Accounting by companies for the Kyoto Protocol in the EU

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Abstract: In attempting to achieve the goals of the Kyoto Protocol, the European Union agreed to reduce member countries' greenhouse gas emissions to 92% of their 1990 levels by the end of 2012. We assess here the carbon emissions for companies from those countries that were among the largest emitters of carbon in the EU. This evaluation includes emissions in 2008 and 2012 together with disclosures regarding environmental performance that these companies made in the two years. Upon analysing 141 companies from seven of the EU countries, we found that the firms that emitted the most carbon effluents in their home country and that voluntarily disclosed the greatest amount about their carbon emissions also were the ones that provided the most extensive disclosures concerning company environmental performance. These results appear to support legitimacy concepts as the basis for which voluntary reporting will be generated.

Keywords: carbon disclosure; carbon emissions; Kyoto Protocol; sustainability accounting; environmental accounting.

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1 Introduction

At the Paris Conference on Climate Change held at the end of 2015, 195 nations decided to make a major effort to reduce greenhouse gases (GHGs). Essentially, they agreed to take actions so that temperatures would not rise by 2 degrees Celsius (Davenport, 2015). A number of sceptics believe that since the nations did not agree to take immediate actions there remains some doubt about this timetable.

Most previous climate conferences failed to reach any measurable goals, but the one that was successful in requiring specific benchmarks, the 1997 Kyoto Meeting, has had mixed success in bringing about improved environmental-impact outcomes. The Kyoto Protocol (Kyoto), like the Paris Agreement, was signed by representatives from most of the countries of the world. Kyoto, and the new Paris Agreement, had to be *ratified* by signatory bodies before it took effect. Although most of the world's industrialised nations ratified Kyoto, the USA and Australia did not. The EU committed to reducing its GHG emissions to 92% of its 1990 level by 2012; this bloc of countries was successful in achieving that goal (EEA, 2013). Other countries were not as successful: Canada, for example, pulled out of the agreement when it was clear the goals set were unattainable.

One of the methods the EU implemented to control GHG emissions was a cap-and-trade scheme. Each of 27 EU countries was provided a specific number of pollution 'permits'. These were allocated to companies and allowed the recipient firms to emit a maximum amount of carbon-equivalent effluents. Nine specific industries and one general industry group that comprised the largest carbon emitters in the EU were

targeted for permit distribution. Each country allocated permits annually to plants from these industries. Facility owners could be from any country; many of the owners were foreign-headquartered companies.

The EU's cap-and-trade system, which has been termed the EU-ETS, officially commenced in 2008. The effluent reduction goals were to be achieved by the end of 2012. Companies from the ten industries that were included in the EU-ETS had to either reduce their carbon emissions so that they were within the allocated limit or purchase more permits to cover any overage. Since most companies involved in EU-ETS would be impacted on some level, what is examined in this study is the change of emissions from 2008 to 2012 made by companies operating in certain of the EU countries and the disclosures firms made regarding their involvement in EU-ETS.

We assess in this study carbon emissions for companies from the countries that were the largest emitters of carbon in the EU (Germany, France, the UK and Spain), two Scandinavian countries (Sweden and Denmark), and Greece (a nation-state that recently has had some very serious economic problems). The assessment includes emissions in 2008 and 2012 and disclosures that these companies made in those two years.

The results of the assessment of 141 companies from the seven EU countries was that firms that emitted the most carbon effluents in their home country and that voluntarily disclosed the greatest amount about their carbon emissions also were the ones that provided the most extensive disclosures concerning company environmental performance. These results appear to support legitimacy concepts as the basis for which voluntary reporting were generated.

The paper is structured as follows: first the background, which includes a brief summary of cap-and-trade and the effectiveness of EU-ETS in reducing GHG, is provided. Next, the overall carbon emission performance for the countries included in the study is presented. The hypothesis and methodology then are provided. Results, analysis, and conclusions complete the paper.

2 Background

At the 1992 Earth Summit in Rio De Janeiro, the United Nations Framework Convention on Climate Change was created. A key component of the convention-creating treaty was a recognition of the need to reduce carbon emissions globally. The means of attaining this reduction were not decided at that time (Kolbert, 2015). Five years later, the Kyoto Protocol was signed and most of the world's industrialised nations had agreed to specific reductions of GHGs by the end of 2012.

The EU agreed to reduce its GHG to 92% of 1990s emissions. The 27 EU members and Norway created a market-mechanism cap-and-trade system for reducing emissions for nine specific industries and one general industry designation (see Table 1 for the full specifications). However, it is important to note that the emissions targeted by this system constituted only a relatively small percentage of the total emissions in each country. In France, for example, the targeted emissions comprised only 21% of its total GHG emissions.[1] On balance, for Greece, the industries under cap-and-trade generated about 53% of that country's total GHG emissions.

Table 1 Industry classifications

Activity #	*Description of industrial activities in sector*
1	Combustion installations with a rated thermal input exceeding 20 MW
2	Mineral oil refineries
3	Coke ovens
4	Metal (including sulphide) ore roasting or sintering installations
5	Installations for production of pig iron or steel (primary or secondary fusion), including continuous casting
6	Installations for production of cement clinkers in rotary kilns, lime in rotary kilns, or other furnaces.
7	Installations for the manufacture of glass and glass fibre
8	Installations for manufacture of ceramic products by firing, in particular roofing tiles, bricks, refractory bricks, tiles, stoneware and porcelain
9	Industrial plants for the production of pulp from timber or other fibrous materials and paper and board
99	Other activities opted-in pursuant to Article 24 of Directive 2003/87/EC

2.1 Study countries

Although 27 nations are included in the EU-ETS mechanism, the focus of this study is on only seven of these. France, Germany, and the UK are the largest nations in the EU and are included in the study for that reason alone. Spain is among the largest nations and it has been severely impacted by the economic downturn during most of the 2008–2012 period. Greece has been financially crippled by the so-called 'Great Recession'. Denmark and Sweden represent the Scandinavian countries; they have long been considered to be at the forefront in dealing with many environmental matters.

Table 2 EU GHG 1990, 2008–2012

Country	*Base 1990*	*Target*	*2008*	*2012*	*% change base to 2012*	*% change 2008 to 2012*
Denmark	69.3	63.8	64.0	51.6	–24.8	–0.19
France	563.9	518.8	537.0	490.0	–13.1	–0.09
Germany	1,232.4	1,133.8	976.0	939.1	–23.8	0.04
Greece	107.0	98.4	131.0	111.0	3.7	–0.15
Spain	289.8	266.6	404.0	340.8	17.6	–0.16
Sweden	72.2	66.4	64.0	57.8	–20.2	–0.10
UK	776.3	714.2	626.0	580.8	–25.2	–0.07
EU 26 countries (no Cyprus or Malta)					–19.2	

As agreed to by the EU, Kyoto provides for an 8% reduction in GHG emissions by the end of 2012 as compared to the 1990 base year. Matching the emissions level in 2012 to that of 1990 (see Table 2 for all the details), we find that only two EU countries – Greece and Spain – did not achieve the 8% reduction goal. In fact, comparing these two countries' pollution levels between 1990 and 2012, the volume of their CO_2 emissions increased by 3.7% and 17.6%, respectively. Still, in terms of what was

expected for these countries, both did meet the volumetric level targeted for them by the EU (EEA, 2014).

Before the EU-ETS program officially began, Germany, Sweden, and the UK already had achieved the requisite 8% GHG reduction; Denmark was very close to the target reduction goal. Along with that achievement, these countries and the others in the group reduced their overall GHG emissions during the 2008 to 2012 period.

2.2 EU-ETS scheme

The EU chose to implement their cap-and-trade system on a plant-level, country-wide basis. Each country was allocated permits each of which allowed emission of one metric ton (tonne) of carbon equivalent (EEA, http://www.eea.europa.eu/publications/trends-and-projections-2013). These freely allotted permits were distributed annually to the plants in the ten industries targeted by the EU. For each tonne of verified emissions that occurred in a given year, the plant's owner surrendered an allowance. A trading market was created in which firms could buy or sell allowances depending on whether they emitted more or less than their allowances. Firms also could bank any unused allowances.[2]

As was indicated previously, EU-ETS was concerned with carbon emitted from plants in ten industry groups. These emissions constituted only a portion of the total GHG generated in the EU. In Table 3, the emissions by the seven countries included in this study for the targeted plants are shown for the 2008–2012 Kyoto period. For six of the seven countries, cap-and-trade resulted in an emissions reduction of more than 8% over the period. Germany, with only a 4% reduction, already had achieved its targeted emissions level prior to 2008, so whatever reduction made there would have been acceptable to help the EU meet its goal.

Table 3 Emissions (in millions of tonnes) from targeted plants in ten industries

Country	*2008*	*2012*	*% change*
Denmark	26.5	18.2	–0.31
France	124.1	103.5	–0.17
Germany	472.6	452.6	–0.04
Greece	69.9	61.4	–0.12
Spain	163.5	135.6	–0.17
Sweden	20	18.2	–0.09
UK	265.1	231.2	–0.13

3 Hypotheses

Reduction of GHG emissions is a critical step if the world is to achieve a limited rise in global temperature. Since the EU has instituted a means to reduce emissions using a cap-and-trade system, the examination here is about what firms involved in the system reported to their stakeholders. By assessing the change in emissions for the domestic plants and the disclosures made by the impacted companies, a sense of how transparent these firms are can be ascertained.

Plants above a specified size that are classified in one of the ten industry groups were given an allocation of allowances each year beginning in 2008. Only plants that are owned by public companies are considered in this study. Although a public company plant owner could be from any country, we have restricted the analysis to those that are headquartered in the same country as the plant. For example, Vattenfall is a Swedish company that is the owner of utility plants in Sweden and a number of other EU countries. For this analysis, only the Swedish plants of Vattenfall are included. The basis for this approach is that even though we are in a world replete with multi-national corporations, environmental disclosures are known to be impacted by domestic or local culture (Freedman and Jaggi, 2005). Disclosures about the EU-ETS, carbon or GHG emissions, and allowances should be a function of what has transpired domestically.

All of the firms included in this study owned plants that received carbon allowances during the 2008 through 2012 period. The allowances received and actual emissions for each year are publicly available from a website maintained by the EU-ETS. Data are provided on a plant-by-plant basis, since that is how the permit allocation occurs. Stakeholders interested in carbon emissions and/or allowances for these companies, either domestically or throughout the EU, must calculate the data on a plant-level basis – or purchase the information from a third-party information supplier – unless the company provides the disaggregated data in published reports. As we will argue below, since companies are not required to disclose this information, all such reporting is delivered on a wholly voluntary basis.

Each of the countries included in this study is governed by EU environmental disclosure regulations and their own domestic disclosure rules. Although there are EU-ETS environmental disclosure requirements (by plant), there was nothing that required disclosure of company-wide GHG performance measures during the 2008 to 2012 period (UNEP et al., 2013; Bebbington and Larrinaga-Gonzalez, 2008). The EU-ETS requires that annual carbon emissions and permit allocations for each plant given carbon allowances be reported, but disclosure for the company as a whole is not mandated. Starting in 2013, these disclosures are required for the UK-based firms (Sherman and Sterling LLP, 2015), but this new rule is not applicable to this study.

France, in the application of Article 75 of the *Grenelle* Law, does mandate GHG emissions disclosure starting in 2012 (Kauffmann et al., 2012). However, the disclosure is not required to be audited and there are no provisions for sanctions if disclosure is omitted. During the 2008–2011 period, the Law on New Economic Regulations was in effect requiring firms of a certain size to disclose how they account for environmental and social consequences of their actions (Kauffmann et al., 2012). This has not been interpreted as mandating GHG disclosure (Barbu et al., 2014).

In 1997, the German Government promulgated guidelines for environmental reports, but they were retracted before the EU-ETS period (Barbu et al., 2014). Spain passed environmental disclosure requirements in 1998 and 2002, but as Larrinaga et al. (2002) and Criado-Jimenez et al. (2008) discovered, many firms essentially ignored the requirements. In essence, what was a mixture of mandated and voluntary requirements was in actuality merely voluntary. Greece does not require mandatory reports on environmental issues (EY Greece, 2014). However, the number of voluntary stand-alone Greek sustainability reports has increased from 2010 to 2012 (EY Greece, 2014).

For the Scandinavian countries included in this research, Denmark enacted the Green Accounts Act in 1995 that required extensive reporting on plants' environmental

activities (Hibbit and Collison, 2004). However, only corporate environmental actions, as opposed to just plant-level activity, are reported in the management section of the annual report. The form and nature of the report is left to the discretion of management (Hibbit and Collison, 2004). Sweden encourages environmental reporting following the Global Reporting Initiative as a guide; compliance in terms of GHG reporting is voluntary.

The justification for firms voluntarily disclosing climate change information from the management literature is that firms can benefit from the disclosures (Hahn et al., 2015). Such reporting can improve the company's image in the eyes of owners and other stakeholders (Sullivan and Gouldson, 2012). It also could provide information that will help investors better evaluate the company's risks related to climate change (McLaughlin, 2011). Finally, such disclosures will improve transparency (Simnett et al., 2009).

Although there are a number of theories proposed in the accounting literature as to why firms voluntarily disclose environmental data in this study we are focusing on two of them: voluntary disclosure theory (Clarkson et al., 2008) and legitimacy theory (Patten, 1991, 1992; Deegan, 2002; Joshi et al., 2011).

Voluntary disclosure theorists (Clarkson et al., 2004, 2008) believe that firms that have incurred costs to clean up the environment, and have done well in terms of environmental performance, would like to disclose this information in a way not easily mimicked by poor performers. By using objective measures of environmental performance in their reporting, such firms should show a positive relationship between environmental disclosures and environmental performance. Firms, therefore, use their disclosure strategy to signal to users their proactive approach to environmental performance. Although, there is mixed evidence that this expectation occurs, Clarkson et al. (2008) found that companies that did better in terms of environmental performance made more extensive environmental disclosures.

According to Dowling and Pfeffer (1975), for an organisation to be socially legitimate it must conform to societal expectations. Failure to meet these expectations creates a legitimacy gap (Deegan, 2002). Legitimacy theory, according to environmental accounting researchers (Patten, 2000; Deegan, 2002), posits that firms appear to behave in a way that society anticipates. By utilising environmental disclosures to create the appearance of meeting the environmental expectations of society, the firm remains legitimate. This is true even though the company actually may be a poor environmental performer.

Since environmental disclosure can be seen as a communication device, it can be used to address social and political pressures. Firms with poor environmental performance can mitigate the impact of this performance by making extensive environmental disclosures (Cho et al., 2012). Cho and Patten (2007) find that firms with poorer environmental performance make the most extensive environmental disclosures.

We believe that companies that participated in the EU-ETS would like to inform stakeholders of their participation in this endeavour and their positive accomplishments. Those firms that have done well in limiting their carbon emissions would, based on voluntary disclosure theory, make the most extensive disclosures. Under legitimacy theory, those firms that have done poorly in limiting their carbon emissions would provide the most extensive disclosures as a 'smokescreen' to disguise their lacklustre performance.

First, we examine companies' carbon emissions and carbon disclosure prior to the implementation of the EU-ETS. If either voluntary disclosure theory or legitimacy theory holds, then it should manifest itself prior to the start of the program. The supporting null hypothesis can be stated as follows:

H_{01} The extensiveness of the EU-ETS disclosure in 2008 is not related to 2008 domestic carbon emissions.

Next, we examine the impact that the EU-ETS had on carbon emissions and carbon disclosure. After experiencing a potentially non-material carbon emissions reduction program did firms disclose in a way consistent with voluntary disclosure theory or with legitimacy theory? The supporting null hypothesis can be stated as follows:

H_{02} The extensiveness of the EU-ETS disclosure in 2012 is not related to 2012 domestic carbon emissions.

Finally, some firms might have done very little to reduce their carbon emissions or even increased these emissions due to their performance prior to the implementation of EU-ETS. If the EU-ETS is a factor in carbon disclosure we would expect that the change in emissions should be a trigger for carbon disclosure and again supporting one of the two theories. The supporting null hypothesis can be stated as follows:

H_{03} The change in the extensiveness of EU-ETS disclosure from 2008 to 2012 is not related to the change in carbon emissions that occurred during this same time period.

4 Methodology

4.1 Sample

The sample companies all are public firms headquartered in one of the seven countries studied that owned a plant domestically and received carbon allowances for each of the years from 2008 to 2012. Table 4 lists the firms and the number of each firm's plants that received allowances during this five-year period. As is indicated by Table 4, there were 141 companies that owned 1,130 domestic plants for which allowances were received in this time frame.

4.2 Carbon emissions

Each plant receiving carbon allowances files a report with EU-ETS on their allotment, verified emissions, and the number of permits surrendered each year. These reports are publicly available. Based on the data reported, we calculated yearly carbon emissions for each plant located in every sample company's home country for each year from 2008 to 2012.

Table 4 Sample firms and their domestic plants

Country	*Firm name*	*Number of plants*
Denmark	Aalborg Portland	1
	AP Moeller Maersk	5
	Brodrene Hartman	1
	Carlsberg	2
	Danfoss	2
	Egetaepper	1
	Novo Nordisk	1
	Novozymes	1
	Rockwool International	1
	Total	*15*
France	Aeroporto des Paris	4
	Airbus	5
	Air Liquide France	1
	Albioma	3
	Aluminium Pinchney	1
	Arkema	14
	Baccarat	1
	Banque de France	1
	Bonduelle	5
	Borealis	2
	Caisse des Depots et Consignations	116
	Cogema	1
	Danone	3
	EDF	31
	Eramet	3
	Bel Group (Fromageries Bel)	1
	GDF-SUEZ	83
	Imerys	20
	Lafarge S.A.	13
	Michelin	12
	Parisienne de Chauffage de Urban	7
	Peugot	7
	Poweo	1
	Renault S.A.	7
	Rhodia	11
	Safran	1
	Saint-Gobain	14
	Sam	2

Table 4 Sample firms and their domestic plants (continued)

Country	*Firm name*	*Number of plants*
France	Sanofi	6
	Sequana	5
	SGD	2
	Societe Nationale Des Francais	2
	Total Raffinage	6
	Veolia	140
	Total	*531*
Germany	ADM Hamburg AG	1
	BASF	12
	Bayer	6
	BMW	7
	Daimler AG	2
	ENBW	6
	E.ON	31
	Evonik Industries	10
	EWE AG	12
	HeidelbergCement AG	5
	K+S AG	13
	Lufthansa	1
	Mainova AG	7
	MTU Aero Engines AG	1
	Robert Bosch GmbH	5
	RWE AG	22
	Salzgitter AG	5
	Siemens AG	1
	Suedzucker	10
	ThyssenKrupp AG	4
	Wacker Chemie AG	1
	Wincor Nixdorf AG	1
	Volkswagen AG (also Audi)	12
	Total	*175*
Greece	Hellenic Petroleum1	1
	Hellenic Sugar Industry	5
	Motor Oil Hellas	1
	Protergia (Mytelinos)	1
	Titan Cement	4
	VIS Containers	1
	Total	*13*

Table 4 Sample firms and their domestic plants (continued)

Country	*Firm name*	*Number of plants*
Spain	Abengoa, S.A.	11
	Acerinox	1
	Cementos Alfa	1
	Cementos Molins Industrils	1
	Cementos Portland Valderrivas	1
	Construcciones y Auxiliar de Ferrocarriles	1
	Enagas	24
	Endesa Generacion	34
	Gas Natural	15
	Grifols	1
	Grupo Empresarial ENCE	9
	Iberdrola Generacion	22
	OHL	1
	Repsol	12
	Viscofan	1
	Total	*135*
Sweden	Aarhuskarlshamn	1
	BillerudKorsnas	11
	Boliden	2
	Borealis	2
	Hoganas	4
	Holmen	3
	Luossavaara-Kiirunavaara	3
	NCC	1
	NIBE	1
	Nynas	2
	Ovako Steel	4
	Preem Petroleum	2
	Rottneros	3
	Saab	1
	Sandvik	3
	Skansa	1
	Sodra Skogsaganna	6
	SSAB	3
	Svenska Cellulose	9
	Vattenfall	35
	Volvo	6
	Total	*103*

Table 4 Sample firms and their domestic plants (continued)

Country	*Firm name*	*Number of plants*
UK	Assorted British Foods	1
	Astra Zeneca	5
	BAE Systems	10
	Balfour Beatty	1
	Barclays Bank	5
	BG Group	3
	BHP Billiton	3
	BP	13
	British Airways	1
	BT Group	9
	Centrica	12
	Croda International	2
	Cropper (James)	1
	Diageo	4
	Drax Group	1
	DS Smith	1
	Enquist	3
	GlaxoSmithKline	13
	Greene King	5
	Imperial Tobacco	1
	Mondi	1
	National Grid	29
	Premier Foods	7
	Premier Oil	2
	Rolls-Royce	12
	Serco	2
	Severn Trent	1
	Smith and Nepew	1
	SSE	15
	Tate-Lyle	2
	Unilever	3
	United Utilities	1
	Wessex Water	1
	Total	*171*
	Overall total	*1,130*

4.3 Environmental disclosure

The focus of this study is on reporting made by EU firms that participated in the EU cap-and-trade system. Therefore, we included for analysis disclosures concerning participation in EU-ETS, allowances received and used, costs of allowances, capital expenditures to reduce carbon emissions, and the results of all this involvement regarding the amount of carbon emitted for the period. We examined all public disclosures made by the sample companies for the two years 2008 and 2012.

The reporting venue for many of these disclosures is each company's website. However, published environmental, sustainability, or citizenship reports also are a significant source of disclosure. Annual reports for these companies also were analysed, but disclosures in these documents concerning EU-ETS tended to be much less informative.

4.4 Content analysis of disclosures

To evaluate extensiveness of a firm's reporting related to carbon emissions, we conducted content analysis on all available disclosure sources. After considering various aspects of firms' emissions issues, we developed a disclosure index for the content analysis as follows:

1 statements regarding climate change

2 statements about the Kyoto Protocol

3 statements concerning the EU-ETS and/or cap-and-trade

4 reports on the amount (in tonnes) or costs (in euros) of carbon allowances

5 disclosure of the amount (in tonnes) of carbon/GHG emissions

6 statements about capital expenditures made in response to climate change risk

7 costs (in euros) of capital expenditures incurred for climate change risks.

Each of these seven index items is equally weighted, as we have no conceptual basis to presume that one item is more information-potent than any other. The maximum disclosure score for each firm-year observation is 7.

5 Analyses and results

Table 5 shows basic descriptive statistics of firms' disclosure score and carbon/GHG emission amount by each of the seven countries and each of the two analysis years (i.e., 2008 and 2012). The disclosure score is collected from the content analysis procedure described above. For the carbon/GHG emission amounts, two metrics are adopted. The first is based on the amount that firms self-reported or disclosed voluntarily. Firms often disclose their emission amounts as a total lump-sum CO_2-equivalent volume that includes the amounts that their subsidiaries and branches emitted. Since such reporting will include non-domestic plant emissions, we compute a second metric of carbon/GHG emissions that indicates the amount emitted domestically in the country where the

headquarters is located. As discussed earlier, emissions data are disclosed at the plant level, so we aggregated the amounts of all domestic plants for each firm to compute the total emissions that each firm emitted in its home country.

Table 5 Descriptive statistics of disclosure scores and two emission measures

			Disclosure score	*GHG emission*$^{+}$	*GHG emission*$^{++}$
Denmark	2008	N	9	6	9
		Mean	1.78	8.53	0.23
		Median	2.00	0.70	0.03
		Min.	0.00	0.18	0.01
		Max.	5.00	48.20	1.74
	2012	N	9	7	9
		Mean	1.89	6.22	0.18
		Median	2.00	0.95	0.02
		Min.	0.00	0.13	0.00
		Max.	3.00	38.63	1.41
France	2008	N	34	12	34
		Mean	1.09	12.98	1.60
		Median	0.00	2.31	0.12
		Min.	0.00	0.03	0.00
		Max.	5.00	107.00	16.76
	2012	N	34	18	34
		Mean	1.56	17.49	1.44
		Median	1.50	2.62	0.13
		Min.	0.00	0.04	0.01
		Max.	5.00	96.70	15.93
Germany	2008	N	23	13	23
		Mean	2.74	25.46	6.70
		Median	3.00	6.63	1.00
		Min.	0.00	1.18	0.08
		Max.	5.00	172.10	94.61
	2012	N	23	16	23
		Mean	2.87	26.63	6.91
		Median	3.00	6.07	0.89
		Min.	0.00	0.08	0.09
		Max.	6.00	179.80	98.73
Greece	2008	N	6	4	6
		Mean	1.83	4.54	1.38
		Median	2.00	3.01	1.01
		Min.	0.00	1.95	0.00
		Max.	4.00	10.20	1.38

Notes: $^{+}$GHG emission amount in millions of tonnes as disclosed by sample firms.
$^{++}$Domestic GHG emission amount in millions of tonnes.

Table 5 Descriptive statistics of disclosure scores and two emission measures (continued)

			Disclosure score	*GHG emission*$^{+}$	*GHG emission*$^{++}$
Greece	2012	N	6	4	6
		Mean	2.00	4.99	0.93
		Median	2.00	3.70	0.94
		Min.	0.00	1.97	0.01
		Max.	4.00	10.60	1.95
Spain	2008	N	15	14	15
		Mean	3.20	10.56	5.30
		Median	3.00	0.87	0.50
		Min.	2.00	0.02	0.00
		Max.	5.00	54.42	33.43
	2012	N	18	16	17
		Mean	3.06	11.22	4.42
		Median	3.00	0.47	0.20
		Min.	0.00	0.02	0.00
		Max.	5.00	78.32	35.51
Sweden	2008	N	21	12	18
		Mean	1.90	8.50	0.53
		Median	2.00	1.02	0.19
		Min.	0.00	0.07	0.01
		Max.	5.00	82.50	3.91
	2012	N	21	13	17
		Mean	1.95	7.60	0.46
		Median	2.00	1.00	0.15
		Min.	0.00	0.02	0.00
		Max.	5.00	83.50	2.79
UK	2008	N	33	24	32
		Mean	2.39	9.47	1.27
		Median	2.00	0.99	0.08
		Min.	0.00	0.07	0.00
		Max.	5.00	61.40	22.30
	2012	N	33	27	32
		Mean	2.18	8.12	1.00
		Median	2.00	1.00	0.05
		Min.	1.00	0.08	0.00
		Max.	4.00	59.80	22.69

Notes: $^{+}$GHG emission amount in millions of tonnes as disclosed by sample firms.
$^{++}$Domestic GHG emission amount in millions of tonnes.

As given in Table 5, the firms in Spain and Germany disclosed about three items of the total seven items in both years 2008 and 2012. Firms in other countries disclosed merely one or two items, on average. In all the countries except for Spain and the UK, the average disclosure in 2012 is slightly improved compared to that in 2008. But, we find

that some firms received zero for their disclosure scores, indicating that they did not disclose any item in either 2008 or 2012.

Based on domestic emissions data, the firms in Spain and Germany emitted much larger amounts of GHGs than those in other countries, on average. Also, although the firms in many countries reduced domestic GHG emissions in 2012 compared to 2008, those in Germany did not. In all countries, the average amount of domestic GHG emissions is much smaller than the amount that firms disclosed voluntarily, suggesting that firms' operations located in other countries emit much larger amounts of GHGs than did plants in a firm's home country.

To test if the change in disclosure score and GHG emissions is statistically significant, we conducted two-sample t-tests and paired-sample t-tests for mean difference and non-parametric Wilcoxon rank-sum tests and Wilcoxon signed-rank tests for median difference. In Panel A of Table 6, the mean value of all firms' disclosure scores is 2.09 for the year 2008 and 2.19 for the year 2012. Although the average disclosure score was higher in 2012 compared to 2008, the two-sample t-test results reveal that this increase is not statistically significant at any conventional level. The insignificant difference in disclosure score between the two years is somewhat surprising. This finding suggests that European firms did not revise their disclosure posture even as public pressure and global interest in climate change issues has been rising.

The mean values of both self-reported GHG emission amounts and domestic GHG emission amounts are lower in 2012 compared 2008. For example, the average domestic GHG emission amount for sample firms is 2.54 million tonnes in 2008 and only 2.39 million tonnes in 2012. That outcome might be interpreted as evidence that the EU-ETS effectively motivated firms to curtail GHG emissions. To control for firm size, we also employ size-adjusted variables by dividing the raw variables by firms' total assets. The result shows that all three size-adjusted variables slightly decreased in 2012 compared to 2008, indicating that the disclosure score has a different pattern between the raw variable and the size-adjusted variable and the GHG emission has a consistent pattern between them. However, the two-sample t-test results reveal that this reduction lacks statistical significance at any conventional level, except that the median difference in size-adjusted domestic GHG emission is significant at 10% level.

It remains noteworthy to mention that the two-sample t-test tends to disregard individual firm level change since it simply compares the average numbers of the sample groups after mingling all variations within each sample. Furthermore, some firms in the sample disclosed their GHG emission amounts via a voluntary source in only one year, not both. The inclusion of those firms in the two-sample t-tests does not ensure a fair comparison between the two years.

To deal with the above-noted methodological issues, we conducted complementary analyses such as paired-sample t-tests and Wilcoxon signed-rank tests after computing the yearly change (year 2012 index score minus the year 2008 one) for each firm. Panel B of Table 6 presents the results. The mean and median values of the changes in disclosure score and self-reported GHG emissions are not statistically different from zero. However, the mean value of the change in domestic GHG emission amounts is significantly negative at a 10% one-tailed level. Its median value also is negative and statistically significant at the 1% two-tailed level, suggesting that more than a majority of the sample firms reduced domestic GHG emissions in 2012 compared to 2008.

Table 6 Temporal comparisons of firms' disclosure scores and GHG emissions

Panel A: two-sample tests	*Year 2008*			*Year 2012*			*Diff (year 2012 – year 2008)*					
	N	*Mean*	*Median*	*N*	*Mean*	*Median*	*Mean*	*Sig.*[a]	*Sig.*[b]	*Median*	*Sig.*[a]	*Sig.*[b]
Disclosure score	141	2.08511	2.00000	144	2.19444	2.00000	0.10933			0.00000		
GHG emission[+]	85	12.15438	1.48000	101	12.89188	1.48000	0.73750			0.00000		
GHG emission[++]	137	2.54499	0.14712	138	2.39195	0.12990	–0.15304			–0.01722		
Disclosure score / TA[+++]	133	0.00125	0.00016	137	0.00096	0.00016	–0.00029			0.00000		
GHG emission[+] / TA	83	0.00079	0.00031	97	0.00073	0.00020	–0.00006			–0.00011		
GHG emission[++] / TA	129	0.00036	0.00002	131	0.00027	0.00002	–0.00009			0.00000	*	

Panel B	*N*	*Mean*	*Sig.*[a]	*Sig.*[b]	*Median*	*Sig.*[a]	*Sig.*[b]
Change in disclosure score	141	0.09929			0.00000		
Change in GHG emission[+]	77	2.34522			–0.00085		
Change in GHG emission[++]	135	–0.13511	*		–0.00800	***	***
Change in [disclosure score / TA[+++]]	133	–0.00036	**	*	–0.00001	***	***
Change in [GHG emission[+] / TA]	75	–0.00014	**	*	–0.00002	***	***
Change in [GHG emission[++] / TA]	127	–0.00009	***	***	–0.00001	***	***

Notes: [+]GHG emission amount in millions of tonnes as disclosed by sample firms.
[++]Domestic GHG emission amount in millions of tonnes.
[+++]Total assets in millions of Euros measured at fiscal year-end.
[a]One-tailed significance level, ***, ** and * correspond to 1%, 5% and 10% level, respectively.
[b]Two-tailed significance level, ***, ** and * correspond to 1%, 5% and 10% level, respectively.

Table 7 Correlation results between disclosure scores and emissions

Panel A: year 2008					
	Disclosure score	*GHG emission*$^{+}$	*GHG emission*$^{++}$	*GHG emission*$^{+}$ */ TA*	*GHG emission*$^{++}$ */ TA*
Disclosure score	1	0.26175**	0.21164**	0.21429*	0.15496*
GHG emission^{+}	0.30684***	1	0.68981***	0.29687***	0.04930
GHG emission^{++}	0.26381***	0.64365***	1	0.24757**	0.27127***
GHG emission^{+} / TA	0.09939	0.62774***	0.49726***	1	0.77641***
GHG emission^{++} / TA	0.09833	0.26496**	0.77354***	0.62002***	1
Panel B: year 2012					
	Disclosure score	*GHG emission*$^{+}$	*GHG emission*$^{++}$	*GHG emission*$^{+}$ */ TA*	*GHG emission*$^{++}$ */ TA*
Disclosure score	1	0.24173**	0.13621	0.16332	0.07653
GHG emission^{+}	0.32346***	1	0.67512***	0.33915***	0.10302
GHG emission^{++}	0.23065***	0.62272***	1	0.17659*	0.30986***
GHG emission^{+} / TA	0.28859***	0.75127***	0.54112***	1	0.49040***
GHG emission^{++} / TA	0.04706	0.32823***	0.78629***	0.60987***	1
Panel C: full					
	Disclosure score	*GHG emission*$^{+}$	*GHG emission*$^{++}$	*GHG emission*$^{+}$ */ TA*	*GHG emission*$^{++}$ */ TA*
Disclosure score	1	0.24784***	0.17408***	0.17789**	0.11978*
GHG emission^{+}	0.24784***	1	0.68014***	0.31985***	0.07284
GHG emission^{++}	0.17408***	0.68014***	1	0.19690***	0.28706***
GHG emission^{+} / TA	0.17789**	0.31985***	0.19690***	1	0.57320***
GHG emission^{++} / TA	0.11978*	0.07284	0.28706***	0.57320***	1
Panel D: change					
	Change in disclosure score	*Change in GHG emission*$^{+}$	*Change in GHG emission*$^{++}$	*Change in [GHG emission*$^{+}$ */ TA]*	*Change in [GHG emission*$^{++}$ */ TA]*
Change in disclosure score	1	0.09921	–0.09454	0.12599	0.04555
Change in GHG emission^{+}	0.22980**	1	0.05816	0.26045**	0.10393
Change in GHG emission^{++}	0.08888	0.18293	1	0.05284	0.22050**
Change in [GHG emission^{+} / TA]	–0.04417	0.47329***	0.10774	1	0.49917***
Change in [GHG emission^{++} / TA]	–0.01138	0.05958	0.53904***	0.29813**	1

Notes: The Pearson (Spearman) correlation results are presented in the upper (lower) diagonal of these tables.
The variable definitions are the same as those in previous tables.
The significance level, ***, ** and * correspond to 1%, 5% and 10% level, respectively.

The extended analysis findings are more pronounced in the results with size-adjusted variables. The mean and median values of the changes in size-adjusted disclosure score are negative and statistically significant, suggesting that the extensiveness of firms' 2012 emissions disclosure declined compared to that of 2008. The change in size-adjusted GHG emissions is negative and statistically significant in both self-reported overall emission amounts and the domestic volume. These further tests with change in size-adjusted variables provide evidence that the EU firms included in this study did curtail their GHG emissions under EU-ETS.

Next, as a principal test of the hypotheses, we examined the correlations between firms' disclosure scores and GHG emissions. For these tests, we use each of the two measures of GHG emissions: self-reported GHG emission amounts and domestic GHG emission amounts. Also, we use both the raw data of GHG emission and its size-adjusted alternative.

For the correlation matrix in Table 7, the Pearson (Spearman) correlation results are presented in the upper (lower) diagonal. In Panel A with 2008 data, the correlations between the disclosure score and raw GHG emission amounts are positive and statistically significant in both Pearson and Spearman correlation analysis, while the correlations with size-adjusted GHG emission amounts are relatively weak. Overall, the findings suggest that the extensiveness of the EU-ETS disclosure in 2008 is positively associated with 2008 carbon emissions, rejecting H_{01}. A similar result also is found in Panel B for 2012, rejecting H_{02}. But, the Pearson correlation with the raw domestic GHG emission is not significant, while the Spearman correlation with the size-adjusted self-reported GHG emission is.

Furthermore, the correlations with the full dataset provide stronger evidence than do the yearly association results. In Panel C of Table 7, all the Pearson and Spearman correlations between the disclosure score and GHG emissions are significantly positive (although the correlation with size-adjusted domestic GHG emission is relatively weak). The overall results provide evidence that firms with more GHG emissions also disclose more, supporting legitimacy theory rather than voluntary disclosure theory. To be specific, firms that emit more GHGs – that is, have done poorly in limiting carbon emissions – provide more extensive disclosures in an apparent attempt to legitimise their weak environmental performance.

In order to test H_{03}, we examined the correlation between the change in disclosure score and the change in GHG emission. As discussed earlier, voluntary disclosure (legitimacy) theory predicts that firms that do a better (worse) job in limiting carbon emissions over the period from 2008 to 2012 are more likely to make more extensive disclosure for the same period. Panel D of Table 7 presents the analytic results. Overall, both the Pearson and Spearman correlations with the change variables are not statistically significant at conventional levels, so H_{03} is not rejected. The only significant association detected is the Spearman correlation between disclosure score and raw self-reported GHG emissions (at the 10% significance level). Thus, only the aggregated findings can be interpreted as evidence that firms' disclosure policy was not changed in response to their change in carbon emission amounts over the five-year period. Possibly, this is a result of offsetting impacts by the two conflicting theories; our data and these analyses cannot detect whether that is an accurate or reasonable interpretation.

Table 8 OLS regression results of disclosure scores and emissions

Panel A: yearly data						
Independent variables	*Dependent variable: disclosure score*					
	Year 2008			*Year 2012*		
Intercept	2.90390***	2.12926***	2.92816***	2.73616***	2.24324***	2.75452***
GHG emission^{+}	0.01043**		0.01168*	0.00925**		0.01434***
GHG emission^{++}		0.03003*	–0.00549		0.01427	–0.02147
TA^{+++}	0.00089	–0.00011	0.00091	–0.00038	–0.00016	–0.00046
N	83	129	81	97	131	94
Adjusted R^2	0.0603	0.0137	0.0457	0.0358	–0.0068	0.0454
F-value	3.63	1.89	2.28	2.78	0.56	2.48
P-value	0.0310	0.1554	0.0862	0.0669	0.5714	0.0665
Panel B: full data						
Independent variables	*Dependent variable: disclosure score*			*Dependent variable: change in disclosure score*		
Intercept	2.81579***	2.18675***	2.83859***	–0.28660***	0.09194	–0.29951**
GHG emission^{+}	0.00960***		0.01227***			
GHG emission^{++}		0.02187**	–0.01133			
TA^{+++}	0.00013	–0.00012	0.00013			
Change in GHG emission^{+}				0.00433		0.00457
Change in GHG emission^{++}					–0.07624	–0.03168
Change in TA^{+++}				0.00015	–0.00016	0.00013
N	180	260	175	75	127	73
Adjusted R^2	0.0446	0.0098	0.0422	–0.0257	–0.0130	–0.0405
F-value	5.18	2.29	3.55	0.07	0.19	0.07
P-value	0.0065	0.1038	0.0157	0.9295	0.8262	0.9777

Notes: The variable definitions are the same as those in previous tables, except that TA^{+++} used here is in billions of euros.
The significance level, ***, ** and * correspond to 1%, 5% and 10% level, respectively.

In addition to the univariate correlation analyses described above, we conducted regression analyses as a way to control for firm size. In the regression model, the dependent variable is the firm's disclosure score and independent variables include raw GHG emission amounts as main test variables and the total asset amount as a control. As shown in Panel A of Table 8, the estimated regression coefficients of the self-reported GHG emission amounts are significantly positive at the 5% level in both 2008 and 2012, after controlling for firm size. This finding supports H_{01} and H_{02} and confirms the univariate analysis results that there is a positive relationship between a firm's GHG emissions and the extensiveness of its climate change disclosure. As was the case with the univariate analysis results, the regression outcome with the yearly data also shows that the domestic GHG emission amounts have a relatively weak connection with disclosure scores. This finding is more pronounced in the regression results with both self-reported GHG emission and domestic GHG emission amounts. While the estimated coefficients of the self-reported GHG emission amounts are significantly positive, those of the domestic GHG emission amounts are not. Thus, the firm's climate change disclosure is significantly correlated with the self-reported GHG emission amounts rather than its domestic GHG emission amounts.

The findings with the full data are presented in Panel B, they are qualitatively unchanged compared with those of the yearly data. To test H_{03}, we replace all the dependent and independent variables with change ones in the regression model. The finding, in not rejecting H_{03}, is consistent with the univariate analyses. It appears that legitimacy theory is not supported with the firm's temporal data even though it is supported from a cross-sectional viewpoint.

6 Conclusions

The EU utilised several methods to achieve an 8% reduction in GHG emissions that they committed to under Kyoto. Their use of cap-and-trade for emissions from ten specific industries certainly contributed to the emission reduction. In analysing 141 companies from seven EU countries, we found that companies that emitted the most in their home country and voluntarily provided the most extensive disclosures about carbon emissions also voluntarily divulged the most concerning their overall environmental performance. This was true for both 2008, when the EU-ETS began, and 2012 when the EU was supposed to have achieved its GHG goals under Kyoto. It would appear that this is evidence in support of legitimacy theory as the driving force for voluntary disclosure.

A limitation of this study is that we did not examine the disclosures to see if the companies were using specific techniques to manage their disclosures. In the literature on disclosure one of these techniques, impression management, has been extensively highlighted (see for example, Cooper and Slack, 2015; Cho et al., 2010). Although impression management can be utilised by any firm to enhance disclosures, firms trying to legitimate their poor environmental performance would be good candidates to utilise impression management. As a suggestion for future research, examining the techniques that firms use to make environmental disclosures should be a fruitful area, Furthermore, extending the study by both years and to more EU countries should contribute to the literature.

To extend this study to the USA, the Securities and Exchange Commission is ostensibly mandating climate change disclosures in firms' annual regulatory filings. Although various countries in the EU now are encouraging more extensive disclosures, the USA seems to be at the forefront in terms of mandating these disclosures. Whether firms will make more meaningful and extensive climate change disclosures is an empirical question and one that is also the basis for future research.

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Notes

1 France is a particularly useful point of reference to understand how difficult it is to design/implement cross-country GHG control mechanisms. Because of the relatively large proportion of electricity generated by nuclear power stations in France, most of the carbon emissions do not originate in the industries targeted by the EU-ETS.

2 Whether firms involved in EU-ETS actually speculated in these tradeable permits – that is, buying and holding permits to reap profits from a future market swing upward – is not known. The expectation at creation of the scheme, and its conceptual underpinning, was that the 'free' allocation would contribute toward the balanced goal of matching ever-shrinking facility-level allotments with enhanced environmental performance through a reduction in emissions.