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On the Obligation to Provide Environmental Information in the 21st Century – Empirical Evidence from Germany

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Abstract

In this paper, we study the effectiveness of environmental information disclosure as a regulatory instrument. In particular we analyze its impact when environmental regulation is already advanced. Using German stock market data, we are able to identify the impact of the European Pollutant Emission Register (EPER) on the market value of listed firms using a Multivariate Regression Model (MVRM). First, we show that the publication of EPER data leads to negative abnormal returns of the respective listed firms in Germany. Second, we study drivers of these abnormal returns. Here, we find that the firms' individual level of non-carbon emissions can explain the observed changes in market valuation, while carbon dioxide emissions do not seem to be punished by the market. Moreover, we include information on voluntarily provided environmental reports and find that these reports can serve as a substitute to the obligatory register.

JEL Classification: G14, L51, Q52

Keywords: information disclosure, EPER, event study, environmental reports

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1 Introduction

Disclosure of environmental information is an increasingly popular instrument of regulation throughout the world. Recent studies (e.g. Hibiki and Managi, 2011, 2010; Canon-de-Francia, Garcesayerbe, and Ramirez-Aleson, 2008) have started to analyze the impact of Pollutant Release and Transfer Registers (PRTRs) outside the US, its country of origin. The idea to use information disclosure as a regulatory approach stems from the Anglo-Saxon political tradition of the freedom of information. With the implementation of the Toxics Release Inventory (TRI) in 1989, which provides site-level data on emissions, this idea became a new paradigm in environmental regulation (Sunstein, 1999) and led Tietenberg (1998) to classify it as the third wave of environmental regulation, adding to the previously prevailing concepts of command and control and market-based instruments. As the firms' polluting behavior is generally unknown to the public, the obligation to disclose information aims at reducing information asymmetry in the market, thereby increasing efficiency. In particular, the publication also addresses the gap between corporate reporting and stakeholder demands (Gouldson and Sullivan, 2007).

The TRI is thought to be causal for a reduction in US-American emissions of 45 percent (Koehler and Spengler, 2007). Moreover, Hamilton (1995) and Khanna, Quimio, and Bojilova (1998) find that capital markets show a significant reaction to the TRI publications leading to the view that. (Konar and Cohen, 1997) find that firms with large stock price decline subsequently reduced emissions and conclude that the TRI is an effective measure. As a consequence, today, this approach enjoys great popularity across the world. Also in Europe, a similar platform has been installed: On February 23, 2004, the first data of the European Pollutant Emission Register (EPER) was released to the public. While most empirical studies focus on the US-American TRI, we provide one of the first analyses of the effectiveness of transparency as a regulatory instrument in continental Europe. This is of particular interest, as the importance of environmental protection is much more present in the German society in the 21st century as opposed to its US-American counter-

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part in the late 1980s. In 1989, when the TRI was implemented, the environmental regulatory system was in an early stage of its development allowing the TRI to fill an important gap (Kraft, Stephen, and Abel, 2011). In contrast to this, at the beginning of the 2000s, when the EPER was put into operation, the regulatory system was generally much more developed, particularly in Germany. According to the GDP per capita weighted Environmental Regulatory Regime Index (ERRI), Germany was ranked among the top five high-income countries (GDP per capita $\geq$ \$35,000) whereas the US occupied the bottom rung. Hence, our data allows us to answer the question, to what extent the provision of information remains a powerful regulatory tool in the context of a stronger regulatory framework. Does such a setting induce stronger reactions to the provided information (due to stronger preferences for a clean environment reflected by the stronger regulation) or are market reactions weaker (as there is less value added in an already well-informed public)?

We base our analyses on the first two EPER waves (2001 and 2004). Applying an event study approach based on a Multivariate Regression Model (MVRM), we show that firms listed in the EPER loose market value in both years after the publication. We then run a large set of estimations to identify drivers of the observed devaluation. Our results show that market reactions can be explained by the reported emission levels if firms do not provide environmental reports - and when excluding carbon dioxide.

The remainder of the paper is organized as follows. Section 2 summarizes the related literature. Section 3 describes the data set and provides the empirical specification as well as the research hypotheses. Section 4 reports the results of our analyses including some robustness checks. In Section 5 we discuss the conclude.

2 Related Literature

2.1 Disclosure of environmental information as a regulatory instrument

Since environmental pollution was identified as a negative external effect, ideas have been suggested to recover efficiency. The regulation of polluting emissions can be grouped into three categories: command and control instruments, market-based instruments and information disclosure strategies. The classic command and control approach uses quantitative restrictions (e.g. emission limits or technological standards) in combination with fines for non-compliers. From a current point of view of environmental economics these instruments should be seen skeptical. Tietenberg (1998) points out that this results mainly from their inefficiency and ineffectiveness regarding costs. With respect to economic aspects market-based instruments are favorable. Here, only qualitative goals are determined by the regulator, but not how to achieve these. Market signals induce the regulatory outcome (e.g. emissions trading).

The third wave is characterized by quasi-regulatory instruments. Tietenberg (1998) defines environmental disclosure strategies as "public and/or private attempts to increase the availability of information on pollution to workers, consumers, shareholders and the public at large". This form of regulation tries to regulate through non-traditional players (e.g. the public opinion). Information disclosure strategies can substitute classic instruments of regulation as well as be used simultaneously.

In the absence of traditional regulation, information disclosure shall create market-based incentives for better ecological performance. Through these market forces the affected economic subjects shall self-regulate their pollution level in a way traditional regulation cannot achieve. According to Delgado-Ceballos, Kassinis, and Aragon-Correa (2009), pressure on polluting firms shall be created by different stakeholders, such as investors, consumers and Non-Governmental Organizations (NGOs), which are provided with the emission information of each facility and firm.

2.2 Pollutant Release and Transfer Registers

A Pollutant Release and Transfer Register (PRTR) is defined by the OECD (2001, p.12) as "a database or register of chemicals released to air, water and land, and wastes transferred off-site. Based on a list of priority chemicals, facilities that released one or more of the listed chemicals report periodically - usually annually - on the amount of released and/or transferred and to which environmental media. Reported data are then made available to the public". On a more abstract level, the goals of PRTRs are the promotion of the "right-to-know" premise, the monitoring of environmental policy as well as the support of the reduction of emissions and risks (Kerret and Gray, 2007). According to Tietenberg (1998), there are four functions a PRTR has to incorporate. PRTRs shall help to detect environmental risks and collect reliable information about them. Furthermore, this information has to be disseminated to those who are exposed to the risks of the pollution. Additionally these private or public agents have to have the possibility to use the information to put pressure on the emitting subjects. Blackman, Afsah, and Ratunanda (2004) propose a fifth element on the basis of their empirical analysis. This element is the information distribution to the polluter itself. This could create an audit effect and shed light on previously unknown room for improvement.

One important fact for the regulator is that information disclosure programs are generally thought to cost less than other regulatory instruments, especially since new information technologies (both hardware and software) facilitate the dissemination of environmental information. Furthermore, information disclosure programs serve an important social function - as they satisfy the "right-to-know" paradigm with respect to third-party pollution - making them politically more acceptable. As a consequence, in more and more countries information disclosure strategies are applied as environmental regulation.

2.2.1 US-American TRI

The best-known PRTR is the TRI, which was implemented in the USA at the end of the 1980s. The legal foundation of the TRI is the Emergency Planning and Community Right to Know Act (EPCRA) (Arora and Gangopadhyay, 1995). The US Congress passed the law as a consequence of the environmental catastrophe of Bhopal, India. This catastrophe had fatal effects of both the environment and population. Due to the EPRCA all industrial facilities needed to report annually about release and transfer of over 320 chemicals.

Cohen (2001) states that the TRI program led to a significant voluntary decrease in the total amount of TRI-listed chemicals released in the USA. According to their estimations, the total on- and off-site releases and transports between the years 1988 and 1999 were reduced by 45 percent.[1] However, one has to bear in mind, that the reduction of toxic releases is not connected with a reduction of the production of toxics, but instead with a development towards the recycling of these substances (Dasgupta, Wang, and Wheeler, 2006). Therefore it cannot be concluded that a conversion to safer or less harmful toxics was realized. Nevertheless, the TRI is widely viewed as a success and has been copied throughout the world.

Kerret and Gray (2007) compare emissions reductions after the implementation of the TRI in different commonwealth countries. They find that in no other country such significant and constant emission reductions could be realized as in the US. According to Kerret and Gray, this can be explained by different characteristics as well as by differing prerequisites in the countries. However, we can think of an alternative explanation. The impact might also be reduced due to improved environmental regulation by the time the PRTRs were installed outside the US.

2.2.2 European Pollutant Emission Register

The basis for the public access to pollution registers in Europe is the European Council Directive 96/61/EC, concerning Integrated Pollution Prevention and Control (IPPC) (Canon-de-Francia, Garcesayerbe, and Ramirez-Aleson, 2008). In this directive there are basic requirements defined which industrial and agricultural facilities have to meet. Goal of this directive is the achievement of a high environmental level in the European Union. Companies are also obliged to disclose information about their emissions in the European Pollutant Emission Register (EPER). The final Decision 2000/479/EC by the Commission was made on July 17, 2000.

[1] Originating in the TRI, additional voluntary emission reduction programs were implemented, such as the 33/50-program.

Every three years, the EPER publishes new information on the releases of 50 chemicals, which are divided into five categories: Environmental themes, metals and compounds, chlorinated organic substances, other organic compounds and other compounds. Out of these 50 chemicals 37 are air and 26 are water emissions. The disclosure of the pollution data requires the excess of specific thresholds. But these thresholds do not represent emission limits whose violation will be fined. The German emission data for 2001 and 2004 are available at http://www.home.eper.de.[2] According to the **?** this website shall give all stakeholders the possibility to browse and use the register. But not all industrial facilities have the duty to report their emissions. Only the facilities which perform activities of annex 1 of the IPPC-Directive are integrated. There are 56 activities reported in the EPER, which are divided in six categories (Energy industry, Production and processing metals, Mineral industry, Chemical industry and chemical installations, Waste management, Other activities).

2.3 Previous research

Different studies have analyzed the reactions of the (financial) market to the disclosure of environmental information. Most of them used data from the US.

The study of Hamilton (1995) represents the first analysis of the effectiveness of environmental information disclosure as a regulatory instrument. The study considers 436 firms listed on the stock exchange. At the day of publication of the TRI data from the year 1987 on June 19, 1989, Hamilton identifies a significant average abnormal return of -0.3 percent. In monetary terms, the loss was $4,1 million per firm. Furthermore, Hamilton finds that the higher the emissions of each company the more probable is the publication of articles in print media. Hence, he finds evidence that the released information is indeed news to investors and journalists. Put differently, the hypothesis can be accepted, that the TRI functions as a source of environmental information for economic markets.

Synthesizing Hamilton's work, Konar and Cohen (1997) examine, if negative returns, connected to the publication of the TRI data, are related to the emission

[2] In 2007, EPER was replaced by the European Pollutant Release and Transfer Register (E-PRTR).

reductions of the concerning firms. Hence, they test whether behavioral changes can be observed as reaction to the disclosed information. Konar and Cohen find that the companies with the highest negative abnormal returns subsequently reduced their TRI emissions more than other firms in their respective industries (including firms with the highest level of revenue weighted TRI emissions). They can also show that these firms had a lower likelihood of receiving large fines from the government in subsequent years. Summarizing, the study of Konar and Cohen strengthens the hypothesis, that the pressure of financial markets is an incentive for firms to increase their environmental performance.

Khanna, Quimio, and Bojilova (1998) study the long-term effectiveness of the TRI. In particular, they investigate the effect of repeated disclosure of environmental information, looking at firms from the chemical industry over a period of six years (1989 - 1994). In their sample, abnormal returns are insignificant in the fist reporting year (1987) and significant in the subsequent years. Moreover, they find that the decrease of environmental performance was followed by statistically significant negative abnormal returns at the stock market. These abnormal negative returns also had an impact on the firms' behavior.

In a more recent contribution to the literature, Ferraro and Uchida (2007) analyze stock market reactions after the first publication of the Japanese PRTR. Withal they could not identify significant negative abnormal returns, also when restricting to the top 50 polluters regarding total emissions. Hence, they reject the hypothesis of negative abnormal returns as a reaction to the publication of the Japanese PRTR. The authors explain the differences as opposed to the TRI with a lack of media presence as well as the absence of public pressure, normally created by NGOs. It can be summarized that the success of the TRI is not easily transferable to other countries due to differences in institutions, cultural norms and interests.

Canon-de-Francia, Garcesayerbe, and Ramirez-Aleson (2008) analyze the effectiveness of the Spanish EPER. As in our paper, they use a MVRM to estimate the abnormal returns. According to their estimations, the information provided in the EPER has a significant negative impact on the listed firm's market value. Furthermore, they find evidence that companies with higher emissions show also higher significant negative abnormal returns. As explanation the authors suppose,

Table 1: Event studies of PRTRs

Authors	Register	Year (Disclosure)	Method	Estimation window	Event window	Abnormal returns
Hamilton (1995)	TRI (USA)	1987 (1989)	traditional	(-115,-15)	-1	0.001%
					0	-0.284%***
					(0,5)	-1.200%***
Konar and Cohen (1997)	TRI (USA)	1987 (1989)	traditional	(-250,-10)	-1	-0.033%
					0	-1.324%***
					(0,5)	-1.113%***
Khanna et al. (1998)[1]	TRI (USA)	1987 (1989)	traditional	(-110,-10)	0	-0.144%
					1	0.184%
					(0,1)	-0.329%
					(0,5)	-0.406%
Ferraro and Uchida (2007)	PRTR (Japan)	2001 (2003)	traditional	(-117,-18)	0	0.023%
					1	-0.195%
					(0,5)	2.069%***
Canon-de-Francia et al. (2008)	EPER (Spain)	2001 (2004)	MVRM	(-250,19)	-1	-0.14%
					0	0.26%
					1	-0.28%***
					(-1,+1)	-0.16%

Note. "Year" reports the year in which the data was collected; year of data disclosure is given in parentheses.
"Estimation window" describes the interval at which the market model was calibrated.
"Event window" describes the interval or point in time for which abnormal returns were captured.
Points in time are given as days relative to the first day of trading after the event occurred.
[1] Khanna et al. (1998) only analyzed firms in the chemical industry; in the paper also the abnormal returns for the reporting years 1988-1992 are available which are mostly significant.
* Significant at the 10% level. ** Significant at the 5% level. *** Significant at the 1% level.

that investors imply a lack of future competitiveness in contrast to companies with lower emissions.

Table 1 summarizes the different event studies that analyze stock market reactions to the disclosure of emission registers.

3 Data and Empirical Specification

3.1 Identification of Abnormal Returns

We apply an event study to identify the influence of environmental information on market value. This method has been established as the standard approach to capture market reactions to events or publications (Binder, 1998). Identification rests on the assumption that stock price developments follow a market model.

Given this assumption, systematic deviations from the "normal" price development can be attributed to the event or information release occurring associated with this day (Brown and Warner, 1980). Hamilton (1995) was one of the first to stress that this method, which originally stems from the field of finance, is also suitable to evaluate effectiveness of regulatory instruments.

Identification rests on the assumption of an efficient market in the sense of Fama (1970).[3] Based on this assumption, share prices reflect the current value of future cash flows. Moreover, the observed return at day t of share i (R_{it}) consists of an idiosyncratic part (α_i), a part that hinges on the average market return (R_{mt}) and a random error term with mean zero (u_{it}).

$$R_{it} = \alpha_i + \beta_i R_{mt} + u_{it} \tag{1}$$

On the day of the event, we allow for abnormal returns that are captured by a dummy variable D_{0t} which takes the value of 1 on the day after publication of the information. According to McWilliams and Siegel (1997), the effect of the event can also affect days close to the event itself (while the applied time window should not be too large to avoid the influence of disturbing effects). Hence, to allow information leaks on the day before as well as delayed information processing on the day after, we include two more dummies D_{-1t} and D_{1t} that are set to 1 on the preceding and following day respectively. In doing so, the dummy variable captures any significant deviation on the respective day. Put differently, we extract the systematic component of u_{it} to restore a zero mean error term. A large number of studies have been published based on this identification strategy. Most early studies used simple panel models with a firm independent dummy for abnormal returns (e.g. D_0), which is now known as the traditional approach. However, the method has been refined in the last years. In particular the work of Binder (1985) has helped to establish the Multivariate Regression Model (MVRM): To allow for heteroscedasticity across firms, the MVRM consists of n stacked equations, according to the number of firms in the sample, with firm specific dummy variables, yielding the following set of GLS equations:

[3] There are also alternative models for stock prices, e.g. the capital asset pricing model. However, the chosen market model is still the most commonly used approach (see e.g. Campbell, Lo, and MacKinlay, 1997; Binder, 1998).

Table 2: Sample distribution by sectors

Sector	NACE Kode WZ 2003	Number of firms in sample		Number of facilities in sample	
		2001	2004	2001	2004
Total amount		38	36	156	161
Food, drink and tobacco	DA	5	4	21	12
Paper and print	DE	1	1	6	4
Chemicals	DG	9	10	35	32
Petrochemicals	DH	1	0	2	0
Cement, glass and ceramics	DI	6	5	12	19
Metallurgy and manufacturing of metal articles	DJ	2	3	4	18
Mechanical engineering	DK	1	1	2	1
Electrics and electronics	DL	3	1	29	1
Vehicle manufacturing	DM	4	5	7	18
Energy and water production and distribution	EA	6	6	38	56

$$\begin{aligned} R_{1t} &= \alpha_1 + \beta_1 R_{mt} + \textstyle\sum_{a=-1}^{1} \gamma_{1a} D_{at} + u_{1t} \\ R_{2t} &= \alpha_2 + \beta_2 R_{mt} + \textstyle\sum_{a=-1}^{1} \gamma_{2a} D_{at} + u_{2t} \\ &\dots \\ R_{nt} &= \alpha_n + \beta_n R_{mt} + \textstyle\sum_{a=-1}^{1} \gamma_{na} D_{at} + u_{nt} \end{aligned} \tag{2}$$

We choose the same estimation time window as in Khanna, Quimio, and Bojilova (1998), letting t run from 110 up to 10 trading days before the publication of the EPER. For market values of the emitting firms we use firm i's daily closing prices (P_{it}) at the Frankfurt stock exchange. Further, we use quotations of the German Stock Index (DAX) as measure for the average market performance. To get daily stock market returns on day t, we take differences of the corresponding logged quotations.[4]

$$R_{it} = logP_{i,t} - logP_{i,t-1} \tag{3}$$

We restrict the sample to those firms listed on a German stock exchange[5], with

[4]An alternative approach would be the calculation of the discrete return using $R_it = \frac{P_{it}-P_{i,t-1}}{P_{i,t-1}} = \frac{P_{it}}{P_{i,t-1}} - 1$ which is, however, hardly used in event studies. Moreover, Henderson (1990) points out that both approaches yield similar results.

[5]We use data from the Frankfurt Stock Exchange.

headquarters in Germany, which also appeared in the EPER. Further, it is important to exclude confounding effects like the declaration of dividends, release of a new product, announcement of an impending merger, or of unexpected earnings (McWilliams and Siegel, 1997). The stock quotations are corrected for mergers, dividends and splits. We checked for further events in the Lexis-Nexis database and excluded those firms with potentially confounding events during the event window, leaving us with 38 and 36 observations, in 2001 and 2004 respectively.

3.2 Drivers of Abnormal Returns

In a second step we want to identify drivers of the observed market reaction. Therefore, we regress all significant dummy coefficients (γ_{ia}) on the observed emission levels and a set of additional regressors.

As our source of environmental information, we use data from the European Pollutant Emission Register (EPER). European firms are obliged to report their emissions of 50 different pollutants whenever they exceed a certain threshold. Our data contains two waves, 2001 and 2004. In 2001, a total number of 1863 sites reported their emissions while in the second wave, 1686 facilities submitted the respective values to the European authorities. The EPER provides information on emissions in kilograms, reported for each plant and substance. Hence, we need to do some transformations to receive a meaningful measure. First, we weigh the emissions with the inverse of the reporting threshold to receive emission levels that are comparable across substances (as suggested by King and Lenox, 2001).[6] As the data is given on plant level we also aggregate the data over all substances s and all plants p to receive firms i's cumulative weighted emissions in year y (e_{iy})

$$e_{i,y} = \sum_{\forall p} \sum_{\forall s} w_s * e_{psi,y} \tag{4}$$

where w_s represents the relative toxicity of the polluting substance s, and $e_{psi,y}$ captures the emission of substance s on plant p for firm i in year y. Moreover, we believe that carbon dioxide (CO2) represents a special case of a pollutant. As

[6]E.g., the threshold for CO2 emissions is 100,000,000 kg per year. As a consequence, the corresponding weight is 1/100,000,000.

a consequence, we capture (similarly weighted) emissions of this substance in the variable $CO2$. We also control for size effects. As production levels are not reported in the German EPER, we use sales in year y ($sales_{i,y}$) as a proxy. The sales data is taken from the annual reports. When data was unavailable the respective firms were dropped. To allow for industry effects, we also include information on the firm's sector, captured by the NACE code which is reported in EPER (see Table 2). We include a sector dummy for all sectors with at least two firms.

Summarizing, our equation for abnormal returns after the publication of the first wave of EPER data includes emissions levels (e_i and CO_i), turnover level ($sales_i$), a dummy for environmental reports (ER) with interaction effects and a set of sector dummies (D_s).

$$AR_{ia,2001} = \hat{\gamma_{ia,2001}} = \beta_0 + \beta_1 e_{i,2001} + \beta_2 CO2_{i,2001} + \beta_3 sales_{i,2001} + \beta_4 ER + \sum_S \delta_s D_s + \mu_i \tag{5}$$

The abnormal returns on day a in year y stem from the previous regression and are thus equal to $\hat{\gamma_{ia,y}}$. In this regression, identification requires the level of e_i to be informative to the market. However, it is possible that the market reactions will include the expected value of e_i in their former valuation of the firm. Hence, only the difference between actual and expected emissions should be treated as news. We can test this hypothesis using emissions levels of 2001 as a proxy for expected emissions in 2004. Hence, we run the following regression where we take differences of emissions and sales and keep the previous dummy variables to allow for sector time trends.

$$AR_{ia,2004} = \hat{\gamma_{ia,2004}} = \beta_1 \Delta e_i + \beta_2 \Delta CO2_i + \beta_3 \Delta sales_i + \beta_4 ER + \sum_S \delta_s D_{s,y} + \mu_i \tag{6}$$

where $\Delta e_i = e_{i,2004} - e_{i,2001}$, $\Delta CO2_i = CO2_{i,2004} - CO2_{i,2001}$ and $\Delta sales_i = sales_{i,2004} - sales_{i,2001}$.

3.3 Research Hypotheses

The assumption of efficient capital markets leads to the hypothesis that new, unexpected information may cause abnormal changes in the stock prices (Fama, Fisher, Jensen, and Roll, 1969). In addition to this, Porter and Van der Linde (1995) argue that high pollutions of companies can be seen as inefficiencies and therefore lead to a lack of innovation and competitiveness in the future - which is in turn reflected in the current stock price of the firm. These processes were empirically verified for example by Hamilton (1995). He points out, that the first publication of the TRI data led to negative abnormal returns of the listed firms. Canon-de-Francia, Garcesayerbe, and Ramirez-Aleson (2008) confirm this hypothesis for the Spanish data of the EPER. Khanna, Quimio, and Bojilova (1998) examine additional to the first publication following periods. They could verify that repeated disclosure of environmental information leads to significant negative abnormal returns, although the reaction to the first publication was not negative. Hence, we formulate the following first hypothesis for the German data of the EPER:

H1. The publication of the EPER produces negative abnormal returns in the share price of listed firms.

Also, the pollution level has an influence on the perception of the competitiveness of firms. As Lanoie, Laplante, and Roy (1998) as well as Khanna, Quimio, and Bojilova (1998) argue, the higher the pollutions the lower is the stream of profits that a firm is expected to earn in the future, which is represented by the stock prices. Thus the costs of environmental liability for contamination caused by emissions are uncertain, because there is uncertainty about the occurrence of environmental damages of being held liable for those damages. Furthermore Canon-de-Francia, Garcesayerbe, and Ramirez-Aleson (2008) show in their analysis of the EPER, that the negative abnormal returns are related to the relative level of firms‘ emissions. Ajar to this result, the second hypothesis H2 states:

H2. The first publication of the EPER induces greater negative abnormal returns, the greater the level of (toxicity weighted) pollution.

As mentioned above Khanna, Quimio, and Bojilova (1998) analyze the repeatedly publication of environmental information through the TRI. They examine that stakeholder used these information as a tool to benchmark the companies' performance over several years. Hypothesis H3 is formulated out of this insight:

H3. Listed firms get punished with negative abnormal returns if their emissions increase from 2001 to 2004 and rewarded with positive abnormal returns respectively if their emissions decrease.

4 Results

Tables 3 and 4 present the estimated abnormal returns for the Multivariate Regression Model (MVRM) as described in (2). As in Canon-de-Francia, Garcesayerbe, and Ramirez-Aleson (2008), we assign day 0 of the event to the first day on which the information on the new EPER data appeared in the press: Feb 24, 2004 and Nov 24, 2006, respectively.[7]

Table 3: MVRM estimates for 2001

Day (a)	Date	Average Abnormal Return ($\hat{\gamma_a}$)	Test Statistic H_0:$\gamma_a = 0$
-1	02/23/2004	0.05%	F(38,99)=0.80
0	02/24/2004	-0.07%	F(38,99)=1.11
1	02/25/2004	-0.31%	F(38,99)=1.92***

Window	Dates	Average Abnormal Returns ($\sum\hat{\gamma_a}$)	Test Statistic H_0:$\sum\gamma_a = 0$
(-1,+1)	02/23/2004-02/25/2004	-0.32%	F(1,99)=0.19

*** Significant at the 1% level.

In particular, we present four different estimates for each year. First we estimated the abnormal returns on the three days of interest and, in addition to

[7] Note that this notation slightly differs from the literature on the TRI, where day 0 marks the day of the publication of the data.

that, also test whether the cumulated abnormal returns are different from zero. The results show significant abnormal returns which makes us accept **H1** for both waves.

Table 4: MVRM estimates for 2004

Day (a)	Date	Average Abnormal Return ($\hat{\gamma_a}$)	Test Statistic H_0:$\gamma_a = 0$
-1	11/23/2006	-0.33%	F(36,99)=1.32
0	11/24/2006	-0.25%	F(36,99)=2.57***
1	11/27/2006	-0.61%	F(36,99)=1.07

Window	Dates	Average Abnormal Returns ($\sum \hat{\gamma_a}$)	Test Statistic H_0:$\sum \gamma_a = 0$
(-1,+1)	11/23/2006-11/27/2006	-1.20%	F(1,99)=4.03**

***/**/* Significant at the 10/5/1% level.

Moreover, the results contain two additional effects. First, in 2001, the effects are less strong and are insignificant in the three day interval. Second, market reactions seem to be faster when the EPER data are published for the second time. Summarizing, the second publication of EPER seems to have caused both more immediate and more intense reactions. This finding is in line with the results of Khanna, Quimio, and Bojilova (1998) who report a similar effect for the TRI. The abnormal returns are, however, generally of slightly smaller size when compared to their US counterparts.

Next, we test the second hypothesis and estimate equation (5) for the significant abnormal returns in each data wave. We test different models. First, we restrict the model to emissions only, separated into $CO2$ and the remaining substances (e_i). Then, we subsequently add $sales_i$, sector dummies ($Sectors$), a dummy for environmental reports (ER) and its interaction effects with emissions. The richest model has the highest explanatory power and significant coefficients for the reported level of emissions (see table 5). The interaction term of emissions with the provision of environmental reports is highly significant, meaning that the effect of the public register is different for firms that provide voluntary reporting. In fact, we see that for these firms the emissions reported in EPER do no longer affect abnormal returns (F-test, $F(1,9)=3.31$, $p>0.10$). With respect to $CO2$ emissions, our results suggest that they are not necessarily a bad signal for the market. With the introduction of the European Emissions Trading Scheme (EU-ETS), firms were endowed with large numbers of certificates. The market for carbon thus might serve as destigmatization while at the same time it does not lead to high costs for the firms. We cannot rule out, however, that $CO2$ partially captures production size and thus might lead to a biased estimate. In fact, the insignificance of $sales$, our intended proxy for size, even supports this view. Summarizing, we can confirm **H2**, but only for pollutants other than CO2, and only for firms that had not provided an environmental report before.

In a last step, we check H3 and estimate equation (6). The results point in a similar direction as the previous findings. Apart from CO2, emissions induce negative abnormal returns if firms do not provide environmental reports themselves (see Table 6). For firms that do provide these reports, the effect of the change in EPER emissions, measured as the sum of the two relevant coefficients, looses significance (F-test, $F(1,8)=4.47$, $p>0.05$). Hence, corporate environmental reports seem to serve as a substitute for the public pollutant register, neutralizing the effect of the latter. In the case of $CO2$, we see a positive impact, independent of environmental reports. This hints to a special role of CO2 in this context. Again, however, the interpretation of this coefficient should be treated with care. Given the lack of significance of $sales$, $CO2$ might simply pick up variation in the production levels. In summary, we conditionally accept **H3** for all non-carbon emissions and firms without additional voluntary environmental reporting.

4.1 Robustness Checks

While most event studies just report a single estimation window - often without further justification - we offer an innovative robustness check. We systematically vary the window size and thus provide a much broader set of estimates. In Tables 7 and 8 in the appendix, we provide the p-values for estimation windows from 50

Table 5: Drivers of the abnormal returns (2001)

	(1)	(2)	(3)	(4)
e_i	-1.00	-1.04*	-3.670**	-4.28***
	(0.177)	(0.096)	(0.028)	(0.000)
$CO2$	2.73	2.26	3.85	5.99
	(0.403)	(0.305)	(0.451)	(0.729)
$sales_i$		1.21	3.29	-2.03
		(0.792)	(0.629)	(0.574)
$e_i * ER$				11.10**
				(0.016)
$CO2 * ER$				-14.60
				(0.470)
ER				0.002
				(0.787)
Sectors	no	no	yes	yes
Constant	-0.003	-0.003	0.001	-0.0004
	(0.417)	(0.458)	(0.708)	(0.958)
R-squared	0.0076	0.0080	0.2533	0.3256
N	38	38	38	38

Note. Dependent variable is $gamma =_{1,2001}$.
Standard errors clustered at sector level; p-values are in parentheses.
***/**/* Significant at the 1/5/10% level.

to 250 days before the event occurred. The picture strengthens the impression that the effect of the first publication of EPER is less robust than the second publication which survives all window sizes. Moreover, it demonstrates the limitations of event studies, as for too small estimation windows, we get significant coefficients for nearly all days observed.

In a second robustness check, we studied a possible extension to the market model in (1), allowing the oil price to matter for stock market quotations. The results do not change substantially, the main results survive. Further, we re-estimated equations (5) and (6) for each sector separately which also yielded similar

Table 6: Explaining abnormal returns by changes in emissions

	(1)	(2)	(3)	(4)
Δe_i	1.40**	1.34*	2.50***	-12.75***
	(0.047)	(0.082)	(0.000)	(0.008)
$\Delta CO2$	13.60	19.30	19.20	25.01***
	(0.510)	(0.471)	(0.101)	(0.003)
$\Delta sales_i$		-1.26	-1.96*	-2.15
		(0.361)	(0.091)	(0.176)
$\Delta e_i * ER$				13.07***
				(0.008)
$\Delta CO2 * ER$				-6.74
				(0.748)
ER				0.003
				(0.591)
Sectors	no	no	yes	yes
Constant	-0.0001	-0.0002	-0.004	-0.0004
	(0.978)	(0.952)	(0.551)	(0.568)
R-squared	0.0286	0.0318	0.5132	0.6009
N	32	32	32	32

Note. Dependent variable is $\gamma_{0,2004}$.

Standard errors clustered at sector level; p-values are in parentheses.

***/**/* Significant at the 1/5/10% level.

results.

5 Conclusion

Our results provide new insights into the effects of the public provision of environmental information. In particular, we can present evidence that a pollutant release and transfers register still matters today - even in countries with high levels of environmental regulation. Further, our data show that carbon emissions are treated differently by the stock market, suggesting that the installation of a market for emission allowances, like the EU-ETS for carbon, might crowd out public interest in the traded good. Moreover, we could show that environmental reports can serve as a substitute for the public register. If firms voluntarily provide such reports, changes in emission levels published in EPER can no longer explain abnormal returns. This suggests that the information provided in environmental reports was seen to be sufficient by investors, thereby reducing the impact of the public register. In summary, however, EPER seems to be an effective instrument. In 2007, EPER was replaced by a new European register, E-PRTR, which provides yearly reports and covers an extended number of firms and pollutants, thereby offering further research opportunities.

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A Appendix: Robustness check data

Table 7: Abnormal returns in 2001, p-values

	$\gamma_{-1,2001}$	$\gamma_{0,2001}$	$\gamma_{1,2001}$	$\sum_{-1}^{1} \gamma_{-1,2001}$
(-50,-10)	1.20e-08	4.48e-08	8.54e-09	.450891
(-60,-10)	2.02e-11	1.91e-12	1.13e-23	.6072292
(-70,-10)	.0598362	.0145771	9.09e-11	.8909603
(-80,-10)	.2091059	.0389231	2.53e-07	.827836
(-90,-10)	.6356966	.2116899	2.98e-07	.8340944
(-100,-10)	.6644117	.2329448	.000049	.8055787
(-110,-10)	.8171702	.3487436	.0018378	.6793579
(-120,-10)	.8006431	.6225821	.0194071	.6983867
(-130,-10)	.7735217	.7973409	.0501972	.6497523
(-140,-10)	.8672028	.7348984	.0522307	.6006724
(-150,-10)	.8252246	.760308	.0676052	.5960792
(-160,-10)	.8127792	.8655134	.0538861	.57134
(-170,-10)	.8079769	.8726592	.0848965	.5690038
(-180,-10)	.8289992	.8966409	.1334073	.5646787
(-190,-10)	.8760175	.8739314	.1107719	.5396393
(-200,-10)	.8725137	.9215527	.2273415	.5416952
(-210,-10)	.9221516	.9234356	.2963669	.5429159
(-220,-10)	.9380672	.9402381	.2968925	.5075682
(-230,-10)	.9517484	.942132	.281509	.6508514
(-240,-10)	.9543974	.93439	.2974297	.6666317
(-250,-10)	.9603083	.94337	.2749454	.6629117

Note. First column contains estimation window. The subsequent columns contain p-values for the hypothesis that the estimated abnormal returns are equal to zero.

Table 8: Abnormal returns in 2004, p-values

	$\gamma_{-1,2004}$	$\gamma_{0,2004}$	$\gamma_{1,2004}$	$\sum_{-1}^{1}\gamma_{-1,2004}$
(-50,-10)	4.68e-10	3.82e-21	1.20e-17	.0037918
(-60,-10)	1.01e-06	8.35e-10	7.54e-08	.0109501
(-70,-10)	7.59e-06	1.03e-06	.0000337	.0089519
(-80,-10)	.0029411	.0001041	.0014542	.0028617
(-90,-10)	.0029411	.0001041	.0014542	.0028617
(-100,-10)	.215067	.0001686	.0066541	.0204713
(-110,-10)	.1697567	.0001705	.0288917	.0566581
(-120,-10)	.2087325	.0004199	.0729503	.1165944
(-130,-10)	.2792337	.0017748	.0863231	.2127319
(-140,-10)	.3585194	.0067394	.110714	.4991585
(-150,-10)	.317761	.0069464	.1992936	.4636408
(-160,-10)	.4500583	.0148086	.2324958	.4260968
(-170,-10)	.7002058	.0166454	.214616	.3945487
(-180,-10)	.8081755	.0192828	.3716203	.3730198
(-190,-10)	.8403016	.0252759	.3647323	.366814
(-200,-10)	.8293191	.0734079	.3633097	.3267645
(-210,-10)	.8298257	.0485298	.347829	.3144028
(-220,-10)	.8422295	.0342808	.4143885	.2982365
(-230,-10)	.9001778	.0320569	.3680477	.2770736
(-240,-10)	.9128671	.0282849	.3444621	.2757701
(-250,-10)	.8984343	.022841	.3017932	.2722521

Note. First column contains estimation window. The subsequent columns contain p-values for the hypothesis that the estimated abnormal returns are equal to zero.