Factors influencing the disclosure of greenhouse gas emissions in companies world-wide

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Abstract
Purpose – The purpose of this study is to analyse different factors behind the disclosure of corporate information on issues related to greenhouse gas emissions and climate change world-wide.

Design/methodology/approach – The empirical analysis carried out was performed in two stages: analysis of the data obtained through content analysis and analysis of the factors that influence the disclosure of greenhouse gas emissions and climate change using a dependency model, a multiple linear regression. Several variables were introduced to represent the size of the companies, leverage, return on assets (ROA), return on equity (ROE) and Market-to-Book ratio. Also, other dummy variables have been incorporated: Kyoto Protocol, activity sector in which the company operates and inclusion in the Dow Jones Sustainability Index.

Findings – The results obtained show a direct relationship between corporate size, its market capitalization and the disclosure of information in addition to proposed Global Reporting Initiative (GRI) indicators on greenhouse gas emissions. Conversely, an inverse relationship between ROE and disclosure is detected.

Practical implications – The findings emphasize that the main quoted companies operating in industries related to greenhouse gas emissions typically reveal information on almost all the GRI core indicators as well as the additional items specifically proposed for this issue. Moreover, the results suggest a trend for companies to utilize information on greenhouse gas emissions as a mechanism that enables them to legitimise themselves with those groups that can be of benefit to them.

Originality/value – The paper has analysed the disclosure of greenhouse gas emissions and other information of importance to climate change in companies from different countries, some of which have ratified, approved, adhered to or accepted the Kyoto Protocol, and some of which have still not accepted it.

Keywords Global warming, Climatology, Environment management

Paper type Research paper

1. Introduction

In recent years companies from different countries have increased their disclosure of information on environmental issues (e.g. Harte and Owen, 1991; Gamble et al., 1995; Gray et al., 1995, Patten, 2002; Cormier and Magnan, 2003, Prado-Lorenzo et al., 2008) by considering forests, protection of the ozone layer, climate change, water, energy and natural resources, biodiversity, and so forth. Although all of these topics affect the environment and are of maximum priority, the issue that has generated the most expectations recently is climate change.

Climate change is thought to be caused by the GHG/CO₂ emissions that will eventually lead to an increase in ground level temperatures. To deal with this problem,
the Kyoto Protocol of the United Nations Framework Convention on Climate Change was signed in 1997. The Kyoto Protocol is aimed at lowering greenhouse gas emissions and favours a distribution of the costs associated with climate change, by moving them from citizens of poor countries that are not producers of greenhouse gas emissions to the firms that are really responsible for the emissions and who profit from them. Many countries have already ratified this protocol, but others, such as the USA, have still not ratified or approved it.

Governments, environmental groups, leaders, trade associations and other groups worldwide are calling for action and putting forward various proposals. The European Union has agreed to an ambitious target to curb CO₂ emissions by 20 per cent by 2020. The USA has called for negotiations among the world’s economic powers to create the framework for a successor agreement to the Kyoto Protocol. Companies from different activity sectors worldwide must also become involved in this environmental issue, in addition to the contributions of governments and organizations.

In order to test whether different companies undertake environmental activities related to climate change and greenhouse gas emissions, the current work aims to:

- analyse the information disclosed about these issues on the websites of 101 companies from different countries and activity sectors which are considered to be more sensitive to greenhouse gas emissions; and
- study the influence of certain factors on the disclosure of information related to greenhouse gas emissions and climate change in companies in the international context.

With this purpose in mind, several dependency models have been developed in order to determine the factors underlying the information revealed in relation to greenhouse gas emissions on the websites of companies from different countries. The explanatory variables proposed to test the hypotheses have to do with corporate size, leverage, return on assets, return on equity, Market-to-Book ratio and the Kyoto Protocol, and we also control for the activity sector and the inclusion of the company in the Dow Jones Sustainability Index.

We selected this type of environmental information rather than others owing to Engels’ (2008) evidence about a serious delay in the practices of greenhouse gas emissions control, which may indicate that companies are not as concerned as one would expect and could omit information about climate change in order to conceal their behaviour. Although these practices have been included in the analysis of the drivers behind the disclosure of environmental information (i.e. Clarkson et al., 2008), they are studied jointly with other environmental issues, such as energy, water, materials, waste, biodiversity, and so forth. Although they have been partially analysed by Freedman and Jaggi (2005), these authors did not use GRI indicators as objective items in the disclosure of this information, and focused instead on data more related to future lines of corporate activities regarding this issue.

Moreover, we also consider other kinds of additional information, which companies can disclose as a consequence of the demands deriving from the Carbon Disclosure Project. This information may be necessary to assess the policy of greenhouse gas emissions control more appropriately; in addition, it could generate competitive advantages for those companies that disclose it, by allowing them to stand out from their competitors.
Unlike previous studies, our analysis includes additional explanatory variables, such as the status of listing on the Dow Jones Sustainability Index as a proxy for sustainability in business behaviour, which can be considered as a broader concept than environmental performance as used by Patten (2002), Al-Tuwaijri et al. (2004), Clarkson et al. (2008), etc. This variable allows us to observe the corporate purposes underlying the voluntary disclosure of this kind of information. Thus, according to the theory of proprietary costs, a positive effect may indicate its use for obtaining competitive advantages, while a negative effect suggests its use as a mechanism to regain legitimacy in those companies with poorer sustainability practices.

Furthermore, another contribution of our study is that it analyses companies located in different countries and continents, which operate internationally, providing a higher degree of diversity to the results of the analysis.

Our findings show that analysing only the Global Reporting Initiative (GRI) indicators leads to several limitations in the results, given that almost all companies accept them completely. In contrast, the additional information proposed in this paper allows us to observe the effects of other factors, which explain the voluntary disclosure of environmental information.

More specifically, our results point to a direct relationship between corporate size and market capitalization and the disclosure of information in addition to the GRI indicators proposed for greenhouse gas emissions. Conversely, return on equity is detected to have an inverse relationship with that index.

The paper is structured as follows: in Section 2, the relevance of the information on greenhouse gas emissions is justified in the current context, by describing both the most recent studies dealing with this issue and the main repercussions of the Kyoto Protocol. Section 3 develops our research hypotheses in relation to the factors that may influence the amount of information disclosed on environmental issues. Section 4 describes our research methods: sample, variables, disclosure index and analysis techniques. In Section 5, the results of the empirical analysis are given and then discussed in Section 6. Section 7 summarises the main findings and consequences and presents the conclusions.

2. Environmental information: special reference to greenhouse gas emissions
Recently, topics related to environmental issues have received special attention and have been widely studied both in the international sphere and in national contexts. At the same time, several theories such as stakeholder or legitimacy theories have explained and justified the fact that many interest groups wish to know an increasing amount of corporate information and not only strictly financial information. Stakeholder theory recognises the role played by agents other than shareholders who have an interest in a company’s activities and in receiving information about it. From the perspective of the legitimacy theory, the disclosure of social and environmental information can be considered as a reaction to economic, social and political factors in the business context; its purpose is to legitimise the activities undertaken by the company.

In this context, research on environmental issues has increased notably. Many previous studies have focused on large companies in the US. For instance, Wiseman (1982) analyses the extent of disclosure of voluntary environmental information in
annual reports, through an index with 18 items reflecting aspects related to environmental litigation, pollution abatement activities and other environmental aspects. Subsequently, Freedman and Wasley (1990) also study 50 US corporations from four industries (Steel, Oil, Pulp and Paper, Electric utilities) in order to analyse the relationship between corporate pollution performance and pollution disclosures contained in annual reports and 10k reports.

In Canada, Bewley and Li (2000) study factors associated with environmental disclosures in 188 Canadian manufacturing firms, using the Wiseman index. Their findings stress a negative relationship between environmental disclosures and environmental performance.

Most previous studies performed in European countries have emphasized a notable environmental concern in German firms, which tend to reveal a greater degree of environmental information than companies from other countries in the same context. KPMG (2002) finds that 36 per cent of German firms have reported environmental information compared to 21 per cent of French firms. In a comparative analysis of corporate environmental reporting from 1985 to 1995, Adams and Kuasirikum (2000) find that the proportion of German companies reporting environmental information and the average volume of that reporting is consistently higher compared to UK firms during that period.

Among the studies comparing the environmental disclosure of firms from different countries, Guthrie and Parker (1990) find that US companies issue a greater amount of environmental information in comparison to UK or Australian organisations. Gamble et al. (1995) reach similar findings in their study comparing companies from the US with firms from 27 nations.

These studies mentioned are based on the environmental information provided in the annual reports of companies from different countries. Such reports were the main information sources available at that time; however, this situation has changed considerably in the last few years. Increasingly, companies are revealing more environmental information voluntarily on their websites through Sustainability Reports, whose contents incorporate GRI indicators (Global Reporting Initiative, 2006) and in many cases other economic, social and environmental aspects.

As several papers have shown (e.g. Harte and Owen, 1991; Gamble et al., 1995; Gray et al., 1995; Patten, 2002; Cormier and Magnan, 2003; Prado-Lorenzo et al., 2008), companies around the world have extended their information on environmental issues, considering forests, protection of the ozone layer, climate change, water, energy and natural resources, biodiversity, and so on. Although all of these topics affect the environment and are of maximum priority, climate change has recently generated special expectations.

The Kyoto Protocol was an intensive agreement reached in order to obtain the active participation of public administrations, citizens and business in the process of reducing greenhouse gas emissions. Although at the time the industrialized countries promised to put into effect a set of measures to reduce greenhouse gases, the Protocol did not go into effect until 16 February 2005, after it was ratified by Russia on 18 November, 2004. Many countries have signed the Protocol since 1998 and it was gradually ratified by different countries with the exception of the most important country in the world economy: the United States, which to date has not ratified it. This decision lies in the fact that “the Protocol
does not include the participation of developing countries and also that the costs of compliance would damage the US economy” (Hoffman, 2005, p. 21).

According to Revkin (2001), the countries ratifying the Protocol shall, individually or jointly, ensure that their emissions of greenhouse gases do not exceed their assigned amounts, calculated pursuant to their quantified emission limitations and reduction commitments with a view to reducing their overall emissions of such gases by at least 5 per cent below 1990 levels in the commitment period 2008 to 2012. Developing countries “are not required to reduce their emissions over this same timeframe, based on the concept of contraction and convergence” (Bebbington and Larrinaga-González, 2008, p. 701). More specifically, some countries will have to reduce their emissions and others will be able to increase their emissions targets in the 2008-2012 period.

In line with that purpose, the issue that arises is how different countries can reduce their greenhouse gas emissions. According to the Kyoto Protocol, countries will have a certain degree of flexibility in how they make and measure their emissions reductions. An international emissions trading regime would be developed to allow the industrialized countries to buy and sell emissions credits amongst themselves. Woerdman et al. (2008, p. 568) argues that “emissions trading is cost-efficient because polluters with high emission reduction costs will buy emission rights from polluters with low emission reduction costs”.

Furthermore, a mechanism known as joint implementation is also used to acquire emission reduction units by financing certain kinds of projects in other developed countries. In addition, a clean development mechanism will enable industrialized countries to finance emissions-reduction projects in developing countries and receive credit for doing so (European Commission, 2005).

Undoubtedly, all these aspects having to do with greenhouse gas emissions are important, because they affect all countries worldwide. The significance of this issue has justified an increasing amount of research devoted to it (e.g. Lash and Wellington, 2007; Bebbington and Larrinaga-González, 2008; Johnston et al., 2007; Freedman and Jaggi, 2005; Engels, 2008). Some of these studies are theoretical or descriptive, whereas others attempt to analyse how certain corporate variables influence the divulgation of this kind of environmental information. For instance, within the last group, Freedman and Jaggi (2005) focus on analysing the disclosure of greenhouse gas emissions in annual reports, environmental reports and websites from 120 large companies in the chemical, oil, energy, motor vehicle and casualty insurance industries. Their findings indicate a positive association between the index of disclosure regarding greenhouse gas emissions and companies from nations, which have ratified the Kyoto protocol. Similarly, firm size also shows a direct relationship, so that the largest companies usually reveal more information on greenhouse gas emissions than smaller organizations.

3. Factors influencing the disclosure of information on greenhouse gas emissions: research hypotheses

In the divulgation of greenhouse gas emissions and other issues related to climate change in corporations, certain factors can have a notable influence; among them, corporate size, leverage, return on equity, return on assets, Market-to-Book ratio, Kyoto Protocol, industry sector, inclusion in the Dow Jones Sustainability Index can be highlighted, since their influence can be particularly significant.
3.1. Firm size

Corporate size is one of the variables most used in the previous literature to explain the publication of environmental information (Patten, 1991; Gray et al., 2001). Large companies are supposed to receive more public attention, leading to higher levels of disclosure of environmental information with the aim of avoiding and solving conflicts (Archel, 2003). Liu and and Anbumozi (forthcoming) argue that “larger firms are more likely to be under public scrutiny and are expected to have a higher propensity of environmental disclosure” and “are also capable of having superior resources for environmental efforts”.

From the perspective of a cost-benefit analysis, the costs of preparing and disseminating information on the Internet are likely to be unrelated to corporate size (Larran and Giner, 2002; Bonsón and Escobar, 2004). Nevertheless, the potential benefits will be greater for larger-sized corporations, since there is a direct relationship between disclosure costs and benefits.

The results obtained in previous studies on the divulgation of environmental information have pointed out that corporate size has a positive influence on the amount of voluntary environmental information disclosed on websites, for instance, Cormier et al. (2005) for German companies; Liu and Anbumozhi (2009) for Chinese corporations; and Clarkson et al. (2008) for US organizations. By analysing 120 large companies from countries that have ratified the Kyoto Protocol and from countries that have not, Freedman and Jaggi (2005) also find that greenhouse pollution disclosures are positively associated with firm size.

Most of the studies mentioned have used total assets, sales and market capitalization to measure corporate size. In this work, we have used revenues in 2007, obtained from the financial information disclosed online.

Taking into consideration these theoretical arguments, the following hypothesis is established:

**H1.** Large-sized companies will disclose a higher volume of information on greenhouse gas emissions on their websites, compared to smaller companies.

3.2 Leverage

From the agency theory perspective, the amount of leverage is another factor associated with a larger amount of disclosed information, especially as a result of conflicts stemming from leverage. In this sense, companies with more debt have greater agency costs, because there is a possibility of transference of wealth from debt holders to stockholders. By increasing the amount of information disclosed, corporations can reduce their agency costs and any possible conflicts of interest between owners and creditors.

In this respect, by analysing the influence of agency theory, several studies have found a positive effect of leverage on the amount of information revealed voluntarily (for example, Jaggi and Lee, 2002; Xiao et al., 2004; Prencipe, 2004), whereas other works do not find a statistically significant relationship (Oyelere et al., 2003; Gul and Leung, 2004). By studying environmental information exclusively, Clarkson et al. (2008) obtain a positive relationship.

According to Freedman and Jaggi (2005, p. 220) “in the absence of detailed pollution disclosures, investors and creditors would not be able to properly evaluate the firm’s risk of default, and thus they may avoid investing in the firm”. They do not detect a
significant relationship between leverage and greenhouse pollution disclosures, concluding that this variable does not play a notable role in the revelation of greenhouse pollution.

In line with the above, the following hypothesis is proposed:

**H2.** Companies with more leverage will disclose a higher volume of information on greenhouse gas emissions on their web sites, compared to corporations with less leverage.

### 3.3 Corporate performance

If the costs derived from environmental activities carried out by companies are taken into consideration, economic performance will be a relevant factor in determining whether environmental activities are a priority. In periods of low economic performance, economic objectives will prevail over environmental objectives.

Lang and Lundholm (1993) show that companies with greater profitability are more prone to reveal their “good news” to financial markets. In this sense, the different theories on the disclosure of information also point to a positive relation. Other works (e.g. Khanna *et al.*, 2004; Gul and Leung, 2004) obtain a positive influence of profitability on the amount of voluntary disclosure, both in multinational companies listed on NYSE and in quoted companies from Hong-Kong, respectively. On the other hand, Oyelere *et al.* (2003) and Marston and Polei (2004) do not find a statistically significant relationship between the extent of voluntary revelation and the profitability level.

In the specific area of environmental information, empirical research has not reached definitive and conclusive results (Gray *et al.*, 1995). Along this line, Archel (2003) and Clarkson *et al.* (2008) emphasize that profitability is not related to the publication of environmental information for Spanish companies and American corporations, respectively. Liu and Anbomuzhi (forthcoming) include return on equity as a variable in their study on several items of environmental information, obtaining a direct relationship with return on equity for a significance level of 0.05. With regard to greenhouse gas emissions, Freedman and Jaggi (2005) do not find a significant relationship between these variables either.

Several studies use both return on equity (ROE) and return on assets (ROA) to measure profitability. In this research, they are considered independently, given that ROA reflects a more technical character, more related to efficiency, whereas ROE provides a more financial view, that of stockholders (reflecting the demands expected by stockholders). Consequently, based on previous research, the following hypotheses are proposed:

**H3.** Companies with a higher return on equity will disclose a higher volume of information on greenhouse gas emissions on their web sites, compared to corporations with a lower return on equity.

**H4.** Companies with a higher return on assets will disclose a higher volume of information on greenhouse gas emissions on their web sites, compared to those that show a lower return on assets.
3.4 Market-to-Book
When corporate public information is increased, information asymmetry is reduced, so that the disclosure of a large amount of information can be especially useful for predicting future incomes and for reducing a firm’s capital costs.

Li et al. (2008) analyse this relationship for UK companies, concluding that the Market-to-Book ratio is related to the voluntary information provided by the company. As for environmental information, Garcia-Ayuso and Larrinaga (2003) find that the MB ratio is lower when corporations provide users with environmental information. Consequently, the following hypothesis can be formulated:

\[ H_5 \] Companies with higher Market-to-Book ratios will disclose a higher volume of information on greenhouse gas emissions on their web sites, compared to corporations with a lower Market-to-Book ratio.

3.5 Kyoto Protocol
As mentioned above, unlike most countries, which have already ratified, approved, adhered to or accepted the Kyoto Protocol, there are other countries, which have not, such as the USA. As a consequence, this must be taken into consideration in our research, in order to test empirically the effect of belonging to a country, which has ratified the protocol.

Freedman and Jaggi (2005, p. 219) include this variable in their model, arguing that “because large expenditures may be required to meet the protocol’s requirements, it is important that these firms provide detailed disclosures of their efforts and achievements in reducing greenhouse gas emissions to assist investors in assessing the trade off between risk and return”.

The results of previous research usually lead to a positive and statistically significant association between disclosure and a variable, which differentiates between Kyoto and non-Kyoto firms. Companies, which have their headquarters in countries which have ratified the Kyoto Protocol display more information on pollution, greenhouse gas emissions and global warming.

Therefore, the following hypothesis is established:

\[ H_6 \] Companies from countries that have ratified the Kyoto Protocol will disclose a higher volume of information on greenhouse gas emissions in their web sites, compared to corporations from countries, which have not ratified it.

4. Research methods
4.1 Population and sample
In order to test the hypotheses proposed for this study, we selected as the target population companies from different countries worldwide (the USA, Australia, Canada and the European Union), and sought to represent both countries that have not ratified, approved, adhered to or accepted the Kyoto Protocol, and countries that have. Firms from the USA belong to the former situation, while organizations from Canada, Europe and Australia have evolved towards the latter situation.

The database used is that of the Fortune 500, because that database compiles the largest companies – the most public and visible ones, and, consequently, the ones most interested in disclosing information – worldwide, classified by activity sectors. We have selected only companies from the countries cited above. Ratification or
non-ratification of the Kyoto protocol will be one of the explanatory variables in the model proposed.

The activity sectors selected to undertake this research are consistent with those established in the Green Paper on Greenhouse Gas Emissions Trading within the European Union (European Commission, 2000) and in the Kyoto Protocol: Aerospace and Defence; Airlines; Chemicals; Energy; Forest and Paper Products; Industrial and Farm Equipment; Metals; Mining, Crude-Oil Production; Motor Vehicles and Parts; Petroleum Refining and Utilities.

This sample was chosen with a view to extending and generalising the results obtained in previous studies focused on environmental information provided in annual reports, by including the advantage derived from the use of the internet as a way of revealing information to the general public. A wider range of variables considered in the analysis and the specific use of the internet can overcome some of the limitations of previous studies.

Therefore, the sample used corresponds to 101 firms from different countries and industries. After selecting the sample in this research stage, we carried out a content analysis of the companies’ web sites.

4.2 Content analysis: creating a disclosure index

In order to perform the analysis, we created a disclosure index. Creating this type of index forms one branch of content analysis and is one of the main techniques used to study the information provided by public and private institutions (Ortiz and Clavel, 2006). Thus, the disclosure index is one of the main ways of evaluating the information transparency of public and private institutions (Bonson and Escobar, 2004).

To create the index, we initially considered several descriptive studies, which analyse the amount of information provided by companies on their websites, in different countries such as the USA (Ettredge et al., 2001), Germany (Marston and Polei, 2004), Austria (Pirchegger and Wagenhofer, 1999), Denmark (Petersen and Plenborg, 2006) and Spain (Larrán and Giner, 2002). These studies focus on verifying a set of issues in the information disclosed on websites, using binary values (1: presence of the information sought; 0: absence of the information sought). Then, the values obtained are aggregated and, where appropriate, weighted.

Concerning the environmental information provided by companies on their websites, several works focus on greenhouse gas emissions and climate change and have been used as a basis for this study (e.g. Liu and Anbumozhi, 2009; Clarkson et al., 2008; Cormier et al., 2005; Freedman and Jaggi, 2005).

After this revision, and considering the contributions from different works, we designed the disclosure index, focusing on the search for information on greenhouse gas emissions, climate change, global warming, targets to reduce greenhouse gas emissions and other related issues, taken from the Green Paper on Greenhouse Gas Emissions Trading within the European Union (European Commission, 2000) and the Kyoto Protocol.

In order to define the items included in the disclosure index we considered both the indicators proposed by the GRI (G3) referring to emissions (EN16, EN17, EN18, EN19, EN20) and a report drawn up by KPMG and GRI (2007) on climate change. This survey analyses a sample of 50 sustainability reports published in 2006 for the year 2005 by leading international companies. The issues studied are structured in four sections and
have to do with background information related to climate change, opportunities arising from climate change, risks arising from climate change, and issues that can be both risks and opportunities.

Therefore, the index is made up of 19 items, which compile a large amount of information on the topic analysed. Moreover, it is one of the most extensive indices in this kind of research; Freedman and Jaggi (2005), for instance, only take into consideration five aspects on greenhouse gas emissions and global warming.

After defining the items in the index, the next stage was their quantification. When applying this methodology to establish the volume of information disclosed for each item, one can choose a binary variable, which takes a value of either 1 or 0, depending on whether the data is reported or not (Cooke, 1989), or alternatively one may attempt to estimate a score ranging from 1 to 0. Although the latter solution may be considered conceptually superior, it can lead to a completely subjective evaluation (Giner, 1997). In this study, according to the most widely used methodology in online disclosure (e.g. Bonson and Escobar, 2004, in their study about online transparency in the banking sector), we have opted for the binary variables.

Finally, another relevant issue is the probable weighting of the items, as performed in some studies (Pirchegger and Wagenhofer, 1999; Gandia, 2001). In our research, we have chosen an unweighted index, given that, according to Giner (1997), there is some arbitrariness inherent to the use of any weighted index. Moreover, studies that use both weighted and unweighted indices draw similar conclusions from both types of indices (Choi, 1973; Chow and Wong-Boren, 1987). As a result, we have chosen the aggregation of the scores obtained for each item in an unweighted index (as in Cooke, 1989; Raffournier, 1995; Giner, 1997).

After defining the items of information, which must be included in the disclosure index and studying their quantification and weighting, we performed a thorough analysis of the contents on the company web sites.

4.3 Dependent variable

After undertaking the content analysis and drawing up the index, we analysed the factors that may influence greater disclosure. To do so, we formulated a dependency model in which the dependent variable corresponds to the creation of a disclosure index of information revealed by companies from different countries on their web sites.

By considering previous studies and placing special emphasis on the publication of environmental information, focusing mainly on greenhouse gas emissions, we selected the information items to be considered in the disclosure index. Table I shows these environmental information items.

4.4 Independent variables

Table II describes the explanatory variables proposed to test the hypotheses from the third section. The information needed to create these variables was obtained from each company’s web site on 31 December, 2007.

As for control variables, we control for the influence of two dummy variables. The first variable represents the activity sector (SECTOR) in which the company operates within the following industries: Aerospace and Defence; Airlines; Chemicals; Energy; Forest and Paper Products; Industrial and Farm Equipment; Metals; Mining, Crude-Oil
**GRI indicators**
1. Total direct and indirect greenhouse gas emissions by weight
2. Other relevant indirect greenhouse gas emissions by weight
3. Initiatives to reduce greenhouse gas emissions and reductions achieved
4. Emissions of ozone-depleting substances by weight
5. NO, SO and other significant air emissions by type and weight

**Additional information**
6. Target to reduce greenhouse gas emissions
7. Specific statement from the CEO or company chairman that mentions climate change
8. Consideration of climate change by the board of directors
9. The words "climate change" or "global warming"
10. Business opportunities from climate change, for example related to products, services or technologies
11. Use of energy (electricity use, coal, diesel petrol, gas etc.)
12. Section devoted to climate change or global warming
13. Involvement in emissions trading, such as buying or selling emissions allowances under the EU
14. A target to reduce energy use or improve energy efficiency
15. Opportunities for setting up a carbon fund or engaging in emissions brokering (within the EU emissions trading scheme)
16. Management responsibility for climate change specifics
17. Credits for Clean Development Mechanism (CDM)\(^a\) projects under the Kyoto protocol
18. Credits from Joint Implementation (JI)\(^b\) projects under the Kyoto Protocol
19. Increased forest fires

**Notes:**
\(^a\) Clean development mechanism (CDM) “is a mechanism implemented by the Kyoto Protocol that allows Annex B countries (Kyoto Protocol) to invest in projects that reduce emissions in other countries and generate emission credits”; \(^b\) Credits from joint implementation (JI) “is a mechanism implemented by the Kyoto Protocol that allows Annex B countries (Kyoto Protocol) to invest in projects that reduce emissions in other countries and generate emission credits; while CDM (article 12 of the Kyoto Protocol) referes to projects in developing countries without emission constraints, JI projects (article 6 of the Kyoto Protocol) are undertaken in Annex B countries” (Schmitz and Michaelowa, 2005, p. 84)

**Sources:** The authors, based on the Global Reporting Initiative (2006) and the KPMG and GRI (2007)

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<th>Variable</th>
<th>Description</th>
<th>Hypothesis</th>
<th>Expected sign</th>
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<tr>
<td>SIZE</td>
<td>Corporate size measured by total revenues (annual sales turnover)</td>
<td>(H1)</td>
<td>+</td>
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<tr>
<td>LEVERAGE</td>
<td>Represented by the ratio total debt/stockholders’ equity</td>
<td>(H2)</td>
<td>+</td>
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<td>ROE</td>
<td>Return on equity measured as the ratio net income/stockholders’ equity</td>
<td>(H3)</td>
<td>+</td>
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<td>ROA</td>
<td>Return on assets measured as the ratio operating income/total assets</td>
<td>(H4)</td>
<td>+</td>
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<tr>
<td>MtoB</td>
<td>Market to Book ratio measured as the ratio between market capitalization on 31/12/2007 and stockholders’ equity</td>
<td>(H5)</td>
<td>+</td>
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<td>KYOTOPRO</td>
<td>Dummy variable which takes the value 1 if the company mainly operates in a country that has ratified, approved, adhered to or accepted the Kyoto Protocol, and 0 otherwise</td>
<td>(H6)</td>
<td>+</td>
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Production; Motor Vehicles and Parts; Petroleum Refining and Utilities, given that they are more prone to emit greenhouse gases. Activity sectors are also considered as control variables in Freedman and Jaggi (2005) but their inclusion is more restrictive: Chemicals, Oil and Gas, Energy and Motor Vehicles and Casualty Insurance Industries. The second variable represents whether the corporation is listed on the Dow Jones Sustainability Index (DJSI); inclusion in this index may influence the disclosure of environmental information and, more specifically, of greenhouse gas emissions. According to López et al. (2007), the DJSI “includes 10 per cent of the firms that belong to the Dow Jones Global Index, conduct their activity in terms of corporate sustainability and are leaders in their respective activity sectors”. Table III shows the control variables considered.

4.5 Analysis techniques
Based on the variables selected to test the hypotheses proposed, we have defined the following model (1), in which the amount of environmental information on greenhouse gas emissions, disclosed by companies on their web sites, is a function of: Firm Size, Leverage, ROE, ROA, Market-to-Book ratio, Kyoto Protocol, Activity Sector, and Dow Jones Sustainability Index:

Online Disclosure of Information on Greenhouse Gas Emissions =

\[
\text{f} (\text{Size, leverage, ROE, ROA, MtoB, Kyoto Protocol, Activity sector, Dow Jones Sustainability Index})
\]

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<th>Table III. Control variables</th>
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<td>SECTORAEDE</td>
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<td>DJSI</td>
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</table>
The model (1) can be empirically estimated by using equation (2):

\[ \text{DIGGEO}_i = \beta_0 + \beta_1 \text{SIZE}_i + \beta_2 \text{LEVERAGE}_i + \beta_3 \text{ROE}_i + \beta_4 \text{ROA}_i + \beta_5 \text{MtoB}_i + \beta_6 \text{KYOTOPROTO}_i + \beta_7 \text{DJSI}_i + \sum_k \beta_{ki} \text{SECTOR}_k + \varepsilon \] 

\( k = 1 \ldots 11 \). In which:

- **DIGGEO**\(_i\) is the greenhouse gas emissions disclosure index obtained after analysing company \( i \)'s web site;
- **Size**\(_i\) is company \( i \)'s revenue as a variable related to corporate size;
- **Lev**\(_i\) is company \( i \)'s leverage, established as the ratio between total debt and stockholders’ equity;
- **ROE**\(_i\) is company \( i \)'s return of equity, measured as the ratio between net income and stockholders’ equity;
- **ROA**\(_i\) is company \( i \)'s return on assets, measured as the ratio between operating income and total assets;
- **MtoB**\(_i\) is company \( i \)'s market to book value, measured as the ratio between market capitalization on 31 December 2007 and stockholders’ equity;
- **KYOTOPROTO**\(_i\) is a dummy variable, which takes the value 1 if the company has its headquarters in a country, which has ratified, approved, adhered to or accepted the Kyoto Protocol, and 0 otherwise;
- **DJSI**\(_i\) is a dummy variable, which takes the value 1 if the company belongs to the Dow Jones Sustainability Index, and 0 otherwise; and
- **SECTOR**\(_k\) is a dummy variable, which takes the value 1 if the company does business in sector \( k \), and 0 otherwise.

Model (2) was checked empirically through a linear regression, estimated by OLS. As mentioned above, the dependent variable was obtained from the analysis of items in the disclosure index of the web sites.

Furthermore, in order to analyse whether the factors proposed explain the different types of information disclosed – GRI indicators and additional information – two additional models were run, substituting the dependent variable DIGGEO for the types of information which comprise it.

5. **Results of empirical analysis**

5.1 **Descriptive statistics of the index on information disclosed about greenhouse gas emissions**

Tables IV and V synthesise the descriptive statistics for the overall dependent variable (DIGGEO) and for the two partial dependent variables proposed (GRIINDICATORS and ADDITIONALINFORMA). In addition, it compiles information on the absolute and relative frequencies of the specific indicators, which form each index individually.
With regard to global indices, on average, companies report ten out of 19 indicators considered, with a variability ranging from six to 13 indicators. Focusing on the core and additional indicators proposed by the GRI, it is detected that organizations disclose, on average, four out of the five indicators established in the guide drawn up by that agency. As for the additional relevant information, companies, on average, reveal six of the 14 remaining indicators proposed.

Consequently, notable differences in the information reported are observed. While there is wide acceptance of GRI indicators, the remaining information appears less frequently in the corporate Sustainability Reports. In this sense, the individual analysis proposed for each type of information will allow us to determine which factors mainly explain the inclusion of information in addition to the measures indicated by the GRI as a mechanism to allow us to differentiate among companies.

Analysis of the frequencies of the 19 indicators comprising the DIGGEO index yields the following significant frequencies:

- More than 90 per cent of companies report EN16 and EN18 GRI indicators (our 1 and 3 indicators, in Tables IV and V).
- More than 80 per cent of firms additionally disclose our indicators 9, 6 and 11.
- More than 50 per cent of the organizations reveal information on our indicators 12, 5 (EN20 GRI), 2 (EN17 GRI) and 10.
- Indicator EN19 (our indicator number 4), related to the emissions of ozone-depleting substances by weight, is the least frequently disclosed of the set of indicators proposed by the GRI.

### 5.2 Univariate analysis

Tables VI and VII display the descriptive statistics of the independent and control variables; for the numerical variables, the mean and standard deviation are reported, and for the binary variables, the absolute and relative frequencies are given.

According to the data for industrial variables, the activity sectors with the most influence on our sample are petroleum refining (19.8 per cent); motor vehicles and parts (18.8 per cent); and utilities (11.9 per cent). On the other hand, the sector with the least weight is forest and paper products (3 per cent).

In Tables VIII and IX, the bivariate correlations between the variables proposed in the analysis are summarised. The variables SECTORAEDE, DJSI and KYOTOPROTO show the highest correlation with the dependent variable DIGGEO. DJSI, SECTORPEREF, SECTORCHEMI and KYOTOPROTO exhibit the highest correlations with GRIINDICATORS, whereas SECTORAEDE, DJSI, KYOTOPROTO and SECTORUTILIT show the closest relationship with ADDITIONALINFORM.

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<th>Standard deviation</th>
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<td>ADDITIONALINFORMA</td>
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<td>2.86</td>
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</table>

Table IV. Dependent variable: descriptive analysis
### GRI indicators

1. Total direct and indirect greenhouse gas emissions by weight: 96 (95%)
2. Other relevant indirect greenhouse gas emissions by weight: 63 (62.4%)
3. Initiatives to reduce greenhouse gas emissions and reductions achieved: 92 (91.1%)
4. Emissions of ozone-depleting substances by weight: 38 (37.6%)
5. NOx SOx and other significant air emissions by type and weight: 69 (68.3%)

### Additional information

6. Target to reduce greenhouse gas emissions: 82 (81.2%)
7. Specific statement from the CEO or company chairman that mentions climate change: 24 (23.8%)
8. Consideration of climate change by the board of directors: 29 (28.7%)
9. The words “climate change” or “global warming”: 88 (87.1%)
10. Business opportunities from climate change, for example related to products, services or technologies: 63 (62.4%)
11. Use of energy (electricity use, coal, diesel petrol, gas etc.): 81 (80.2%)
12. Section devoted to climate change or global warming: 75 (74.3%)
13. Involvement in emissions trading, such as buying or selling emissions allowances under the EU: 49 (48.5%)
14. A target to reduce energy use or improve energy efficiency: 50 (49.5%)
15. Opportunities for setting up a carbon fund or engaging in emissions brokering (within the EU emissions trading scheme): 23 (22.8%)
16. Management responsibility for climate change specifics: 9 (8.9%)
17. Credits for Clean Development Mechanism (CDM) projects under the Kyoto protocol: 13 (12.9%)
18. Credits from Joint Implementation (JI) projects under the Kyoto Protocol: 7 (6.9%)
19. Increased forest fires: 4 (4%)

### Numerical variables

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<td>MtoB</td>
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</table>

Table V.

Table VI.

Dependent variable: descriptive analysis

Independent and control variables: descriptive analysis
No significant correlations are detected between the control and independent variables, and there are no multicollinearity problems. However, restrictions will be used in the different linear regressions estimated in order to avoid statistical problems.

### 5.3 Multivariate analysis

The results obtained in the estimations of the three models proposed are synthesised in Table X.

The first model – that which attempts to determine the explanatory factors of the overall practices in the disclosure of information on greenhouse gas emissions – shows a relatively high explanatory power, 38.33 per cent, for a confidence level of 99 per cent ($p$-value, 0.01).

From the six independent variables proposed to test the hypotheses, two of them, SIZE and KYOTOPROTO, turn out to be statistically significant for a confidence level of 95 (0.01, $p$-value, 0.05) and 99 per cent, respectively. Both display a positive effect on the dependent variable DIGGEO. The remaining independent variables – LEVERAGE, ROE, ROA and MtoB – have a statistically non-significant and negative effect, except for the last variable.

As for the control variables, all of them, except for the Aerospace and Defence industry, show a positive relationship with the environmental reporting practices analysed. Nonetheless, only the variables related to chemicals, metals, mining, crude-oil production, motor vehicles and parts, and utilities are statistically significant for confidence levels ranging from 95 to 99 per cent.

The estimation of the second model – that whose dependent variable has to do with the volume of information disclosed on the indicators proposed by the GRI – has a lower explanatory power, 24.6 per cent, for a lower confidence level, 90 per cent ($p$-value < 0.1).

The independent variables SIZE and KYOTOPROTO exert a positive influence on the dependent variable, while the rest show a negative effect, although none of the six variables turn out to be statistically significant.
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Table VIII: Bivariate correlations

Greenhouse gas emissions
Table IX.

Bivariate correlations

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<td>0.20025966</td>
<td>0.19609307</td>
<td>0.16848379 **</td>
<td></td>
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</tr>
<tr>
<td>SECTORMOVEP</td>
<td>0.2548191</td>
<td>0.30567358</td>
<td>0.13838172 **</td>
<td></td>
<td></td>
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<tr>
<td>SECTORPEREF</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>SECTORUTILIT</td>
<td>0.23452309</td>
<td>0.258505</td>
<td>0.17284751 **</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>DJSI</td>
<td>0.14016853</td>
<td>0.14782778</td>
<td>0.13347804 **</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>R²</td>
<td>0.383</td>
<td>0.246</td>
<td>0.435</td>
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<tr>
<td>F</td>
<td>2.992***</td>
<td>1.573*</td>
<td>3.756**</td>
<td></td>
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</tr>
</tbody>
</table>

Notes: SECTORPEREF was removed because of collinearity problems among dummy variables; * p-value < 0.1; ** p-value < 0.05; *** p-value < 0.01
Except for the Energy sector, the control variables have positive relationships with the disclosure of GRI indicators. As for their statistical significance, SECTOR AIRL and SECTORMOVEP are econometrically relevant for a confidence level of 95 per cent, SECTORCHEMI for a 99 per cent level and SECTORUTILIT for a 90 per cent confidence level.

The third model – estimated to determine the explanatory factors of the disclosure of information in addition to the GRI indicators – has the highest explanatory power, 43.5 per cent, for a confidence level of 99 per cent. Four of the six independent variables proposed and three control variables of the eleven initial variables are statistically significant.

More specifically, positive effects, statistically significant for a confidence level of 95 per cent, are detected for SIZE and MtoB ratio. A similar effect is exhibited for KYOTOPROTO, although for a lower confidence level (90 per cent). On the other hand, the independent variable ROE has a negative and significant effect for a confidence level of 90 per cent. LEVERAGE and ROA display a non-significant and negative effect.

Concerning control variables, DJSI again shows a non-significant and positive effect. From the different activity sectors included, metals and forest and paper products positively influence the dependent variable ADDITIONALINFORMA for a confidence level of 99 and 90 per cent, respectively. On the other hand, the aerospace and defence industry negatively influences ADDITIONALINFORMA for a confidence level of 95 per cent.

The overall results obtained for the three models estimated allow us to accept H1 and H6, related to positive relationships between corporate size, the location of a company in a country which has adopted or ratified the Kyoto Protocol and the disclosure of a larger volume of information on greenhouse gas emissions. The effect of ROE and MtoB on the index that measures the disclosure of information in addition to GRI indicators allows us to accept H3 and H5, although the first one is accepted with the opposite sign to that expected.

6. Discussion of findings
Our findings regarding the control variables allow us to affirm that the volume of information on greenhouse gas emissions significantly depends on the activity sectors in which the company operates. The effect of the industry on the disclosure of any type of voluntary information -usually, with the purpose of reducing political costs (i.e. legal demands or requirements) – has been widely analysed in previous literature (e.g. Cowen et al., 1987; Patten, 1991; Hackston and Milne, 1996; Deegan and Gordon, 1996; Archel, 2003; García-Ayuso and Larrinaga, 2003 for corporate social responsibility; or Craven and Martson, 1999; Oyelere et al., 2003; Marston and Polei, 2004; Giner, 1997; Gul and Leung, 2004 for the disclosure of information online).

However, the absence of differences in the reporting practices between those companies belonging to the DJSI and those which are not listed on the DJSI is surprising, because the inclusion of a company as one of the most sustainable depends on a broad set of criteria, among which the quality and contents of the environmental information disclosed are especially relevant. The lack of divergence may be explained by the type of companies analysed, belonging to Fortune 500 index; in day-to-day
business, they are strongly scrutinised in their activities by many organizations, academics, etc.

With regard to the independent variables, a notable influence of corporate size and commitment to environmental protection on behalf of the country where the company is located is observed. A lower effect for the different measures of corporate performance is also detected. These empirical findings are partially consistent with those obtained in previous studies which have focused on the reporting practices of the sustainable activities of corporations (i.e. Trotman and Bradley, 1981; Cowen et al., 1987; Patten, 1991; Hackston and Milne, 1996; Adams et al., 1998; Archel, 2003; García-Ayuso and Larrinaga, 2003; Fernández and Luna, 2004), as well as those works focused exclusively on the disclosure of information on greenhouse gas emissions (i.e. Freedman and Jaggi, 2005).

More specifically, large-sized companies are thoroughly analysed by the mass media, public opinion and governments, which have encouraged them to reveal a higher volume of information on greenhouse gas emissions as a supplement of GRI indicators (which are widely reported by most companies affected). Therefore, our findings confirm the leadership, which previous studies have observed for the largest companies in the publication of voluntary information of any type.

Furthermore, the fact that the best reporting practices on greenhouse gas emissions are found in those companies whose headquarters are located in countries, which have approved or adhered to the Kyoto Protocol is consistent with the results obtained by Freedman and Jaggi (2005).

However, unlike this latter work, the inverse relationship between economic performance and volume of information issued is statistically significant in our study. This result suggests that companies which perform more poorly reveal a higher volume of environmental information in order to make them more attractive to the different stakeholders, also owing to the significant effect which the Market to Book variable displays, especially for investors.

7. Conclusions
In the last few years, topics relating to environmental issues have received growing attention, at the same time that different theories – such as stakeholder or legitimacy theory – have argued that different interest groups want to know an increasing amount of information, not strictly limited to the financial type.

With the purpose of studying whether different companies undertake environmental activities related to climate change and greenhouse gas emissions, this work has analysed two essential issues:

(1) the information on this topic disclosed on their websites by 101 companies from different countries and activity sectors considered as the most sensitive to greenhouse gas emissions; and

(2) different factors which influence the disclosure of information on greenhouse gas emissions and climate change in companies which operate in the international sphere.

Consequently, we have formulated different dependency models in order to determine the explanatory drivers of the information disclosed on their web sites by corporations worldwide regarding greenhouse gas emissions. The explanatory variables proposed
are: corporate size, leverage, ROA, ROE, Market-to-Book ratio and Kyoto Protocol, also controlling for the activity sector in which the company does business and its inclusion in the Dow Jones Sustainability Index.

Our findings have emphasized that the main quoted corporations operating in sectors linked to greenhouse gas emissions disclose information on almost all GRI indicators proposed for this issue, as well as some additional indicators. The standard deviation observed in the disclosure of these indicators is associated with the company’s activity sector.

However, the largest companies with a less favourable operating income but positively valued by financial markets, mainly located in countries which have adopted or ratified the Kyoto Protocol, tend to stand out from the other companies by revealing a higher volume of information in addition to those indicators.

These findings seem to suggest a business trend to use information on greenhouse gas emissions as a mechanism for companies to legitimise themselves with those collectives that can benefit them in relation to different issues, such as the maintenance of current legal requirements in environmental issues, the decreasing of capital costs or the attraction of new investors, and so on, as well as the presence of economies of scale associated with the costs of drawing up additional information for larger firms.

References


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