 Sample compilation

	Firm-year observations
German firms under EU ETS (2013–2015) with basic financial information in <i>Dafne</i> (total assets, profit/loss)	1547
Minus insolvent observations	15
Minus observations with any missing (control) variable*	425
Minus firms without any GHG emissions (2013–2015) according to Union Registry data	182
Minus firms with no annual report in the <i>Bundesanzeiger</i>	56
Minus public firms	66
Final total sample	803

*Total assets, profit/loss, leverage, industry affiliation, bank relationships

Between 2013 and 2015, 1,412 account holders operated 2,674 installations covered by the EU ETS in Germany. I exclude account holders that were aircraft operators, universities, and other public authorities before matching the remaining account holders (firms) with the data availability of basic financial information (total assets, profit/loss) in *Dafne*, a database containing financial information on German private and public firms. This matching results in a maximum sample of 1,547 firm-year observations. Removing insolvent observations (15) and observations that did not have the necessary control variables (425) reduced the sample to 1107 firm-year observations. I exclude another 195 observations because they showed no verified GHG emissions in the period under consideration; for 43 firm-year observations, no annual report was available in the pertinent source, the *Bundesanzeiger*. A total of 66 firm-year observations originate from public firms. Some firms published an annual report and a consolidated financial statement under the same name; in such cases, both reports were collected and analyzed. I also researched the firms' websites to determine whether the firm (a) published a sustainability/CSR/environmental or a comparable report or (b) published information about its GHG emissions on its website. Table 1 summarizes the sample selection of the analysis.

GHG Disclosure Index

When measuring sustainability, or more specifically the quality of GHG disclosure, existing research often relies on databases such as ASSET4 (e.g., Fiechter et al., 2022), Bloomberg (e.g., Grewal et al., 2021), or CDP (e.g., Döring et al., 2023). However, all typical data sources have in common that they almost exclusively provide data on publicly listed firms and thus do not cover the sample firms of this study.

As an alternative, content analysis is a widely used approach to analyze firms' GHG or sustainability disclosure (Blanc et al., 2019; Fonseka et al., 2019; Kong et al., 2024). Some authors also use automated content analysis

(Hummel et al., 2024). However, when analyzing i.) non-standardized textual resources (such as different sections within the annual reports, websites, as well as very heterogeneous stand-alone reports) provided in an ii.) inaccessible format (PDFs), automated textual analysis is difficult (Lewis & Young, 2019).

Therefore, this study applies (manual) content analysis to construct a self-designed GHG Disclosure Index (*GDI*). After reviewing existing literature as well as key GHG reporting frameworks (e.g., the GRI 305 standard and the CDP, 2022 Questionnaire), I identified key reporting topics that seem to indicate (good) GHG disclosure and discussed these topics with other researchers. A list of the following seven disclosure items was distilled:

- Information on the amount of GHG emissions or comparable information that allows this amount to be determined (such as information on EU ETS allowances needed);
- Statements on reporting boundaries (i.e., information on Scope 1, 2, or 3 GHG emissions);
- Information on the accounting method applied;
- The publication of an emissions target;
- Statements on the firm's commitment to established reporting guidelines and verification;
- The provision of historic GHG emissions data; and
- Information on a climate change policy that reflects awareness of the topic in general.

For each of these seven items—apart from the commitment to guidelines/verification⁵—a firm's disclosure can score a maximum of three points. This approach follows the disclosure index of Wiseman (1982): three out of three points means that a disclosure statement is present and described in monetary or quantitative terms. Two out of three points are assigned to items disclosed with company-specific information, but in non-quantitative terms. A score

⁵ For the commitment to established guidelines, the maximum score is two points because no quantitative statement can be made.

of one means that this item is mentioned in general terms only; zero points mean that the specific item is not present in the disclosure at all. Self-designed disclosure indices that apply this scoring approach are commonly used in the literature (Fonseka et al., 2019; Grewal et al., 2021; Kong et al., 2024).⁶

After collecting the relevant disclosure sources (annual reports, consolidated reports, stand-alone reports, and websites), a small test sample was analyzed independently by three coders (the study author and two research assistants). The coding process was then discussed. It turned out that the Wiseman approach provides a simple and robust way to score the information sources we analyzed. There were only a very few discrepancies that needed to be discussed, such as how to value quantitative information on emission certificates. Once these issues were discussed and clarified, the coding was done by the study author. Notes were taken in order to be able to return to difficult passages later. Finally, these passages were discussed again. At the end of the scoring procedure, a final plausibility check was performed, focusing on these difficult passages and on the sources coded at the beginning, to ensure a consistent coding process.

Finally, I totaled the scores for each item. The highest possible score is therefore 20 ($= 6 \times 3 + 1 \times 2$). If a firm disclosed GHG information on more than one channel, for instance, in its annual report and in a sustainability report, I take the highest score obtained. Thus, the variable *GDI* displays the maximum GHG disclosure across all channels analyzed.

For sensitivity analyses, variations of this index are used: Since *GDI2* refers only to information on direct and/or indirect emissions, it ranges between zero and three. The most relevant items for assessing the quality of a firm's current GHG disclosure (information on direct/indirect emissions, reporting boundaries, accounting method used, verification practices) are summarized in *GDI3*, which ranges from zero to eleven.

Other potential alternative measures from the literature, such as the publication of a stand-alone report (e.g., Chen et al., 2023; Dhaliwal et al., 2011) or the application of GRI guidelines (e.g., Chen et al., 2023; Rezaee & Tuo, 2019), are not appropriate for the analysis of this study because they (i.) relate to the broader concept of sustainability reporting in general (and not GHG disclosure in particular) and (ii.) have been shown not to adequately reflect high-quality reporting (Mahoney et al., 2013; Uyar et al., 2020). As mentioned

above, CDP, ASSET4, etc., generally do not include information on private firms.

Independent Variables

Ownership Dispersion

I measured a firm's ownership dispersion, *OWNDISP*, by (the natural logarithm of) the number of its owners. The more owners a firm has, the more dispersed the ownership structure is.

Bank Relationships

In the relationship lending literature, the closeness of bank relationships is proxied by the number of bank relationships a firm has (Berger & Udell, 1998; Bigus & Hillebrand, 2017; Ongena et al., 2012). I therefore introduce a dummy variable, *SINGLE_B*, which takes a value of 1 if a firm specifies only one bank relationship in the Dafne database. For firms with more bank relationships according to Dafne, this variable is 0.

Local Anchoring

It is not yet common to measure a firm's local anchoring in accounting literature. Although some studies have mentioned the (local) community as an important stakeholder (Cooper & Owen, 2007; Jamali, 2008), they have not analyzed this relationship quantitatively. Prior attempts to proxy local anchoring quantitatively have been either not feasible due to data limitations (e.g., Greenwood et al., 2010) or not appropriate in a private firm context (e.g., Hope & Thomas, 2008).

I approximate the extent of a firm's connection to its local community, *LOCALANCH*, by the number of a firm's sites reported in Dafne, multiplied by -1 so that higher values indicate fewer sites and, thus, greater local anchoring. If a firm has only a few sites, they will probably be quite close together and will use shared resources, e.g., a shared administration building. The more sites a firm has, the more locally dispersed it will likely be. Consequently, firms' top managers must address problems that affect a wider area, reducing a firm's local connectedness.

Actual GHG Emissions

The measure for a firm's actual GHG emissions levels is based on information that the sample firms have to provide to the Federal Environment Agency. Excel sheets with verified emissions for different years can be downloaded from the Union Registry website. Using information from the European Transaction Log website, it is possible to assign facility-level

⁶ Table A1 (Supplementary Material) summarizes the references for the application of the items in previous research and their occurrence in the CDP 2022 Questionnaire and GRI 305. It also provides an overview of alternative measurement approaches. Table A2 (Supplementary Material) shows examples from annual reports or stand-alone reports for each item and score level. Table A3 (Supplementary Material) shows the descriptive statistics for each item.

information⁷ to a particular EU ETS account holder, which is usually a firm. If a firm operates more than one facility, I aggregate the emission data for all facilities of this firm to obtain firm-level data. This approach makes it possible to gather information on actual GHG emissions levels for all sample firms, independent of their decision to disclose GHG information in their annual reports or on their websites.

Taking into account that higher output inherently leads to higher GHG emissions, GHG emissions were normalized by dividing them by total revenues (e.g., Kim et al., 2015). I then use this “specific emissions level,” *SEMIS*, to proxy firms’ actual GHG emissions.

Control Variables

The set of control variables comprises variables that have been frequently applied in studies on (voluntary) environmental disclosure: *SIZE* (e.g., Luo et al., 2012; Prado-Lorenzo et al., 2009), *LEV* (e.g., Luo et al., 2013), and *ROA* (e.g., Clarkson et al., 2008), which are based on financial statement figures. A number of studies have identified industry affiliation as an important driver for GHG disclosure (Luo et al., 2012; Matisoff et al., 2013; Rankin et al., 2011). I therefore include industry fixed effects. Moreover, disclosure quality, including environmental disclosure quality, depends to a great extent on whether or not information is assured (Moroney et al., 2012). Hence, I include a binary variable *ASSURE* that takes the value of 1 if the GHG information source is assured, and 0 otherwise.

The last set of control variables consists of dummy variables that refine the consideration of ownership characteristics, which are of particular interest in a private firm setting. They capture whether the firm’s largest shareholder is a natural person (*NATURALPERS*), whether the firm’s largest shareholder is listed on a stock market (*LSPUBLIC*), or whether the firm’s largest shareholder is a public authority (*LSAUTH*).

The definition of each variable introduced in this section is given in Table A7 (Supplementary Material).

The model to test the hypotheses can be summarized as follows:

$$GDI_{i,t} = \beta_0 + \beta_1 OWNDISP_{i,t} + \beta_2 SINGLE_B_{i,t} + \beta_3 LOCALANCH_{i,t} + \beta_4 SEMIS_{i,t} + \sum_{k=5}^{11} \beta_k CONTROLS_{i,t} + IND_i + YEAR_t + \varepsilon_{i,t}. \quad (1)$$

⁷ Every facility has an ID, the “Installation/Aircraft ID,” which can be found in Excel sheets from the Union Registry (European Commission, 2023b). The account holder of each facility can be identified through this ID on the European Transaction Log website (European Commission, 2023a).

Regression Results

Descriptive Statistics

Table 2 summarizes the descriptive statistics of the full sample. Variables are winsorized at the 1st and 99th percentiles.

The average *GDI* is quite low (3.74 out of a possible score of 20). Although other studies have used older data, this finding reflects previous findings (Lu & Abeysekera, 2014; Rankin et al., 2011). About one-third of the sample firms have only one bank relationship. The median firm has total assets of €154 million. Considering that the mean of total assets is €655 million, there are some very large firms in the sample. The average firm in this sample has 2.2 shareholders and 2.74 sites.

Pearson and Spearman correlation analyses (Table A4 in Supplementary Material) do not indicate high absolute correlation coefficients between any of the independent variables.

Multivariate Results

Although the data structure is a panel, Model 1 uses a pooled OLS regression with control dummies for industry and year fixed effects, and firm-clustered robust standard errors. A fixed effects model is unsuitable because some important variables, above all *SINGLE_B* and *LOCALANCH*, are time invariant. Since the Breusch–Pagan test rejects a random effects model, it is more appropriate to use a pooled OLS model and limit the application of a panel regression with random effects to a robustness check (1.5).

Table 3 contains the regression results. Model specification (1.1) represents the main model, with *GDI* as the dependent variable. For robustness checks, I run other model specifications as well: Model (1.2) represents a binary disclosure decision (*BDISC* = 1 if *GDI* ≠ 0 and *BDISC* = 0 if *GDI* = 0); in Model (1.3), the *GDI* is only estimated within the subgroup of disclosing firms; Model (1.4) is a tobit regression that takes into account the fact that *GDI* is restricted by a lower bound (0) and an upper bound (20).

The results indicate significant associations regarding Hypothesis 1 (ownership dispersion, *OWNDISP*), Hypothesis 2 (bank relationships, *SINGLE_B*), and Hypothesis 4 (actual GHG emissions level, *SEMIS*); for Hypothesis 3 (local anchoring, *LOCALANCH*), however, no statistically significant effect can be found.

Regression results suggest that there is no association between a firm’s local anchoring and its GHG disclosure decision. From a theoretical perspective, this might be explained by the use of private communication channels between firms and their local community.

Table 2 Descriptive statistics

Variable	N	Mean	Std. dev	Min	25th percentile	Median	75th percentile	Max
<i>GDI</i>	803	3.740	4.021	0	0	3	6	18
<i>OWNDISP</i>	803	0.789	0.621	0	0	0.693	1.099	2.944
<i>SINGLE_B</i>	803	0.331	0.471	0	0	0	1	1
<i>LOCALANCH</i>	803	−2.741	4.629	−27	−3	−1	0	0
<i>SEMIS</i>	803	0.00187	0.00524	0.000001	0.00009	0.00036	0.00112	0.03810
<i>SIZE</i>	803	19.007	1.588	15.507	17.899	18.852	20.081	22.883
Total assets in thousand €	803	655,458.3	1,410,447	5425.5	59,376.7	153,992.1	526,179	8,670,496
<i>ROA</i>	803	0.062	0.078	−0.175	0.019	0.047	0.085	0.449
<i>LEV</i>	803	0.642	0.210	0.119	0.489	0.653	0.799	1
<i>ASSURE</i>	803	0.930	0.255	0	1	1	1	1
<i>LSPUBLIC</i>	803	0.046	0.210	0	0	0	0	1
<i>NATURALPERS</i>	803	0.052	0.223	0	0	0	0	1
<i>LSAUTH</i>	803	0.132	0.339	0	0	0	0	1

All variables are winsorized at the 1st and 99th percentiles. For a definition of variables, see Table A7 (Supplementary Material)

The positive and significant coefficient of *OWNDISP* supports the notion that with more owners, and hence more information asymmetries, there is a need for higher GHG disclosure levels. This result is in line with the findings obtained for public firms, for example, Gamerschlag et al. (2011) and Lu and Abeysekera (2014). If the number of owners increases by one, the *GDI* increases by 0.71 points. This increase seems to be rather small at first glance, but considering the low mean GHG disclosure level in the sample, it amounts to almost 19% of the average GHG disclosure level. All other model specifications confirm this association as well.

Similarly, for most model specifications, firms with only one single bank relationship exhibit significantly lower GHG disclosure levels than firms with multiple bank relationships. This result is in line with prior findings on financial reporting quality of German private firms (Bigus & Hillebrand, 2017). With close bank–borrower relationships, there is less need for communication in official documents, but probably more need for private communication. Firms with a single bank relationship disclose 0.63 fewer items on average compared to firms with multiple bank relationships. In light of a mean disclosure level of 3.74, having a single bank relationship amounts to a 17% decrease in GHG emissions disclosure.

Results regarding H1 and H2 support the idea that information asymmetries with capital providers play a role for private firms as well, and are partially mitigated by increased GHG disclosure. Hence, arguments from principal–agent and stakeholder theory appear to be also applicable when a.) considering private firms and b.) dealing with information related to GHG emissions.

With respect to H4, there is a significant positive association between *SEMIS* and *GDI*. The tobit regression (1.4)

and the panel regression (1.5) confirm this association as well. The higher the actual level of a firm’s GHG emissions is (and, hence, the lower its environmental performance), the more the extensive its GHG disclosure is on average. On the one hand, this is consistent with argumentation patterns from legitimacy theory that suggest a more symbolic use of GHG disclosure with no real effort to reduce GHG emissions. On the other hand, it is also consistent with the considerations for SMEs as outlined by Russo and Perrini (2010) and Baumann-Pauly et al. (2013).

To further disentangle whether legitimacy concerns or the size of the firm in connection with restricted resources is the primary mechanism, I run Models (1.6) and (1.7), where I include an interaction term of the GHG emissions level *SEMIS* and *ROA* or *SIZE*, respectively. The insignificant coefficient of the interaction term between *SEMIS* and *ROA* in Model (1.6) indicates that it is not a firm’s financial situation that moderates the link between the actual GHG emissions level and GHG disclosure. When introducing the interaction term between *SIZE* and *SEMIS* in Model (1.7), the regression coefficient of *SEMIS* turns negative, indicating that small firms are reluctant to disclose the “bad news” that their emissions levels are high. However, the larger a firm gets, the smaller this effect becomes; for the average sized firm in this sample, the overall effect of *SEMIS* on *GDI* is positive. If the concepts of relative costs and social capital were the prevalent mechanisms here, I would have expected correlations in the opposite direction⁸. In that case, the interaction term would be negative because the positive association between *SEMIS* and *GDI* should be

⁸ Potentially, the fact that the sample firms are rather large, with the median firm having total assets of €154 million, is one explanation why the considerations for SMEs do not seem to hold in this sample.

Table 3 Multivariate regressions

	(1.1) Main regres- sion, <i>GDI</i>	(1.2) Binary disclo- sure decision, <i>BDISC</i>	(1.3) Sub-sample: disclosing firms only, <i>GDI</i>	(1.4) Tobit regres- sion, <i>GDI</i>	(1.5) Panel regres- sion, <i>GDI</i>	(1.6) Interaction of <i>SEMS</i> and <i>SIZE</i> , <i>GDI</i>	(1.7) Interaction of <i>SEMS</i> and <i>ROA</i> , <i>GDI</i>	(1.8) Sub-index, <i>GDI2</i>	(1.9) Sub-index, <i>GDI3</i>	(1.10) Interaction of <i>SINGLE_B</i> and <i>LOCALANCH</i> , <i>GDI</i>
	Coefficient (<i>t</i> value)	Coefficient (<i>z</i> value)	Coefficient (<i>t</i> value)	Coefficient (<i>t</i> value)	Coefficient (<i>z</i> value)	Coefficient (<i>t</i> value)	Coefficient (<i>t</i> value)	Coefficient (<i>t</i> value)	Coefficient (<i>t</i> value)	Coefficient (<i>t</i> value)
<i>OWNDISP</i>	0.713*** (2.735)	0.216* (1.903)	0.603** (2.274)	0.945*** (3.871)	0.704*** (2.780)	0.694*** (2.717)	0.710*** (2.729)	0.246*** (2.601)	0.409*** (2.894)	0.708*** (2.786)
<i>SINGLE_B</i>	-0.629* (-1.820)	-0.0448 (-0.296)	-0.870** (-2.280)	-0.757** (-2.210)	-0.684** (-1.981)	-0.609* (-1.774)	-0.631* (-1.825)	0.0508 (0.377)	-0.219 (-1.183)	-0.0530 (-0.133)
<i>LOCALANCH</i>	-0.0536 (-1.005)	-0.0150 (-0.905)	-0.0404 (-0.722)	-0.0622 (-1.627)	-0.0455 (-0.874)	-0.0587 (-1.089)	-0.0536 (-1.006)	0.00285 (0.200)	-0.0245 (-0.819)	-0.0891 (-1.562)
<i>SEMS</i>	61.70** (2.100)	57.45** (2.353)	15.12 (0.570)	89.81*** (2.898)	49.30** (2.046)	-912.4** (-1.984)	56.93* (1.957)	48.55*** (4.683)	55.78*** (4.083)	61.90** (2.144)
<i>SEMS*SIZE</i>						53.62** (2.090)				
<i>SEMS*ROA</i>							125.6 (0.419)			
<i>SINGLE_B*</i> <i>LOCALANCH</i>										0.221*** (2.832)
<i>SIZE</i>	0.662*** (5.278)	0.153*** (2.951)	0.601*** (4.340)	0.838*** (7.095)	0.721*** (5.813)	0.566*** (4.226)	0.664*** (5.275)	0.150*** (3.411)	0.262*** (3.495)	0.704*** (5.554)
<i>ROA</i>	-2.770* (-1.728)	0.0329 (0.0383)	-5.127** (-2.325)	-3.266 (-1.549)	-1.066 (-1.141)	-2.569 (-1.609)	-2.957* (-1.802)	-1.428** (-2.463)	-1.659* (-1.895)	-3.247** (-2.005)
<i>LEV</i>	0.102 (0.127)	-0.568 (-1.557)	1.044 (1.132)	-0.500 (-0.642)	-0.405 (-0.622)	0.172 (0.217)	0.0977 (0.122)	-0.107 (-0.367)	0.0465 (0.103)	-0.0447 (-0.0559)
<i>ASSURE</i>	-6.223*** (-7.282)	-0.880*** (-3.190)	-5.876*** (-7.451)	-6.846*** (-11.39)	-4.926*** (-5.779)	-6.340*** (-7.362)	-6.219*** (-7.269)	-1.171*** (-5.568)	-3.812*** (-6.348)	-6.088*** (-7.117)
<i>LSAUTH</i>	0.0321 (0.0432)	-0.116 (-0.475)	0.531 (0.668)	0.00746 (0.0146)	-0.182 (-0.270)	0.0538 (0.0725)	0.0313 (0.0421)	-0.0143 (-0.0596)	0.0863 (0.189)	-0.0364 (-0.0488)
<i>NATURALP-ERS</i>	-1.427** (-1.999)	-0.851*** (-2.662)	0.172 (0.197)	-2.835*** (-3.360)	-1.179* (-1.891)	-1.462** (-2.049)	-1.421** (-1.988)	-0.518** (-2.166)	-0.642 (-1.513)	-1.290* (-1.793)
<i>LSPUBLIC</i>	-0.0175 (-0.0210)	-0.559 (-1.493)	0.683 (0.931)	-0.462 (-0.584)	-0.0550 (-0.102)	-0.0927 (-0.125)	-0.0354 (-0.0423)	-0.109 (-0.334)	-0.264 (-0.756)	-0.140 (-0.168)
Intercept	-3.829 (-1.400)	-1.671 (-1.566)	-1.324 (-0.415)	-7.453*** (-2.991)	-5.708** (-2.176)	-2.001 (-0.698)	-3.844 (-1.403)	-1.050 (-1.143)	-0.0171 (-0.0100)	-4.702* (-1.694)
Observations	803	803	575	803	803	803	803	803	803	803
R ² /Adj. R ²	0.335/0.322		0.363/0.346			0.341/0.328	0.335/0.321	0.189/0.174	0.295/0.281	0.344/0.330

Table 3 (continued)

(1.1) Main regres- sion, <i>GDI</i>	(1.2) Binary disclo- sure decision, <i>BDISC</i>	(1.3) Sub-sample: disclosing firms only, <i>GDI</i>	(1.4) Tobit regres- sion, <i>GDI</i>	(1.5) Panel regres- sion, <i>GDI</i>	(1.6) Interaction of <i>SEMIS</i> and <i>SIZE</i> , <i>GDI</i>	(1.7) Interaction of <i>SEMIS</i> and <i>ROA</i> , <i>GDI</i>	(1.8) Sub-index, <i>GDI2</i>	(1.9) Sub-index, <i>GDI3</i>	(1.10) Interaction of <i>SINGLE_B</i> and <i>LOCALANCH</i> , <i>GDI</i>
Coefficient (<i>t</i> value)	Coefficient (<i>z</i> value)	Coefficient (<i>t</i> value)	Coefficient (<i>t</i> value)	Coefficient (<i>z</i> value)	Coefficient (<i>t</i> value)	Coefficient (<i>t</i> value)	Coefficient (<i>t</i> value)	Coefficient (<i>t</i> value)	Coefficient (<i>t</i> value)
Pseudo R ²	0.116		0.071	0.3269					
Overall R ²									
Ind. + year FE	Included	Included	Included	Included	Included	Included	Included	Included	Included
F-Stat (Prob > F)	13.66 (0)	10.49 (0)	278.7 (0)	171.1 (0)	13.47 (0)	12.84 (0)	9.98 (0)	10.56 (0)	133.21 (0)
Wald/LR chi ² (Prob > chi ²)	58.68 (0)								
Ø VIF (max. VIF)	1.34 (2.50)	1.4 (2.67)			32.57 (251.29)	1.38 (2.5)	1.34 (2.50)	1.34 (2.50)	1.41 (2.51)

Robust standard errors are adjusted – for heteroskedasticity and clustering at the firm level

All variables are winsorized at the 1st and 99th percentiles

***, **, * Significance at the 1%, 5%, and 10% level (two-tailed test)

more pronounced for smaller firms. The fact that the link between *SEMIS* and *GDI* only turns positive for larger firms and becomes stronger is instead an indicator of legitimacy concerns within the firm: While small firms might not be visible, and hence “simply” avoid reporting bad news, larger firms are probably more exposed to the public. For them, maintaining legitimacy by disclosing GHG more extensively is more important – above all when they have high actual levels of GHG emissions.

The control variables *ASSURE* (negative) and *SIZE* (positive) show associations with the *GDI* at a highly significant level in all models. The effects of a firm’s leverage and its financial performance are not clear. Both directions for an association with the *GDI* are possible, and thus, the (partially) insignificant regression coefficients for these two control variables are plausible. Among the control variables introduced to capture special ownership characteristics (*LSAUTH*, *NATURALPERS*, *LSPUBLIC*), only *NATURALPERS* exhibits a significant effect. This could be an indication that firms with a natural person as the largest shareholder are reluctant to disclose GHG information because such firms may want to mitigate potential personal reputation effects related to disclosed environmental pollution of “their” firm.

As robustness checks, alternative measures for all independent variables are applied. The results remain robust (not tabulated).

Using alternative independent variables, namely, the sub-indices *GDI2* and *GDI3*, respectively, the positive and significant effects of ownership dispersion and actual GHG emissions on GHG disclosure quality are confirmed. The coefficients of the other two variables of interest are insignificant in both model specifications (Models (1.8) and (1.9) in Table 3).

Additional Analyses

Interactions among the Determinants

Potentially, these determinants may not only affect a private firm’s GHG disclosure separately, but they may also interact and jointly affect it. The underlying mechanisms can be explained by the same theoretical approaches for each of the potential determinants (stakeholder considerations, legitimacy concerns, reduction of information asymmetries). Therefore, it is not unlikely that at least some of the determinants interact or trade off.

For this reason, I included pairwise interactions of the four potential determinants in Model (1) in separate regressions. It turned out that only the interaction of *SINGLE_B* and *LOCALANCH* has a significant regression coefficient (see Model (1.10) in Table 3). While the two variables alone do not have a significant impact on *GDI* in this model, their joint effect is significantly positive. This suggests that

neither having a single banking relationship nor being a locally anchored firm alone affects the quality of a firm's GHG disclosure, but that firms which have a close banking relationship expand their GHG disclosure the more locally anchored they are. A possible explanation is that the bank involved is also part of the same local community as the firm. Their close relationship may be known to the local community, and therefore, the bank may encourage the firm to increase its efforts to comply with the local norms because the bank expects a spillover of the firm's reputation to itself. Since the other interactions are not significant, the results are not tabulated. However, all analyses again confirm the significant positive effect of *OWNDISP* and *SEMIS*.

Endogeneity Analyses

I assume that a firm's decisions regarding its ownership structure, bank relationships, and local anchoring are all strategic decisions. Such decisions are driven by long-term considerations, such as a focus on certain sales markets; they are also linked to long-term investments. It therefore seems unlikely that one of these particular parameters and the decision about the extent of GHG disclosures in a particular reporting period would be driven by the same unobserved variable(s), or that there would be a problem of reverse causality. The implicitly assumed exogeneity of the *SEMIS* variable is less clear, and will be analyzed in this section in more detail.

Two-Step Heckman Procedure

The two-step Heckman procedure addresses possible self-selection biases, which may arise from unobserved parameters that drive both the decision to disclose information on GHG emissions and the actual level of emissions. To perform this analysis, I introduced the treatment *HIGHSEMIS*, which is the industry-specific median split of *SEMIS*.

I apply the amount of emission allowances a firm receives free of charge, *FREEA*, as an exclusion restriction. *FREEA* is exogenous by nature because it is determined by a national allocation plan. It reflects GHG emissions related to a firm's specific processes, because it is based on a sector benchmark. The benchmark is determined by the GHG emissions of the 10% most efficient facilities in Europe in this sector (DEHSt, 2019). Additionally, I include the results of Germany's Green Party in the election at the beginning of the observation period in 2013, *GREEN*, as a second exclusion restriction (Govdata, 2013). *GREEN* is exogenous as well, because it cannot be influenced by the firm. On the other hand, a high correlation with *SEMIS* is possible, because if there is an area with numerous environmentally polluting firms, it is possible that voters will be more concerned about environmental issues.

The positive and significant association between *HIGHSEMIS* and *GDI* is confirmed by the results depicted in Table 4. The suitability of *FREEA* and *GREEN* as exclusion restrictions is supported by low correlation coefficients of these variables with *GDI* and (high) correlations with *HIGHSEMIS* and their significance in the first-stage regression (not tabulated). Low mean and maximum VIF also indicate high model quality. The statistically significant inverse Mills' ratio indicates a selection bias, underscoring the necessity of endogeneity analyses.

Instrumental Variable Approach

To further address the possible endogeneity issues of the *SEMIS* variable, I replace it with instrumental variables. I again use *FREEA* and *GREEN*, as well as the specific emissions level of the previous period, *PRIORSEMIS*, as instrumental variables.

The right-hand columns of Table 4 summarize the regression results of both stages of this approach.

The significant positive association between *SEMIS* and *GDI* holds up, as the results of the last-stage regression suggest. The results for *OWNDISP* (significant positive association), *SINGLE_B* (significant negative association), and *LOCALANCH* (no significant association) also remain robust. The highly significant associations of *FREEA* and *PRIORSEMIS* with the instrumented variable *SEMIS* lend support for the high quality of the instruments. This is also indicated by the low correlation coefficients of the instruments with the dependent variable (*GDI*) and the high correlation coefficients with *SEMIS* (not tabulated).

I also applied a propensity score matching with *HIGHSEMIS* as the treatment. The results are summarized in Table A5 in the Supplementary Material and again confirm all the main results.

Moreover, firms covered by the EU ETS may be systematically different from firms that are not covered. In that case, analyzing the sub-sample of EU ETS firms could imply a sample selection bias. To address this concern, I run a Heckman sample selection model that is summarized Table A6 in the Supplementary Material. All main results are again confirmed. Moreover, the insignificant Mill's ratios suggest that the main regression probably does not suffer from a sample selection bias.

Conclusion

What are the drivers of private firms' voluntary GHG disclosures? This study has attempted to shed light on this question, and to do so applied and combined theories that

Table 4 Two-step Heckman procedure and IV regression (endogeneity of *HIGHSEMIS*)

	Two-step Heckman procedure			IV regression	
	Original, GDI	1st stage (probit of <i>HIGHSEMIS</i>)	2nd stage, GDI	1st stage (instrumented: <i>SEMIS</i>)	2nd stage, GDI
	Coefficient (<i>t</i> value)	Coefficient (<i>z</i> value)	Coefficient (<i>z</i> value)	Coefficient (<i>t</i> value)	Coefficient (<i>z</i> value)
<i>OWNDISP</i>	0.713*** (2.735)	−0.105 (−1.20)	0.648*** (3.490)	0.0003 (1.46)	0.702*** (2.69)
<i>SINGLE_B</i>	−0.629* (−1.820)	0.223* (1.91)	−0.867*** (−3.316)	−0.00002 (−0.07)	−0.622* (−1.80)
<i>LOCALANCH</i>	−0.0536 (−1.005)	0.119*** (5.17)	−0.0981*** (−3.257)	−0.00002 (−0.82)	−0.051 (−0.97)
<i>SEMIS</i>	61.70** (2.100)				
<i>HIGHSEMIS</i>			3.302*** (7.089)		
<i>FREEA</i>		2.335e−06*** (10.78)		9.02e−010*** (3.11)	
<i>GREEN</i>		−3.575** (−2.24)		−0.003 (−0.64)	
<i>PRIORSEMIS</i>				0.3321*** (2.79)	
\widehat{SEMIS}					83.30** (2.50)
Intercept	−3.829 (−1.400)	7.720*** (7.81)	−8.711*** (−4.327)	0.0097*** (2.97)	−3.729 (−1.34)
<i>MILLS</i>			−1.599*** (−5.009)		
Observations	803	803	803	779	779
R ² /Adj. R ²	0.335/0.322			0.624/0.616	0.332/0.319
Pseudo R ²		0.347			
Ind. + year FE	Included	Included	Included	Included	Included
Control variables	Included	Included	Included	Included	Included
F-Stat (Prob > F)	13.66 (0)			12.08 (0)	
Wald chi ² /LR (Prob > chi ²)		386.27 (0)	572.05 (0)		208.85 (0)
Ø VIF (max. VIF)	1.34 (2.50)		1.59 (3.34)		

All variables are winsorized at the 1st and 99th percentiles

Woodridge's three-stage approach is estimated with robust standard errors that are adjusted for heteroskedasticity and clustered at the firm level

The control variables are *SIZE*, *LEV*, *ROA*, *ASSURE*, *LSPUBLIC*, *NATURALPERS*, *LSAUTH*

***, **, * Significance at the 1%, 5%, and 10% level (two-tailed test)

so far have been primarily used for public firms, as well as approaches that were developed for SMEs.

For firms with a more dispersed ownership structure and for firms with multiple bank relationships, I have found higher levels of voluntary GHG disclosure on average. Information asymmetries between managers and owners or banks, respectively, are often considered to be negligible for private firms. Nevertheless, my results suggest that firms expand

their GHG disclosure when they face more pronounced information asymmetries with their capital providers. This is in line with principal–agent theory, stakeholder theory, and previous findings related to public firms.

Another driver of private firms' GHG disclosure could be the given firm's local anchoring. The more locally connected a firm is, the more mutually important the firm and the surrounding local community might be. Therefore, if the

local community had an information demand with respect to GHG emissions, it would be likely that the firm would seek to fulfill it. The results of this study, however, suggest that private firms do not use their annual reports to fulfill this (potential) demand.

For public firms, there is mixed evidence of how firms' actual GHG emissions and their disclosure are related. The two main explanatory approaches are substantive changes in real actions that are communicated versus more symbolic or even misleading disclosures. I add insights from Russo and Perrini (2010) and Baumann-Pauly et al. (2013) on the CSR practices of SMEs to the theoretical framework. My findings support the view that private firms also use GHG disclosure to ensure legitimacy in a more symbolic way.

By showing that GHG disclosure patterns that are already well documented for public firms also apply for private firms to some extent, my study contributes to the growing literature of sustainability accounting. To the best of my knowledge, there has not yet been a thorough examination of private firms' voluntary GHG disclosure. From a methodological point of view, this study was able to take advantage of reporting requirements imposed by the EU ETS. Having done so obviously restricts the sample to those firms covered by the EU ETS. However, by analyzing EU ETS firms, it became possible to derive firms' actual GHG emissions without having to rely on their GHG disclosure in annual reports. I was therefore able to overcome the typical self-selection problem that studies on voluntary disclosure usually suffer from.

On the other hand, the restriction to EU ETS firms partly limits the generalizability of the results. In terms of GHG emissions, EU ETS firms are special: They operate high-emitting facilities and can therefore be considered "environmentally sensitive" firms. Previous literature has shown that this affects environmental disclosure behavior (Matisoff et al., 2013; Rankin et al., 2011). The results of a simple sample selection model suggest that the main findings are not biased through the use of the sub-sample of EU ETS firms only. However, this analysis was performed for firms operating in the same industries as the EU ETS firms. Therefore, it is not clear whether the results of this study are applicable to other, less emitting private firms in other industries. However, there are other countries in Europe that also participate in the EU ETS that do not yet have mandatory GHG disclosure requirements for private firms (e.g., Spain and Italy). It is conceivable that my results generalize to private firms covered by the EU ETS in these large economies.

Moreover, the self-constructed GHG Disclosure Index might be considered subjective to some extent. Although I have taken the greatest care to avoid any ambiguity in assessing the score, and employed the help of two student assistants to double-check the coding, its external validity remains questionable. However, the construction of the

index has enabled a very easy, straightforward, and reproducible analysis of reports. The internal validity of the GDI can therefore be assumed. The application of theories that were not initially developed for private firms, but rather for public firms or SMEs, might be perceived as another limitation. Since there is no comprehensive set of theories that explicitly aims to explain (sustainability-related) disclosure decisions of private firms, the thoughtful transfer from theories that have shown to be useful for other types of firms can be considered as a second-best solution.

Future research could address this point: Considering the economic importance of private firms and their immense GHG emissions, a solid theoretical framework to explain the GHG disclosure decisions of this type of firm is needed. Empirical studies can elaborate the real effects the introduction of mandatory sustainability reporting requirements has on private firms.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s10551-024-05697-w>.

Acknowledgements The author thanks Jochen Bigus, Lucie Courteau, Katrin Hummel (discussant), Michaela Rankin, and seminar participants at the 2018 EAA in Milan; at the 2018 VHB in Magdeburg; at the 2018 Brown Bag Seminar at Monash University, Melbourne, and at the 2018 FACTS and Management & Marketing Forschungswerkstatt at the Freie Universität Berlin for their valuable comments.

Funding Open Access funding enabled and organized by Projekt DEAL. No funding was received for conducting this study.

Data Availability The data for this study are available from the author upon request.

Declarations

Competing Interests The author has no competing interests to declare that are relevant to the content of this article.

Ethical Approval This study does not involve human participants (ethics approval and informed consent not applicable).

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.

References

- Ball, R., & Shivakumar, L. (2005). Earnings quality in UK private firms: Comparative loss recognition timeliness. *Journal of Accounting and Economics*, 39(1), 83–128.
- Baumann-Pauly, D., Wickert, C., Spence, L. J., & Scherer, A. G. (2013). Organizing corporate social responsibility in small and large firms: Size matters. *Journal of Business Ethics*, 115(4), 693–705.
- Beatty, A., & Harris, D. G. (1998). The effects of taxes, agency costs and information asymmetry on earnings management: A comparison of public and private firms. *Review of Accounting Studies*, 3, 299–326.
- Berger, A. N., & Udell, G. F. (1998). The economics of small business finance: The roles of private equity and debt markets in the financial growth cycle. *Journal of Banking & Finance*, 22, 613–673.
- Bigus, J., & Hillebrand, C. (2017). Bank relationships and private firms' financial reporting quality. *European Accounting Review*, 26(2), 379–409.
- Blanc, R., Cho, C. H., Sopt, J., & Castelo Branco, M. (2019). Disclosure responses to a corruption scandal: The case of Siemens AG. *Journal of Business Ethics*, 156(2), 545–561.
- Bonacchi, M., Marra, A., & Zarowin, P. (2019). Organizational structure and earnings quality of private and public firms. *Review of Accounting Studies*, 24(3), 1066–1113.
- Borgstedt, P., Nienaber, A.-M., Liesenkötter, B., & Schewe, G. (2019). Legitimacy strategies in corporate environmental reporting: A longitudinal analysis of German DAX companies' disclosed objectives. *Journal of Business Ethics*, 158(1), 177–200.
- Braam, G. J. M., Uit de Weerd, L., Hauck, M., & Huijbregts, M. A. J. (2016). Determinants of corporate environmental reporting: The importance of environmental performance and assurance. *Journal of Cleaner Production*, 129, 724–734.
- Burgstahler, D. C., Hail, L., & Leuz, C. (2006). The importance of reporting incentives: Earnings management in European private and public firms. *The Accounting Review*, 81(5), 983–1016.
- Carmo, C., & Miguéis, M. (2022). Voluntary sustainability disclosures in non-listed companies: An exploratory study on motives and practices. *Sustainability*, 14(12), 7365.
- CDP. (2022). Climate Change 2022 Questionnaire.
- Chen, L., Liao, C.-H., Tsang, A., & Yu, L. (2023). CEO career concerns in early tenure and corporate social responsibility reporting. *Contemporary Accounting Research*, 40(3), 1545–1575.
- Chi, W., Wu, S.-J., & Zheng, Z. (2020). Determinants and consequences of voluntary corporate social responsibility disclosure: Evidence from private firms. *The British Accounting Review*, 26(6), 100939.
- Christensen, H. B., Floyd, E., Liu, L. Y., & Maffett, M. (2017). The real effects of mandated information on social responsibility in financial reports: Evidence from mine-safety records. *Journal of Accounting and Economics*, 64(2–3), 284–304.
- Christensen, H. B., Hail, L., & Leuz, C. (2021). Mandatory CSR and sustainability reporting: Economic analysis and literature review. *Review of Accounting Studies*, 26, 1176–1248.
- Clarkson, P. M., Li, Y., Richardson, G. D., & Vasvari, F. P. (2008). Revisiting the relation between environmental performance and environmental disclosure: An empirical analysis. *Accounting, Organizations and Society*, 33(4–5), 303–327.
- Cooper, S. M., & Owen, D. L. (2007). Corporate social reporting and stakeholder accountability: The missing link. *Accounting, Organizations and Society*, 32, 649–667.
- Cormier, D., Magnan, M., & van Velthoven, B. (2005). Environmental disclosure quality in large German companies: Economic incentives, public pressures or institutional conditions? *European Accounting Review*, 14(1), 3–39.
- Crossley, R. M., Elmarghi, M. H., & Ntim, C. G. (2021). Sustainability and legitimacy theory: The case of sustainable social and environmental practices of small and medium-sized enterprises. *Business Strategy and the Environment*, 30(8), 3740–3762.
- da Silva Monteiro, S. M., & Aibar-Guzmán, B. (2010). Determinants of environmental disclosure in the annual reports of large companies operating in Portugal. *Corporate Social Responsibility and Environmental Management*, 17, 185–204.
- Deegan, C., Rankin, M., & Tobin, J. (2002). An examination of the corporate social and environmental disclosures of BHP from 1983–1997: A test of legitimacy theory. *Accounting, Auditing & Accountability Journal*, 15(3), 312–343.
- DEHSt. (2019). Factsheet: Europäischer Emissionshandel 2013–2020. Retrieved May 2, 2023, from https://www.dehst.de/SharedDocs/downloads/DE/publikationen/factsheets/Factsheet_EH-2013-2020.pdf?__blob=publicationFile&v=3
- Dhaliwal, D. S., Li, O. Z., Tsang, A., & Yang, Y. G. (2011). Voluntary nonfinancial disclosure and the cost of equity capital: The Initiation of corporate social responsibility reporting. *Accounting Review*, 86(1), 59–100.
- Döring, S., Drobetz, W., El Ghoul, S., Guedhami, O., & Schröder, H. (2023). Foreign institutional investors, legal origin, and corporate greenhouse gas emissions disclosure. *Journal of Business Ethics*, 182(4), 903–932.
- Downar, B., Ernstberger, J., Reichelstein, S., Schwenen, S., & Zaklan, A. (2021). The impact of carbon disclosure mandates on emissions and financial operating performance. *Review of Accounting Studies*, 23, 1137–1175.
- European Commission. (2023a). Climate Action: European Union Transaction Log. Retrieved May 2, 2023, from <https://ec.europa.eu/clima/ets/>
- European Commission. (2023b). Union Registry. European Commission. Retrieved May 2, 2023, from https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets/union-registry_en
- European Parliament. (2023). Total greenhouse gases emissions per EU country in 2019. Retrieved April 27, 2023, from <https://www.europarl.europa.eu/topics/en/article/20180301STO98928/greenhouse-gas-emissions-by-country-and-sector-infographic>
- European Parliament and the Council. (2003). *Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC: 2003/87/EC*.
- Eurostat. (2022). EU small and medium-sized enterprises: an overview. Eurostat. Retrieved April 27, 2023, from <https://ec.europa.eu/eurostat/de/web/products-eurostat-news/-/edn-20220627-1>
- Fernandez-Feijoo, B., Romero, S., & Ruiz, S. (2014). Effect of stakeholders' pressure on transparency of sustainability reports within the GRI framework. *Journal of Business Ethics*, 122, 53–63.
- Fiechter, P., Hitz, J.-M., & Lehmann, N. (2022). Real effects of a widespread CSR reporting mandate: Evidence from the European union's CSR directive. *Journal of Accounting Research*, 60(4), 1499–1549.
- Fonseka, M., Rajapakse, T., & Tian, G.-L. (2019). The effects of environmental information disclosure and energy types on the cost of equity: Evidence from the energy industry in China. *Abacus*, 55(2), 362–410.
- Freedman, M., & Stagliano, A. J. (2002). Environmental disclosure by companies involved in initial public offerings. *Accounting, Auditing & Accountability Journal*, 15(1), 94–105.
- Gamerschlag, R., Möller, K., & Verbeeten, F. (2011). Determinants of voluntary CSR disclosure: Empirical evidence from Germany. *Review of Managerial Science*, 5(2–3), 233–262.

- Giannarakis, G., Zafeiriou, E., & Sariannidis, N. (2017). The impact of carbon performance on climate change disclosure. *Business Strategy and the Environment*, 26, 1078–1094.
- Govdata. (2013). Bundestagswahl 2013: Amtliche Ergebnisse und Informationen zur Bundestagswahl 2013. Retrieved May 16, 2023, from <https://www.govdata.de/suchen/-/details/de-bundestagswahl-2013>
- Gray, R., Kouhy, R., & Lavers, S. (1995). Corporate social and environmental reporting. *Accounting, Auditing & Accountability Journal*, 8(2), 47–77.
- Greenwood, R., Magán Díaz, A., Xiao, S., & CéspedesLorente, J. (2010). The multiplicity of institutional logics and the heterogeneity of organizational responses. *Organization Science*, 21(2), 521–539.
- Grewal, J., Hauptmann, C., & Serafeim, G. (2021). Material sustainability Information and stock price informativeness. *Journal of Business Ethics*, 171(3), 513–544.
- GRI. (2016). GRI 305: Emissions.
- Griffin, P. A., Lont, D. H., & Sun, E. Y. (2017). The relevance to investors of greenhouse gas emission disclosures. *Contemporary Accounting Research*, 34(2), 1265–1297.
- Guenther, E., Guenther, T., Schiemann, F., & Weber, G. (2016). Stakeholder relevance for reporting: Explanatory factors of carbon disclosure. *Business & Society*, 55(3), 361–397.
- Hickman, L. E. (2020). Information asymmetry in CSR reporting: Publicly-traded versus privately-held firms. *Sustainability Accounting, Management and Policy Journal*, 11(1), 207–232.
- Hope, O.-K., Langli, J. C., & Thomas, W. B. (2012). Agency conflicts and auditing in private firms. *Accounting, Organizations and Society*, 37(7), 500–517.
- Hope, O.-K., & Thomas, W. B. (2008). Managerial empire building and firm disclosure. *Journal of Accounting Research*, 46(3), 591–626.
- Hope, O.-K., Thomas, W. B., & Vyas, D. (2013). Financial reporting quality of US private and public firms. *Accounting Review*, 88(5), 1715–1742.
- Hummel, K., Mittelbach-Hörmanseder, S., Cho, C. H., & Matten, D. (2024). Corporate social responsibility disclosure: a topic-based approach. *Accounting and Business Research*, 54(1), 87–124.
- Hummel, K., & Schlick, C. (2016). The relationship between sustainability performance and sustainability disclosure—Reconciling voluntary disclosure theory and legitimacy theory. *Journal of Accounting and Public Policy*, 35(5), 455–476.
- IPCC. (2022). *Climate change 2022: Mitigation of climate change*. IPCC.
- Jamali, D. (2008). A stakeholder approach to corporate social responsibility: A fresh perspective into theory and practice. *Journal of Business Ethics*, 82, 213–231.
- Jung, J., Herbohn, K., & Clarkson, P. M. (2018). Carbon risk, carbon risk awareness and the cost of debt financing. *Journal of Business Ethics*, 150(4), 1151–1171.
- Kim, E.-H., & Lyon, T. P. (2011). Strategic environmental disclosure: Evidence from the DOE's voluntary greenhouse gas registry. *Journal of Environmental Economics and Management*, 61(3), 311–326.
- Kim, Y.-B., An, H. T., & Kim, J. D. (2015). The effect of carbon risk on the cost of equity capital. *Journal of Cleaner Production*, 93, 279–287.
- Kolk, A., Levy, D., & Pinkse, J. (2008). Corporate responses in an emerging climate regime: The institutionalization and commensuration of carbon disclosure. *European Accounting Review*, 17(4), 719–745.
- Kong, D., Liu, J., Wang, Y., & Zhu, L. (2024). Employee stock ownership plans and corporate environmental engagement. *Journal of Business Ethics*, 189(1), 177–199.
- Langli, J. C., & Svanström, T. (2014). Audits of Private Firms: In: D. Hay, R. W. Knechel, and M. Willekens (Eds.): *Routledge Companion to Auditing*. 147–158. Routledge. London, New York.
- Lemma, T. T., Feedman, M., Mlilo, M., & Park, J. D. (2019). Corporate carbon risk, voluntary disclosure, and cost of capital: South African evidence. *Business Strategy and the Environment*, 28, 111–126.
- Lewis, C., & Young, S. (2019). Fad or future? Automated analysis of financial text and its implications for corporate reporting. *Accounting and Business Research*, 49(5), 587–615.
- Liesen, A., Hoepner, A. G., Patten, D. M., & Figge, F. (2017). Does stakeholder pressure influence corporate GHG emissions reporting? Empirical evidence from Europe. *Accounting, Auditing & Accountability Journal*, 28(7), 1047–1074.
- Lindblom, C. K. (2010). *The implications of organizational legitimacy for corporate social performance and disclosure* (pp. 51–63). Los Angeles: Sage.
- Lu, Y., & Abeyssekera, I. (2014). Stakeholders' power, corporate characteristics, and social and environmental disclosure: Evidence from China. *Journal of Cleaner Production*, 64, 426–436.
- Luo, L., Lan, Y.-C., & Tang, Q. (2012). Corporate incentives to disclose carbon information: Evidence from the CDP global 500 report. *Journal of International Financial Management & Accounting*, 23(2), 93–120.
- Luo, L., Tang, Q., & Lan, Y.-C. (2013). Comparison of propensity for carbon disclosure between developing and developed countries. *Accounting Research Journal*, 26(1), 6–34.
- Luo, L., Tang, Q., & Peng, J. (2018). The direct and moderating effects of power distance on carbon transparency: An international investigation of cultural value and corporate social responsibility. *Business Strategy and the Environment*, 27, 1546–1557.
- Mahoney, L. S., Thorne, L., Cecil, L., & LaGore, W. (2013). A research note on standalone corporate social responsibility reports: Signaling or greenwashing? *Critical Perspectives on Accounting*, 24, 350–359.
- Marquis, C., & Battilana, J. (2009). Acting globally but thinking locally? The enduring influence of local communities on organizations. *Research in Organizational Behavior*, 29, 283–302.
- Matisoff, D. C., Noonan, D. S., & O'Brien, J. J. (2013). Convergence in environmental reporting: Assessing the carbon disclosure project. *Business Strategy and the Environment*, 22(5), 285–305.
- Matsumura, E. M., Prakash, R., & Vera-Muñoz, S. C. (2014). Firm-value effects of carbon emissions and carbon disclosures. *The Accounting Review*, 89(2), 695–724.
- Moroney, R., Windsor, C., & Aw, Y. T. (2012). Evidence of assurance enhancing the quality of voluntary environmental disclosures: An empirical analysis. *Accounting and Finance*, 52, 903–939.
- Ongena, S., Tümer-Alkan, G., & Westernhagen, N. V. (2012). Creditor concentration: An empirical investigation. *European Economic Review*, 56(4), 830–847.
- Prado-Lorenzo, J.-M., Rodríguez-Domínguez, L., Gallego-Álvarez, I., & García-Sánchez, I.-M. (2009). Factors influencing the disclosure of greenhouse gas emissions in companies world-wide. *Management Decision*, 47(7), 1133–1157.
- Rankin, M., Windsor, C., & Wahyuni, D. (2011). An investigation of voluntary corporate greenhouse gas emissions reporting in a market governance system. *Accounting, Auditing & Accountability Journal*, 24(8), 1037–1070.
- Rezaee, Z., & Tuo, L. (2019). Are the quantity and quality of sustainability disclosures associated with the innate and discretionary earnings quality? *Journal of Business Ethics*, 155(3), 763–786.
- Russo, A., & Perrini, F. (2010). Investigating stakeholder theory and social capital: CSR in large firms and SMEs. *Journal of Business Ethics*, 91(2), 207–221.

- Santikian, L. (2014). The ties that bind: Bank relationships and small business lending. *Journal of Financial Intermediation*, 23(2), 177–213.
- Stanny, E. (2013). Voluntary disclosures of emissions by US Firms. *Business Strategy and the Environment*, 22(3), 145–158.
- Statista. (2021). Anzahl der börsennotierten Unternehmen in Deutschland in den Jahren von 1975 bis 2020. Retrieved April 27, 2023, from <https://de.statista.com/statistik/daten/studie/1203613/umfrage/anzahl-der-boersennotierten-unternehmen-in-deutschland/>
- Statista. (2022). Anzahl der umsatzsteuerpflichtigen Unternehmen in Deutschland von 2002 bis 2020. Retrieved April 27, 2023, from <https://de.statista.com/statistik/daten/studie/246358/umfrage/anzahl-der-unternehmen-in-deutschland/>
- Suchman, M. C. (1995). Managing legitimacy: Strategic and institutional approaches. *Academy of Management Review*, 20(3), 571–610.
- Sullivan, R. (2009). The management of greenhouse gas emissions in large European companies. *Corporate Social Responsibility and Environmental Management*, 16(6), 301–309.
- Sullivan, R., & Gouldson, A. (2012). Does voluntary carbon reporting meet investors' needs? *Journal of Cleaner Production*, 36, 60–67.
- Tomar, S. (2023). Greenhouse gas disclosure and emissions benchmarking. *Journal of Accounting Research*, 61(2), 451–492.
- UN. (2023). UN on the progress with respect to SDG 13. https://sdgs.un.org/goals/goal13#progress_and_info
- Uyar, A., Karaman, A. S., & Kilic, M. (2020). Is corporate social responsibility reporting a tool of signaling or greenwashing? Evidence from the worldwide logistics sector. *Journal of Cleaner Production*, 253, 1–13.
- Wiseman, J. (1982). An evaluation of environmental disclosures made in corporate annual reports. *Accounting, Organizations and Society*, 7(1), 53–63.
- World Bank. (2023). Listed domestic companies, total. Retrieved April 27, 2023, from <https://data.worldbank.org/indicator/CM.MKT.LDOM.NO>

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.