Alternatives from policies of disclosure of companies' environmental performance and connections with the reduction of information asymmetry and signaling

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Abstract

Regulatory stakeholders force companies to publish their emissions to society through pollutant releases and transfer registers like the EU EPER and US TRI. Governments aim to reduce environmental information asymmetry between firms and community and send signals to the rest of the stakeholders in order to decrease installations' chemical emissions. However, these efforts to reduce this information asymmetry are not effective and sufficient whether these inventories are reported only on this way. From a managerial point of view, environmental responsible firms may have an incentive to present their information or recalculation of these registers because they can better signal their environmental performance. We argue that by doing a new approach the information asymmetry is further reduced and, therefore, the regulatory stakeholder becomes more effective. From these results a number of implications can be concluded for management, the authorities and research.

Alternatives from policies of disclosure of companies' environmental performance and connections with the reduction of information asymmetry and signaling

Previous literature has repeatedly showed the key importance of government to influence the environmental approach of the firms (Buysse and Verbeke, 2003; Dasgupta, Hettige & Wheeler, 2000; Henriques and Sadorsky, 1996; Regens, Sheldon, and Elliott, 1997). After using the most traditional measures of command-and-control, and the still emerging policies of market-based approaches, governments look now particularly interested in increasing the use of public disclosure of companies' environmental performance to pressure firms to improve their environmental performance (Kerret and Gray, 2007).

Policies of public disclosure of companies' environmental performance are quasi-regulatory instruments, or 'third wave' of environmental regulation (Cohen, 2002; Tietenberg, 1998; Tietenberg and Wheeler, 2001). It is perceived as a "low-cost regulatory option as it does not require formal enforcement procedures" (Wang, 2004: 123). In this type of regulation, the regulatory environment forces companies to report their chemicals emissions and other releases through Pollutant Release and Transfer Registers (PRTRs). The Organization for Economic Co-operation and Development (OECD) defined PRTR as a catalogue or register of releases and transfers of potentially harmful substances to the environment from a variety of sources (OECD, 1996). Several countries have already developed their own Pollutant Release Transfer Registers (PRTR) including U.S. Toxics Releases, Inventory, Canada's National Pollutant Release Inventory (1992), South Korea's Pollutant Release and Transfer Register, Australia's National Pollutant Inventory, Europe's Pollutant Emission Register, Japan's Pollutant Release and Transfer Register.

Literature (Cohen, 2002; Tietenberg 1998; Tietenberg and Wheeler, 2001) claim that the disclosure of installations' environmental emissions pressures companies to improve their environmental performance. The idea behind this policy is that once different stakeholders (shareholders, consumers, environmental groups among others) have information about installations' emissions, their pressure will decrease installations' emissions. In other words, governments try to increase pressure to those companies showing worse environmental performance. In fact, initial evidence shows that installations' emissions disclosure has reduced emissions in different countries (Konar and Cohen, 1997; Tietenberg and Wheeler, 2001; Foulon, Lanoie and Laplante, 2000; Afsah and Vincent, 1997; Blackman, Afsah and Ratunanda, 2000; World Bank, 1999). Although the relevance of the government role to understand the environmental approaches of the firms, and the growing relevance of the policies of public disclosures, so far literature has not analyzed the potential implications of the information emerging from these registers.

Governments, stakeholders and managers are concerned about information from PRTRs. Governments aim to reduce environmental information asymmetry between firms and communities and send signals to markets and society about installations environmental performance. Environmental information asymmetry results when the firms have more information about their environmental practices than the community (Henriques and Sadorsky, 1999; Kullkarni, 2000). Reducing information asymmetry has been delimitated as a legal right in several regulation (e.g. EU European Council Directive 96/61/EC - Integrated Prevention Pollution and Control).

Stakeholders are also concerned by the information provided by these registers as it sends signals about which firms to put pressure on and why. Signaling is a key component of one of the main conceptual streams in the instrumental stakeholder theory (see Jones and Wicks, 1999). The basic premise of instrumental theory is that "if firms contract with their stakeholders on the basis of mutual trust and cooperation, they will have a competitive advantage over firms who do not" (Jones, 1995, p. 404).

PRTRs are also especially important for managers. The extent to which firms respond to stakeholder pressures is a critical concern (Kassinis and Vafeas, 2006; Bansal and Clealland, 2004). The PRTRs' environmental information has showed influence on financial performance of firms (Klassen and Whybark, 1999), the competitiveness and innovation benefits (King and Lenox, 2002; Majumdar and Marcus, 2001), and primary and secondary stakeholder's pressures (Darnall, Jolley and Handfield, 2008; Eesley and Lenox, 2006).

This paper analyzed how governments pressure firms through disclosure environmental information policy. Specifically, it seeks for a better understand about the role of PRTRs in signaling firms' environmental behavior and reducing information asymmetries. In other words, analyze how the way environmental information is presented sends different signals regarding a firm's environmental performance. And, are PRTRs signaling firms' environmental behavior in an accurate way? For this purpose, we are going to test hypotheses that build on the idea whether the use of weighting emissions data and the use of installation's operational dynamics information may possible rank installations more effective. Therefore, send a better signal and reduce the environmental information asymmetry.

In sum, our main contributions are several. We show empirically that in the current model PRTRs signal correctly to installations' ranks. We demonstrate empirically that the use of a weighting scheme and the inclusion of the number of operating hours reduce the information asymmetry and, therefore, PRTRs more effectively signal installations environmental performance.

The paper is organized as follows. We firstly review the literature and develop our research hypothesis. Secondly, we describe the data and methodology. Finally, we present and discuss our results and conclusions.

Theoretical development and research hypotheses

The role of regulatory stakeholders in the diffusion and generation of environmental information

In his seminal work, Freeman (1984) define the concept of stakeholder to include any individual or group who can affect the firm's performance or who is affected by the achievement of the organization's objectives. The stakeholder literature (e.g., Berman, Wicks, Kotha and Jones, 1999; Clarkson, 1995; Freeman, 1984; Henriques and Sadorsky, 1999) has classified stakeholders with identical interests, claims or rights into different categories (e.g., primary and secondary stakeholder) or in different groups (e.g., community stakeholders, regulatory stakeholders, organizational stakeholders, and the media).

Empirical studies (Buysse and Verbeke, 2003, Dasgupta, Hettige & Wheeler, 2000; Henriques and Sadorsky, 1996, Madsen and Ulhøi, 2002) show that pressure from regulatory stakeholders (such as legislative and governments) appears to play the most influential role in various industries and countries. Regulatory pressure can be defined as the extent to which governments can modify a company's operations based on their environmental performance (Delmas and Toffel, 2004). The regulatory environment can affect firms' competitive position (Porter and van der Linde, 1995), firms' financial performance (Hillman and Hitt, 1999; Shaffer, 1995; Williamson, 1979), firms' pollution prevention strategies (Buysse and Verbeke 2003), companies' internal management practices (Delmas and Toffel, 2004), may force a re-evaluation of firms' strategic approaches toward the natural environment (Hart, 1995, Shrivastava, 1995). In fact, there is a high degree of interdependence between a firm's competitive environment and public policy as regulators can alter the size or structure of markets and influence product demand through taxes (Baron, 1995).

Governments and legislatures can employ multiple "carrots and sticks" to pressure companies to improve their environmental performance (Rugman & Verbeke, 1998), and bring about changes in the environmental practices of companies (Dasgupta et al. 2000; Henriques and Sadorsky, 1996). Firstly, governments have the power and capacity to exert criminal enforcement. Breach of law may lead to important penalties, products taken off store shelves and even firm closure. Kassinis and Vafeas (2002) showed that both direct and indirect costs, provoked by environmental regulation are so high that can indeed increase the strategic importance of environmental breaches by firms.

Secondly, legislation authorizes agencies to promulgate and enforce regulations (Delmas and Toffel, 2004). For many years governments have focused mainly on command and control methods- based on pollution limits and technological standards- to exert pressure to companies regarding to their environmental performance. These costly methods were unable to fulfil their established aims (Tietenberg 1985; Tietenberg 1995). Further, governments use market-based incentives (tradable permits, deposit-refunds and performance bonds) to substitute and complement the command and control methods because of it may achieve the same level of environmental protection at significantly less cost (Stavins, 2003; Stewart, 1993).

Finally, regulators also employ environmental information disclosure strategies to modify firms' environmental performance. In this context, regulators play a "facilitator" role rather than a 'coercer' one within this context (Scholz and Gray, 1997) and this option is perceived as a low-cost regulatory one as formal enforcement procedures are not demanded (Konar and Cohen, 1997; Tietenberg and Wheeler, 2001; Foulon et al., 2000; Afsah and Vincent, 1997; Blackman et al., 2000; World Bank, 1999). Tietenberg (1998: 588) define environmental information disclosure strategies as "public and/or private attempts to increase the availably of information on pollution to workers, consumers, shareholders and the public at large". Put simply, this strategy aims to force firms to release environmental information through national registers, called Pollutant Release and Transfer Registers, available through the internet so that society can be aware of installations' emissions.

The U.S. Toxics Release Inventory (TRI) is perhaps the most known example of this methodology based on the use of information as a regulatory instrument. The EPA developed the TRI promoted by the Emergency Planning and Community Right to Know Act of 1986 (also known as Title III of the Superfund Amendments and Reauthorization Act of 1986). Since 1988, the EPA has required all installations that manufacture or process more than 25,000 lb or otherwise use more than 10,000 lb of any listed chemical, more than 600 toxic chemicals, during a calendar year (U.S. EPA, 1999).

In the European context, public access to an inventory of toxic emissions was originally put forward in the European Council Directive 96/61/EC, concerning Integrated Prevention Pollution and Control (IPPC). This was followed by the European Pollutant Emission Register (EPER), which every three years, publishes details of individual emissions of 50 classes of toxic substances. Specifically, the EPER shows installations emissions individually, and it includes all industrial and livestock-sector installations that have acknowledged exceeding the reporting thresholds for one or more of the pollutants listed in European Union Decision 2000/479/CE. These thresholds are not emission limit values, so the data published does not necessarily imply noncompliance with environmental legislation (Cañón de Francia et al., 2007). EPER shows installations emissions individually, it does not aggregate the data, so it makes more difficult to compare them.

Pollutant Release and Transfer Registers background

Before the enactment of such legislation, firms' environmental data (installations' chemicals emissions) were not disclosed publicly. However, pressures from different stakeholders forced greater data availability and disclosure through public policies (Gerde and

Logsdon, 2001). These pressures were mainly based on (1) the willingness to know what was happening within industrial plants and (2) the existence of environmental information asymmetry.

Communities and environmental activists demanded their right to know what was taking place within of industrial plants as a consequence of the disastrous toxic gas leak in Bhopal, India, in December 1984 (Hoffman, 2001). The public right to know encourage the public to influence installations to reduce their emissions through information to exert pressure on facilities (OCDE 2000; OCDE, 2005). As a consequence, governments developed PRTRs driven by the adoption of legislation both on human rights and freedom of access to information (Sullivan and Gouldson, 2007).

Firms' environmental information may be asymmetrically distributed between the firm and the community (Kullkarni, 2000). Information asymmetry results when the firms have more information about their environmental practices than the community. Therefore, workers, consumers and community are only partially aware of installations' environmental behavior (Henriques and Sadorsky, 1999), their health hazards consequences (Henriques and Sadorsky, 1999), their processes impacts (Kullkarni, 2000), and the possibility of harming all parties to an exchange (Akerlof, 1970). In other words, as Henriques and Sadorsky (1996, 381) stated: "Consequently, they will be unable to trade off higher risks for either higher wages or lower prices in an informed way so that the unaided market would not necessarily result in either the right amount or the correct distribution of risk". Even**,** the information asymmetry between a firm and the community may be further reinforced by a firm's desire to act opportunistically (Kulkarni, 2000).

The importance of environmental information disclosure: PRTRS signal installations environmental performance

PRTRS provide essential information to determine firms' environmental performance (Halmiton, 1995), they can have a significant effect on industrial plants' environmental performance (Gouldson, 2004; Joshi, Krishnan & Lave, 2005; Khanna Quimio and Bojilova, 1998; Konar and Cohen, 1997; Maxwell, Lyon, Hackett, 2000; Stephan, 2002; Terry and Yandle, 1997), and firms consider environmental information release as competitively important (Graedel and Allenby, 1995). Bansal and Clelland (2004) show that the information published on PRTRs has an enduring impact on companies as firms perceived as environmental illegitimate will experience increase in unsystematic risk than those seen as legitimate. It also provides information of much greater value in comparative analyses than environmental information publish by the own companies (Sullivan and Gouldson, 2007).

PRTRS send signals to stakeholders and markets about installations environment performance. Signaling theory suggests that key attributes of the firm provide information that shapes the impressions that individuals form of the organization (Rynes, 1991) and can be used to examine firm reputation and its impact on individual behaviors, attitudes, and decision making (Dutton and Dukerich, 1991; Dutton, Dukerich and Harquail, 1994). Firms send signals to spectators and spectators use these signals to form impressions of these firms (Basdeo, Smith, Grimm, Rindova and Derfus, 2006). The more information stakeholders have, the easier it is for them to form impressions about a firm and better able they are to understand the firm's strategy (Smith and Grimm, 1991).

Information, or signal, send by the firm or other stakeholder, can serve as an information-processing shortcut when individuals make evaluations of decisions concerning the firm. For instance, companies that actively comply with environmental regulations signal that they have some degree of interest for the natural environment (Jones and Murrell, 2001), and firms which choose socially responsible actions may signal positive images to higher quality employees (Fombrum and Shanley, 1990). Studies have also shown that consumers are often sensitive to the social performance of companies when making purchasing decisions (Porter and van der Linde, 1995). Researchers (Hall, 1992, Rindova and Fombrun, 1999) claim that favorable stakeholder impressions are valuable to firms because they increase stakeholders' willingness to exchange resources with them.

Stakeholders (consumers, environmentalist groups, financial institutions, insurance companies, and investors) are increasingly using PRTRs data to measure organizations' environmental performance (Toffel and Marshall, 2004). Specifically, *community stakeholders* are concerned about installations' environmental information released by PRTRs because of the consequences for environmental impacts and human hazards. *Community stakeholders* include, among others, geographic communities at large and community groups organized around a political or social cause or interest. The latter may include environmental groups or organizations, which "can mobilize public opinion in favor of or against a corporation's environmental performance" (Henriques & Sadorsky, 1999: 89)—and are especially likely to do so when such performance influences their welfare. So, community stakeholders may pressure firms to improve their environmental performance (Berry & Rondinelli, 1998; Rugman & Verbeke, 1998).

PRTRs rank installations summing annual emissions of substances released by a facility in a given year. Although It may be clear that it is a poor and crude proxy to indicate installations environmental performance (Kleijn, 2001, Lifset 2001) as it depends on various factors as the chemical's characteristics and the medium to which is release (Toffel and Marshall, 2004). Unfortunately, mass media and other stakeholders still apply this approach (Kleijn, 2001). As a consequence, some researchers (Karam, Craig and Currey, 1991; Toffel and Marshall, 2004) argue that in order to measure installations' environmental data, it could be appropriate the use of the weighting emissions data using the each PRTRs standard limits or toxicity estimates so that TRI-based measures more accurately reflect real differences.

Based on the above discussion, the study tests the following hypotheses.

Hypotheses 1: Toxicity-weighted environmental information classifies installations differently than in an absolute environmental pollution terms.

Further information: Operational dynamics

Karam et al. (1991) also claim that other useful adjustments to the data from PRTRs may be done. For example, they suggest including operational dynamics activity by considering number of employees or units produced so that a PRTRs measures more accurately reflect difference. Operational dynamics play a crucial role in order to measure installations' environmental performance (Cairncross, 1992; Hart, 1995; Schmidheiny, 1992), it is essentially related to the "scale" of a facility's (or firm's) operations: the larger it is, the longer the hours of operation, the more it produces and, ceteris paribus, the more it pollutes. Therefore, it is useful to know, not only the total amount of pollution, but also how "efficient" firms are when it comes to the relationship between how large they are and what they produce on the one hand and how much pollution they generate on the other. EPER includes data about installations' number of operating hours and number of employees. Therefore, we can incorporate this data as proxies to analyze an installation's operational dynamics, and test if this further information modifies installations' ranks.

Based on the above discussion, the study tests the following hypotheses.

Hypotheses 2 a: Environmental information expressed in terms that take into account number of employees and toxicity-weighted environmental information may send a more accurate signal to firm management, regulators or market regarding a firm's environmental performance.

Hypotheses 2 b: Environmental information expressed in terms that take into account number of operating hours and toxicity-weighted environmental information may send a more accurate signal to firm management, regulators or market regarding a firm's environmental performance.

Methodology

Sample

To test our hypotheses, we gathered data from the European Pollutant Emission Register (EPER), in its second publication in 2004. Although empirical studies have been conducted on the disclosure of information about polluting firms in the US, there few studies (Cañon-de- Francia et al., 2007; Goudlson and Sullivan, 2006; Sullivan and Gouldson, 2007) in the European context. EPER aims to be a useful tool for researchers, NGO's, and, specially, to the European society who have a right to know about pollution, and a right to get involved in the issues. EPER provides plant-level information on emissions into the air and water (directly and indirectly) from 17 countries (EU15, Norway and Hungary), 50 pollutants (description sheets on environmental and health risks), and 56 industrial activities. It covers 12, 000 large and medium-sized industrial plants which are listed in and which exceed specified emission thresholds (see Annex I of the IPPC Directive; Annex A3 of the EPER Decision).With respect to the accuracy of the data, the quality of the EPER emissions data has been checked at local, regional and national level before the data were included in EPER.

We restrict our analyses to the chemical industry (Two-digit SIC 28 – U.S.; NACE: 24 – Spain) and the energy industry (Two-digit SIC 49 – US; NACE 11 - Spain) in Spain for a number of reasons. First, among installations disclosing their emissions releases there is a clear prejudice towards these two industries as they employ more toxic materials and, therefore, they releases mores emissions to the natural environment (Kassinis and Vafeas, 2008; King and Lenox, 2001). Second, Spanish installations provide supplementary information (i.e. parent company, number of employees, number of operating hours in year and production volume) as installations from other European countries do not report any supplementary information. Third, we limit the scope of our sample to avoid the need to compare very dissimilar industries like chemical production and tannery industry following King and Lenox (2002).

Our final sample consists of 90 facilities out of 114 (n = 78, 94%) and 51 facilities out of 99 (n= 51, 51%) from the Spanish chemical and energy sectors. All the facilities included in our sample provided both number of employees and number of operating hours in year information. Those installations which did not report information about the two issues were excluded.

Measures

In order to measure whether toxicity-weighted environmental information may send a more accurate signal to stakeholders regarding the health impacts of a firm's emissions releases and therefore reduces information asymmetry we compare installations rank following different criterions.

First, we rank installations summing annual emissions of EPER substances released by a facility in a given year. Raw summing technique is still a common method among mass media outlets, several prominent nonprofit organizations, some publications from governments and in the two major reports by the World Resources Institute (Kleijn, 2001).

Second, we rank installations following a pollution index which combines information from all types of chemicals. Although the EPER (like TRI) publishes all the necessary information for comparing the environmental results of the firms, it is difficult to make comparisons before the development of a pollution index which combines information from all types of chemicals. In order to unite information of the different types of chemicals emissions into a single meaningful measure we first compared two alternative TRI measures based on weighting schemes. Lenox and Marshall (2004) show different ways to develop pollution index as toxicity-weighted TRI levels and cancer-and non-cancer weighted TRI levels using the Tool for the Reduction and Assessment of Chemical Impacts (TRACI) developed by the US EPA. Kassinis and Vafeas (2008) found a high positive correlation between raw TRI, used here, with toxicity-weighted TRI (r=0.60) and the four TRACI-weighted measures. Therefore, given the high correlation among these TRI measures and the fact that there is no European version of the U.S. Tool for the Reduction and Assessment of Chemical Impacts (TRACI), the study employs and reports raw EPER levels (as in Kassinis and Vafeas, 2008). In order to combine information of the different types of chemicals emissions into a single meaningful measure we combine them in one *pollution index* (as in King and Lenox, 2001). This index aggregates the different types of emissions due to their level of toxicity. And it is calculated as the inverse of the notified threshold limit in kilogram/year (Annex 1 European Pollutant Emission Register Review Report, 2004).

Pollution Index $(PI_{i)} = (\sum \text{weight}_{c} * \text{waste generated}_{cij})$ (1)

where PI is the pollution index for installations j, weight is the toxicity weight for chemical *c* in year *t,* and waste generated it is the kilograms of generated chemical waste of chemical *c* for facility *i* in year *t*.

For instance, the toxicity weight for an individual chemical, like benzene, will be [1/1000]. Table 1 presents the reportable quantity, weighting and examples of chemicals included. Our source for these pollutants to be reported if threshold value is exceed is the Annex 1 European Pollutant Emission Register Review Report, 2004 (see Table 1). Unlike King and Lenox (2002) who use EPA's toxicity levels, we use

Table 1: Chemical toxicity weightings (King and Lenox, 2002)

Reportable quantity (RQ) (either to water or to the air)	Weighting	Examples of chemicals
1	1,0	Brominated diphenylether
10	0,1	Cadmium
100	0,01	Copper and its compounds
1000	0,001	Benzene
10000	0,0001	Methane

Source: Annex a1: list of pollutants to be reported if threshold value is exceeded

Finally, in order to measure rank installations and comparing ranks in terms that take into account a firm's operational dynamics we develop two ratios and develop two new ranks. In the first ratio, *ratio employees*, we divided an installation's pollution index between its numbers of employees creating a new rank of installations. And in our second ratio, *ratio operating hours*, is calculated dividing pollution index between hours of operating hours,[1]which let us to develop our final rank. Table 2 summarizes all the ranks developed.

[1] The length of time that an installation is actually operating.

Table 2: Installations rank by different measures.

Ranks	Description
Rank A	Installations are ranked by summing annual emissions of EPER substances released by a facility in a given year
Rank B	Installations are ranked by a pollution index which aggregates the different types of emissions due to their level of toxicity.
Rank C	Installations are ranked by an installation's pollution index divided by its numbers of employees
Rank D	Installations are ranked by an installation's pollution index divided by its hours of operating hours.

Analysis and results

Kendall's rank correlation (Kendall's Tau) is used to check whether the ranks are similar or dissimilar from each other in SPSS. "The Kendall rank correlation coefficient evaluates the degree of similarity between two sets of ranks given to a same set of objects" (Abdi, 2007: page 1). Kendall's rank correlation provides a distribution free test of independence and a measure of the strength of dependence between two variables. A Tau of 1 indicates perfect agreement whereas 0 indicates that the rankings are no better than chance. Spearman's rank correlation is satisfactory for testing a null hypothesis of independence between two variables but it is difficult to interpret when the null hypothesis is rejected. Kendall's rank correlation improves upon this by reflecting the strength of the dependence between the variables being compared. Table 3 presents the results.

Table 3: Results of comparing ranks using Kendall Rank-Order Correlation Coefficient

	Chemical Industry	Energy Industry
Rank A versus Rank B	0.588	0.655
Rank B versus Rank C	0.01**	0.05*
Rank B versus Rank D	0.596	0.386

*, **Significant at the 0.05, and 0.01 level respectively.

Hypotheses 1, which compares whether installations are classified differently if installations are ranked by raw data or toxicity-weighted, is rejected. Specifically, it can be observed in table 3 that there is no statistically significant difference between installations ranked by raw data and ranked by emissions aggregated in both sectors -chemistry and energy industry. Surprisingly, installations are ranked similarly if we aggregate their emissions or not. Unexpected EPER signal correctly installations ranks. Although literature (Kleijn, 2001; Lifset, 2001) considered that raw summing technique is a poor proxy to rank installations environmental performance, our results suggest that it is a right proxy to classify them. Therefore, it is not surprising that mass media, NGOs and other international reports use rank following raw data emissions.

Hypotheses 2 a, which takes into account number of employees for determining environmental information may send a more accurate signal to firm management, regulators or market regarding a firm's environmental performance, is also rejected. Our results show that including installations' numbers of employees do not modify statistically significant ranks in any of the sectors analyzed. The inclusion of installations' number of employees may not be a right proxy to measure more accurately environmental "efficient" installations.

On the other hand, hypotheses 2 b, which takes into account number of operating hours for determining environmental information may send a more accurate signal to firm management, regulators or market regarding a firm's environmental performance, is accepted. Table 2 shows that there are statistically significant differences in installations ranked by their pollution index compared to the pollution index/operating rank both in the chemistry sector ($\alpha = 0.05$) and in the energy industry ($\alpha = 0.01$). In other words, installations are ranked differently if the number of hours an installation is actually operating is taken into account. Therefore, our results show that including the numbers of hours an installation is actually operating is a good proxy to determine environmental "efficient" installations.

In sum, our results show that an installation may rank differently depending on how governments and environmental agencies measure its environmental performance in the European Union context using the EPER data. Put simply, governments' alternatives to reduce information asymmetry using information from PRTRs may imply different effects and signaling (ranks). From a managerial point of view, environmental responsible firms may have an incentive to present their information or recalculation of EPER because they can more effectively signal their good environmental performance.

Discussion and conclusions

The most important implications of this study are of diverse nature. Firstly, governments force firms to disclose environmental information through PRTRs for different goals. Governments want to reduce the information asymmetry and send signals about installations environmental performance to society and markets. As a consequence, governments expect that stakeholders control the environmental behavior of firms. In the current model, PRTRs only provide installations' environmental information in absolute values (or raw data) and rank installations summing annual emissions. Literature claims that these governmental efforts are not effective and sufficient if PRTRs is reported only on this format. On one hand, researchers (Toffel and Marshall, 2004) argue that the use of weighting emissions data may provide more accurately ranks. On the other hand, other researchers (Karam et al., 1991) propose the need of supplementary information from installation to rank them from an environmental "efficient" point of view. Contrary to the literature, our study shows empirically that installation ranks do not change if either a weighting scheme or a weighting scheme and number of employees are used to rank them. However, our study reveals that the use of a weighting emissions and number of operating hours in order to rank installations provoke that the environmental information asymmetry is reduced and it would send more accurate signals to stakeholders. Therefore, the regulatory stakeholder becomes more effective

Secondly, as information source PRTRs is very valuable to stakeholders. These registers provide crucial information to the stakeholders to determine which companies put pressure on. PRTRs philosophy is based on societal pressure to modify companies' showing worse environmental performance. However, if information is not accurate, stakeholders may focus their efforts on companies which are better than signaled. Or, even, there are some small installations which do not receive any pressure from any stakeholder due to the information provided in EPER.

Thirdly, European installations are not ranked based on their environmental performance so far although the EPER provides all necessary information for ranking installations. In the world, other countries have developed two ways to face this problem. On one hand, after the publication of the TRI in the USA, some environmental pressure groups attempted to make the information easily comparable, a rank based on their levels of pollution was developed and published on the mass media. (Cañón de Francia et al., 2007). On the other hand, public disclosure programs in Asia (as Indonesia's Proper, Philippines' ECO

WATCH y China's GreenWatch) rate firms' pollution impact, as compliance with regulators and internal environmental management (Wang et al, 2004). Therefore, European regulators may consider either to encourage environmental pressure groups to provide this rank method or follow Asian countries method and, therefore, they can better signal firms' environmental performance.

Fourthly, from a managerial point of view, environmental responsible firms may have an incentive to present their information or recalculation of EPER because they can more effectively signal their good environmental performance. This issue is important as environmentally responsible firms may have better access to resources, faceless scrutiny, and retain the support of important stakeholders (Bansal and Clelland, 2004; Meyer and Rowan, 1977; Suchman, 1995). Companies could send signals to the market and society through their own environmental reports. However, information provided for an outsider will be more legitimate than information from inside of the firms. At the same time, managers should pay attention on changes from how governments pressure companies to modify their environmental performance.

Finally, these results are particularly interesting due to the fact that they have developed using the information facilitated by a database that tries to be a paradigm of regulatory modern approach in environmental arena. So, the European Union raises EPER as a useful tool to the awareness and follow-up of the different European 'stakeholders' interested in the environmental topic.

Three limitations of this study should be recognized. First, we restrict our analysis to one year (2004) and two industries (chemical and energy industries). EPER just includes information from the industrial sector affected by the IPPC legislation (Law 16/2002). For instance, there is no information on the emissions from other pollutant sources such as traffic, agriculture, maritime or air transports or from industrial activities under very specific regulations as it is the case of nuclear or mining industries. Second, although it is spreading the implantation of these registers around the world, so far few countries have established their own PRTRs, so it cannot translate our results to all the countries. Finally, our study focuses on how PRTRs signal installations' environmental performance to society. However, we are aware that firms make attempts to reduce environmental information asymmetry through their policies on environmental performance and other corporate responsibility issues (e.g. annual environment reports and corporate responsibility reports). Although Sullivan and Gouldson (2007) argue that firms do not release complete environmental information through their corporate environmental policies, stakeholders receives signals from firms which there are not included in our study.

In our future lines of research, further studies are needed to analyze what other PRTRs (for example: TRI, Indonesia's Proper, Philippines' ECO WATCH y China's GreenWatch) signal to society, firms and other stakeholders in order to replicate and extent our results.. Stakeholders also have an important role in disseminating information to the rest of the community (Kullkarni, 2000) and, therefore, reduce the information asymmetry. Kerret and Gray (2007) argue that its mere presence may not lead to decrease installations' emissions. So, it might also be interested to analyze the role of environment groups and mass media in spreading PRTRs data to society, and test to what extent it affects firms' environmental strategy and environmental performance. Finally, it might also be interested to analyze the internal impact and importance that PRTRs cause in firm.

References

Akerlof G.A. (1970). The Market for "Lemons": Quality Uncertainty and the Market Mechanism. *The Quarterly Journal of Economics*, *84(·3)*, 488-500.

Afsah, S. & Vincent, J. (1997). Putting Pressure on Polluters: Indonesia’s PROPER Program, A Case Study for the HIID1997 Asia Environmental Economics Policy Seminar. *Harvard Institute for International Development*. Washington, DC: International Resources Group. (Available at: www.worldbank.org/nipr.)

Bansal, P., & Clelland, I. (2004). Talking trash: legitimacy, impression management, and unsystematic risk in the context of the natural environment. *Academy of Management Journal*, *47*(1), 93-103.

Baron, D. P. (1995). Integrated strategy: Market and nonmarket components. *California Management Review*, *37*(2), 47–65.

Basdeo D.K, Smith, K.G., Grimm, C.M. & Rindova, V.P. (2006). The impact of market actions on firm reputation. *Strategic Management Journal*, *27*(12), 1205 – 1219.

Berman, S. L., Wicks, A. C., Kotha, S., & Jones, T. M. (1999). Does stakeholder orientation matter? The relationship between stakeholder management models and firm financial performance. *Academy of Management Journal*, *42*(5), 488–506.

Berry, M. A., & Rondinelli, D. A. (1998). Proactive corporate environmental management: A new industrial revolution. *Academy of Management Executive, 12*(2), 38–50.

Blackman, A., Afsah, S. & Ratunanda, D. (2000). How Do Public Disclosure Pollution Control Programs Work? Evidence from Indonesia. Resources for the Future Discussion Paper, No. 00-44. *Resources for the Future*. Washington, DC.

Buysse, K., & Verbeke, A. (2003). Proactive environmental strategies: A stakeholder management perspective. *Strategic Management Journal*, *24* (5) 453-470.

Cairncross, F. (1993). Costing the earth. Boston: *Harvard Business Scholl Press*.

Cañón-de-Francia, J., Garcés-Ayerbe, C., & Ramírez-Alesón, M. 2007. Analysis of the effectiveness of the first European Pollutant Emission Register (EPER). *Ecological Economics, 67*(1), 83-92.

Clarkson, M.B.E. (1995). A stakeholder framework for analyzing and evaluating corporate social performance. *Academy of Management Review, 20*(1), 65-91.

Clelland IJ, Fryxell GE, Wen T. (1996). Corporate pollution prevention: an empirical test of

Five corporate social performance outcome models. *In Proceedings of the Seventh Annual Meeting of the International Association for Business and Society, Logsdon J, Rehbein K(eds); 306–311. Collins D, Starik M (eds). 1995*. Supplement 1, sustaining

Cohen, M. (2002). Transparency after 9/11: Balancing the "Right-to-Know" with the Need for Security. *Corporate Environmental Strategy, 9*(4), 368-74.

Darnall, N., G. Jolley, J. & Handfield, R. (2008). Environmental management systems and green supply chain management: Complements for sustainability? *Business Strategy and the Environment: 17*(1), 30-45.

Dasgupta, S., Hettige, H., & Wheeler, D. (2000). What improves Environmental Compliance? Evidence from Mexican Industry. *Journal of Environmental Economics and Management, 39* (1), 39-66.

Delmas, M., & Toffel, M.W. (2004). Stakeholders and environmental management practices: An institutional framework. *Business Strategy and the Environment*, *13*(4), 209-222.

Dooley, S. & Fryxell, G.E. (1999). Attaining Decision Quality and Commitment from Dissent: The Moderating Effects of Loyalty and Competence in Strategic Decision-Making Teams. *The Academy of Management Journal, 42*(4), 389-402

Dutton, J. E., & Dukerich, J. M. (1991). Keeping an eye on the mirror: Image and identity in

organizational adaption. *Academy of Management Journal, 34*, 517-554.

Dutton, J. E.. Dukerich, J. M.. & Harquail, C, V. (1994). Organizational images and member identification. *Administrative Science Quarterly, 39*(2), 239-263.

Eesley, C., & Lenox M.J. (2006). Firm responses to secondary stakeholder action. *Strategic Management Journal, 27*(8), 765-781.

European Pollutant Emisión Register Review Report. 2004. Available at www.eper.cec.eu.int

Fomhrun, C, & ShanlBy, M. (1990). What's in a name? Reputation building and corporate strategy. *Academy of Management Journal, 33*(2), 233-258.

Foulon J., Lanoie, P. & Laplante, B. (2002). Incentives for pollution control: Regulation or Information? *Journal of Environmental Economics and Management, 44*(1), 169-187.

Freeman, R. E. (1984). Strategic Management: A Stakeholder Approach. *Boston: Pitman/Ballinger.*

Gerde V.W., & Logsdon J.M. (2001). Measuring environmental performance: use of the toxics release inventory (TRI) and other US environmental databases. *Business Strategy and the Environment, 10*(5), 269–285

Gouldson A. (2004). Risk, regulation and the right to know: exploring the impacts of access to information on the governance of environmental risks in the UK. *Sustainable Development 12*(3), 136–149.

Gouldson A., & Sullivan R. (2007). Corporate environmentalism: Tracing the links between policies and performance using corporate reports and public registers. *Business Strategy and the Environment, 16*(1), 1-11.

Graedel, T.E. and B.R. Allenby, (1995). Industrial Ecology. *Englewood Cliffs, New Jersey: Prentice Hall.*

Hall R., (1992). The strategic analysis of intangible resources. *Strategic Management Journal, 13(2)*, 135–144

Hamilton, J. T. (1995). Testing for environmental racism: prejudice, profits, political power? *Journal of Policy Analysis and Management, 141*(14), 107–132.

Hart, S. (1995). A natural –resource-based view of the firm. *Academy of Management Review, 20(4)*, 986-1014.

Henriques I., & Sadorsky P. (1996). The determinants of and environmentally responsive firm: an empirical approach. *Journal of Environmental Economics and Management, 30* (3), 381-395.

Henriques I., & Sadorsky P. (1999). The relationship between environmental commitment and managerial perceptions of stakeholder importance. *Academy of Management Journal, 42* (1), 87-99.

Hillman, A., & Hitt, M. (1999). Corporate political strategy formulation: A model of approach, participation and strategy decisions. *Academy of Management Review, 24*(4), 825–842.

Hoffman, A.J., (2001). Competitive Environmental Strategy: A Guide to the Changing Business Landscape, *Island Press.*

Jones, T.M (1995). Instrumental stakeholder theory: A synthesis of ethics and economics. *Academy of Management Review, 20 (2)*, 404-437.

Jones, R. & Murrell, A. (2001) Signaling positive corporate social performance. *Business and Society, 40 (1)*, 59 - 78.

Jones, T.M. & Wicks, A.C. (1999). Convergent stakeholder theory. *Academy of Management Review, 24* (2), 206-221.

Joshi S., Krishnan R., & Lave L. (2001). Estimating the hidden costs of environmental regulation. *Account Review, 76*(2), 171-198

Karam J.G., Craig J.W. and Currey G.W. (1991). Targeting pollution prevention opportunities using the Toxics Release Inventory. *Pollution Prevention Review, Spring*, 131-144.

Kassinis, G., & Vafeas, N. (2002). Corporate boards and outside stakeholders as determinants of environmental litigation. Strategic Management Journal, 23 (5), 399-415.

Kassinis, G., & Vafeas, N. (2006). Stakeholder pressures and environmental performance. *Academy of Management Journal, 49* (1), 145-159

Kassinis, G., & Vafeas, N. (2008). Environmental performance and plant closure. *Journal of Business Research*, *62* (4), 484-494.

Kerret, D. & Gray, G. (2007). What do we learn from emissions reporting? Analytical consideration and comparison of pollutant release and transfer registers in the United States, Canada, England, and Australia. *Risk Analysis, 27*(1), 203-223.

Khanna M, Quimio WRH, & Bojilova D. (1998). Toxics release information: a policy tool for environmental protection. *Journal of Environmental Economics and Management, 36*(3), 243–266.

King, A., & Lenox, M. (2001). Are aliens green? Assessing foreign establishments' environmental conduct in the United States. *Strategic Management Journal*, *22*(11), 1069- 1085.

King, A., & Lenox, M. (2002). Exploring the locus of profitable pollution reduction, *Management Science, 48*(2), 289–299.

Klassen R.D., Whybark DC. (1999). The impact of environmental technologies on manufacturing performance. *Academy of Management Journal, 42*(6), 599–615

Konar S, Cohen M. (1997). Information as regulation: the effect of community right to know laws on toxic emissions. *Journal of Environmental Economics and Management, 32*(1), 109–124.

Kulkarni S. (2000). Environmental ethics and information asymmetry among organizational stakeholders. *Journal of Business Ethics, 27*(3), 215-228.

Lifset, R. (2001). Moving from mass to what matters. *Journal of Industrial Ecology 4*(2), 1–3.

Majumdar, S. K., & Marcus, A. (2001). Rules versus discretion: The productivity consequences of flexible regulation. *Academy of Management Journal, 44*(1), 170–179.

Mandsen H., & Ulhøi J.P. (2002). Integrating environmental and stakeholder management. *Business Strategy and the Environment, 10*(2), 77-88.

Maxwell JW, Lyon TP, Hackett SC. (2000). Self-regulation and social welfare: the political economy of corporate environmentalism. *The Journal of Law and Economics, 43*(2), 583–619.

Meyer, J.W., & Rowan B. (1977). Institutionalized organizations: formal structure as myth and ceremony. *American Journal of Sociology, 83*(2), 340-363.

Organization for Economic Co-Operation and Development (OECD). (1996). Pollutant Release and Transfer Registers (PRTRs), a Tool for Environmental Policy and Sustainable Development: Guidance Manual for Governments. *OECD*, Paris.

Organization for Economic Co-Operation and Development (OECD). (2000). Presentation and Dissemination of PRTR Data: Practices and Experiences. Series on Pollutant Release and Transfer Registers No. 3.

Organization for Economic Co-Operation and Development (OECD). (2005). Uses of Pollutant Release and Transfer Register Data and Tools for Their Presentation— A Reference Manual. OECD Environment Health and Safety Publications Series on Pollutant Release and Transfer Register No. 7. Environment Directorate—OECD. ENV/JM/MONO(2005)3.Available at www.olis. oecd.org/olis/ 2005doc.nsf /43bb613 0e5e86e5fc12569fa005

Porter, M., & Van der Linde, C. (1995). Green and competitive. *Harvard Business Review*. *September-October*, 120-134.

Rindova V, Fombrun CJ. (1999). Constructing competitive advantage: the role of firm-constituent interactions. *Strategic Management Journal 20*(8), 691–710.

Rugman, A. M., & Verbeke, A. (1998). Corporate strategies and environmental regulations: An organizing framework. *Strategic Management Journal*, *19*(4), 365-375.

Rynes, S. L. (1991). Recruitment, job choice, and post-hire consequences: A call for new research directions. In M. D. Dunnette & L. M. Hough (Eds*.), Handbook of industrial and organizational psychology* {2nd ed.), vol. 2: 399-444. Palo Alto: Consulting Psychologists Press.

Schmidheiny, S. (1992). Changing course: A global business perspective on development and the environment. *Cambridge, MA: MIT Press.*

Scholz, J. & Gray, W. (1997). Can government facilitate cooperation? An informational model of OSHA enforcement. American Journal of Political Science, 41: 693-717.

Shaffer, B. (1995). Firm-level responses to government regulation: Theoretical and research approaches. *Journal of Management*, *21*(3), 495–514.

Shrivastava, P. (1995). The role of corporations in achieving ecological sustainability. *Academy of Management Review*, *20*(4), 936–960.

Smith K.G., & Grimm C.M., (1991). A communication information model of competitive response timing. *Journal of Management 17*(1), 5–23.

Stavins, R.N., (2003). Market-based environmental policies: What can we learn from U.S. experience (and related research)? *Resources for the future discussion paper 03-43, Washington DC.*

Stewart, R.B. (1993). Environmental regulation and international competitiveness. *The Yale Law Journal*, *102*(8), 2039-2106.

Stephan M. (2002). Environmental information disclosure programmers: they work, but why? *Social Science Quarterly*, *83*(1), 190–205.

Suchman, M.C. (1995). Managing legitimacy: strategic and institutional approaches. *Academy of Management Review*, *20*(3), 571-610.

Sullivan, R., & Gouldson, A. (2007). Pollutant release and transfer registers: Examining the value of government-led reporting on corporate environmental performance. *Corporate Social Responsibility and Environmental Management, 14*(15), 263-273.

Terry, J.C. & Yandle, B. (1997). EPA's toxic release inventory: stimulus and response. *Managerial Decisions Economics, 18*(6), 433–441.

Tietenberg, T. (1985). Emissions trading: An exercise in reforming pollution policy. *Washington, DC: Resources for the future*.

Tietenberg, T., (1998). Disclosure strategies for pollution control. *Environmental and resources economics, 11*(3), 587-602.

Tietenberg, T., & Wheeler, D. (2001). Empowering the Community: Information Strategies for Pollution Control. In S. Gerking and A. Rose (eds.), Frontiers of Environmental Economics, H. Folmer, H.L. Gabel Cheltenham, UK, Edward Elgar, 85-120.

Toffel M.W. & Marshall J.D. (2004). Improving environmental performance assessment: a comparative analysis of weighting methods used to evaluate chemical release inventories. *Journal of Industrial Ecology, 8*(1-2), 143-72

Wang, H., Bi, J., Wheeler, D., Wang, Cao D., Genfa, L., & Wang, Y. (2004). Environmental performance rating and disclosure: China's green watch program. *Journal of Environmental Management, 71*(2), 123-133.

World Bank. (1999). Greening Industry: New Roles for Communities, Markets and Governments. *Oxford/World Bank, New York.*

Williamson, O. (1979). Transaction cost economics: The governance of contractual relations. *Journal of Law and Economics, 26*, 233–261.