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Environmental Information, Asymmetric Information, and Financial Markets: A Game-Theoretic Approach

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Abstract This paper examines the problem of asymmetric information in financial markets due to a lack of essential environmental information. The literature indicates that asymmetric information generates various problems for the actors of financial markets such as incomplete information for investment decisions and lending procedures, misallocation of financial market funds, the underestimating of stock price securities, and poor environmental risk management choices. To this end, this paper develops a game-theoretic approach to examine both the persistent nature of asymmetric information caused by the absence of accurate environmental information and to indicate how a well-organized, trustworthy, internationally agreed auditing accounting certification scheme could play a critical role in limiting the magnitude of this problem.

Keywords Financial markets · Environmental accounting · Asymmetric information · Accounting audit schemes

1 Introduction

Information is very important for an effective decision making process for economic, environmental, and managerial decisions. O' Dwyer [1] says that good information flows advance democratic values for actors in the global financial world. Blowfield [2] considers that information provides the possibility for the accountability of modern firms in the increasingly competitive globalized economic world, while simultaneously giving the essential sources for improving the process of environmental management. Therefore, economic, managerial, accounting, and environmental economic fields have looked closely at the role that such information could play. New Institutional Economics, for example, considers information as a basic parameter of estimating the risks and opportunities of economic actors, while management theorists consider information as the basis for answering the relevant managerial problems at the micro- and macrolevel. Accountants deem information as a very important factor for business and financial market operations and thus, focus on finding specific accounting and auditing certification systems to accurately record all essential information and assure its quality.

Environmental managers and accountants want reliable and accurate information to make decisions regarding environmental problems. They use economic, managerial, and accounting techniques in order to collect relevant information to manage present or potential environmental risks. Gale [3] highlights the necessity of accurate information on the economic and environmental performance of firms. This information not only assists firms in their operations, but also helps financial institutions better organize environmental risk management strategies, thus, guaranteeing the proper functioning of financial markets. Lorraine et al. [4] identify that corporate environmental performance information affects company's share prices while Lanoie et al. [5] argue that new types of environmental information drive financial markets to revise their prospects about the revenues and production costs of a firm. Moreover, de Beer and Friend [6] find a positive relationship between "good" environmental disclosures and the operating of the financial markets. To understand this relationship, authors have examined the ways in which environmental information affects the environmental and economic management performance of different participants of the financial markets such as the banking sector, insurance companies, and stock exchanges [7, 8].

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Although environmental information is essential for reducing the risks of financial markets, firms usually provide incomplete information since this is done in an unstandardized fashion, on a voluntary basis, and as result of the limited number of such auditing certification schemes (e.g., Global Reporting Initiative (GRI)) which operate under a nonmandatory regime. These practices provide a limited amount of low-quality information to the different participants of the financial markets. The absence of formal and rigorous accounting methods for recording environmental information and of an auditing certification scheme may explain a variety of drawbacks, which impede financial markets in managing financial risks arising from poor environmental performance. One significant drawback is the asymmetric nature of information between firms and other participants of the financial markets such as stock exchanges, the banking sector, investors, and insurance companies. Asymmetric information may be described as the study of decisions in transactions where one party has more or better information than the other. Even in the case where firms communicate such information through environmental reports, Schaltegger [9: p. 89] indicates that those reports "*are characterized by an information asymmetry between providers and the recipients of ecological statements*".

We take a game-theoretic approach in order to better understand this problem and to highlight its importance as well as its persistence. The analysis indicates the ways in which environmental information affects the financial and environmental decisions of financial participants and suggests that a well-organized, trustworthy, and commonly agreed environmental certified auditing scheme could increase the quality of this information in an attempt to bridge this knowledge gap. Moreover, it stresses the need for empirical research on the costs of the third-party program implementation.

The remainder of this paper is organized as follows: The following section presents a literature review on the environmental information of firms and financial markets, accounting and information asymmetry and finally, environmental accounting regulations, and auditing schemes. The third section presents the model, which analyzes the problem of information asymmetry in financial markets. Finally, the last section presents the conclusions of this paper.

2 Literature Review

2.1 Environmental Information

Over recent decades, environmental problems such as soil degradation, water resources' depletion, and air quality reduction have increased dramatically. To deal with such problems, different governmental and nongovernmental organizations have implemented policies and tools such as market-based instruments (e.g., environmental taxes, subsidies, and tradable permits), "*command and control*" instruments and voluntary tools (e.g., environmental management systems). The aim of these policies is to stimulate or compel organizations responsible for environmental degradation to implement environmental management practices to mitigate their impact. By introducing the principles of environmental management, firms and participants of financial markets adopt environmental management strategies to both eliminate their environmental impact and enhance economic benefits. Business and industry affect the physical environment through their everyday operations and the financial markets affect the physical environment either as businesses themselves or as motivators for reorganizing corporate strategies to be more environmentally friendly.

The successful implementation of such environmental practices by firms and financial participants requires a range of safe and clear environmental information to be provided mainly by environmental management accounting methods. Relevant literature outlines a number of different environmental management accounting methods that record such information utilizing different measurement units and accounting principles such as life cycle costing, environmental management accounting, and environmental accounting methods based on the generally accepted accounting principles (GAAP) [10].

Such information helps participants of financial markets to avoid potential financial risks associated with the poor environmental performance of firms, while also playing an important role in preserving the environment by stimulating such firms to implement stricter environmental management practices [11, 12]. Even though there is a consensus on the importance of such information for financial markets to manage their risks, more analysis is needed in order to assess how this can be effectively achieved. Firstly, firms require particular financial products from financial markets in order to finance their operations in general and, more specifically, environmentally friendly technologies, environmental management strategies, and other environmental practices [13, 14]. Thus, firms may disclose accurate information about their environmental performance to facilitate the financial markets' decisions about such products. Secondly, financial markets are significantly concerned about firms' environmental performance in order to avoid potential financial risks.

2.2 Asymmetric Environmental Information

(A) An Overview of Asymmetric Information

The problem of asymmetric information is not new. Neo-Classical Economics have recognized that information is not perfect. George Akerlof, who got the

Nobel Prize in Economics in 2001 for his contribution to the study of asymmetric information, succinctly described in his famous 1970 article "*The Market for Lemons*" the problem of how low-quality used cars (lemons) drive high-quality used cars out of the market. New Institutional Economics explain why such an imperfection creates problems. Ronald Coase [15] argued that there are transaction costs in acquiring information, negotiating, monitoring, signing, and enforcing contracts. Oliver Williamson [16] explained how transaction costs can create problems in the smooth functioning of the market. Bounded rationality and opportunism are the two basic behavioral assumptions stated by Williamson [16]. Bounded rationality means that the human brain has limited capabilities and cannot calculate all possible contingencies in the future. Coupled with opportunism, "*self-interest seeking with guile*" as Williamson defines it, is the reason why information asymmetry creates problems.

Asymmetry of information would not be a major problem if economic actors did not behave opportunistically. If the seller of a used car, to refer to Akerlof's example, disclosed the full information about the car, there would be no problem of information asymmetry. However, s/he has the incentive to overestimate the quality of the car in order to gain more from selling it. Similarly, it is in the seller's interest to conceal negative information about the car and disclose only good information. The buyer knows that and cannot trust the seller even if the seller discloses the full information. This means the buyer will try to pay less even if the car is really good. The buyer who cannot distinguish between a good used car and a "*lemon*" will not be able to offer a differentiated price but the same (pooling) price for both. This means the seller of a good car does not have the incentive to sell it because s/he is not going to gain the full price but a lower pooling price as a "*lemon*". Consequently, Akerlof concludes, bad cars drive good cars out of the market reducing thus the quality of used cars sold in the market.

The way to partially solve the problem was discussed by Michael Spence [17]. He argues that in order to have a separating (not pooling) equilibrium, that is, two differentiated prices, a higher price for the high-quality item and a lower price for the lower quality one, the player with superior information (in Akerlof's example, the seller of the used car) should send a costly signal to the second player, the buyer, such as offering insurance or providing a costly third-party credible certification verifying the quality of the car. It is important to stress that the problem is partially, not completely, solved because the solution is costly; it is not "free". Accordingly, the degree of solving the asymmetric information problem depends on the level of the cost of the solution. This will be further discussed presently.

(B) Conventional Accounting and Asymmetric Information

Financial markets need complete and accurate information about the financial structure and the daily operation of firms, which are measured either in financial or nonfinancial units [18]. Healy and Palepu [19] highlight that "*information and incentive problems impede the efficient allocation of resources in a capital market economy*" (p. 407). For this purpose, they suggest that firms' disclosures facilitate investors and financial markets to make precise decisions. Appropriate information is available to financial markets through formal financial statements (published by firms) and external accounting reports prepared by intermediates (e.g., auditors and economic analysts).

Financial statements and reports are prepared mainly on a mandatory basis following GAAP principles and International Accounting Standards. This practice has assisted the production of an internationally acceptable set of high-quality financial reporting standards, which limits management's opportunistic discretion in deciding the information disclosed [20]. Lam and Du [21] also believe that mandatory disclosures practices have a low level of estimation risk in the economy. However, while, accounting standards endeavor to reduce costs of preparing financial statements and to provide a commonly acceptable language for managers and investors, there are no provisions for nonfinancial disclosures.

Healy and Palepu [19] maintain that when a clear accounting regulatory regime and auditing organization are not in place, managers have incentives to reveal or withhold information from investors. Firms are expected to voluntarily disclose such information when a rigorous regulatory regime covering the preferences of stakeholders is not in place. However, this voluntary disclosure poses several dilemmas. The revelation of such information entails disclosure costs [22] especially when bad news appears [23]. Firms have strong incentives to disclose voluntary information when financial participants consider it very significant in determining the fair value of firms and, consequently, improving their benefits (or eliminating the risks) [24]. Moreover, firms are discouraged by increased competition to communicate private information when they have financial losses [25]. This type of information costs is known as proprietary costs. Comparing these types of costs, Skinner [26] considers that firms voluntarily communicate information when disclosure costs are relatively low compared to proprietary costs.

(C) Environmental Information and the Asymmetry Problem

Today, the majority of financial participants want to

know how the level of environmental performance of firms is linked with their financial performance (positive or negative) and the way in which these consequences are transferred to market contracts, which are signed between participants and firms. This consideration focuses on the necessity of those participants to "*keep risky securities out of their investment portfolio or ask for higher risk premiums, whenever they consider a company to have high environmentally induced systematic financial risks*" [9: p. 88]. In this sense, financial market participants demand environmental information to better organize their financial risk management procedures.

Firms provide such kind of information through a range of means such as formal financial statements, annual reports, environmental reports, and internet sites. Current environmental disclosures are based either on the mandatory regulatory regime or on self-regulatory initiatives of firms. The former practice relies on the idea that it is better to disclose environmental information through financial statements based on current accounting regulation [27] since these could be more credible due to the utilization of advance financial auditing standards [28, 29]. Based on those views, governments, and independent regulatory accounting agencies issue accounting regulations such as the Security and Exchange Commission (SEC) and the Accounting Standards Associations. For example, in the USA, the SEC issues certain report standards to record general contingent liabilities, including environmental issues (for instance, SFAS No. 5). Additionally, SFAS No.19 assists the estimation of restoration and abandonment costs as well as residual salvage values. Similarly, the American Institute of Certified Accountants introduced SOP 96-1 Environmental Remediation Liabilities, in which companies are required to publicly communicate their remediation liabilities. In the same vein, several European organizations have issued environmental accounting standards such as the European Commission [30].

However, how complete such standards are is a result of the awareness and the knowledge of such organizations regarding the value of environmental information from financial markets, accounting, and auditing bodies. In most cases, the requirements of financial markets for environmental information exceed the present state of information as upheld by the current accounting regulatory regime. In order to overcome this regulatory drawback or cover the complete absence of relevant regulations, some firms prepare environmental information on a voluntary basis. Actually, voluntary disclosures are a common practice by the majority of firms to face current unregulated (or partially regulated) environmental accounting standards and consequently, they develop a variety of self-regulated norms essential to communicate such information. Authors attempt to explain this voluntary practice of firms mainly based on epistemological and ontological scientific assumptions and specific features of firms. Relevant theories are proposed to explain such voluntary disclosure practices such as the stakeholder theory, the political economy theory, the legitimacy theory, the agency theory, and the social contract theory [31]. In the meantime, several studies examine the effect of different determinants on firms' disclosure choices: company size, industrial sector, location of environmental information in annual report, and firm profitability [32].

However, this practice gives rise to two problems, namely a lack of information and asymmetric information [33]. The former refers to the idea that there are few incentives for a firm to disclose private environmental information as well as lack of specific expertise to record such information. The latter, which impedes financial markets to organize their environmental risk management, is asymmetric information between firms' disclosed information and information needed by financial markets.

2.3 Environmental Auditing

The low quality of environmental disclosures is also a result of a lack of a generally accepted environmental audit certification scheme to verify and assure the quality of this disclosed information. Several authors have proposed a range of auditing schemes in order to facilitate firms in disclosing such information. Some authors maintain that environmental information should be disclosed under the GAAP within formal financial statements [34]. This practice has an advantage due to the fact that firms gain credibility and improve the quality of disclosures in order to exploit the benefits of present financial audit schemes [28]. Following such practices, firms might not disclose some kinds of information, essential for organizations to manage their environmental risks such as nonfinancial and bad environmental news. Other authors state that strict accounting requirements are necessary for reliable and accurate environmental information. In this sense, governmental organizations and financial market associations (e.g., SEC) provide some useful environmental accounting requirements. In this case, financial participants miss the chance to utilize nonfinancial environmental information and information that covers a broad range of environmental issues. Today, most authors look for a formal environmental auditing scheme which can audit how accurate and complete relevant information can facilitate firms to manage their environmental risks [35].

Present environmental auditing practices can be classified in two main categories, namely, internal and external.

Dittenhofer [36] highlights internal auditing as the procedure that determines the level of firms' compliance with regulations and the way to find a range of environmental aspects which firms could improve. To this end, the majority of such environmental auditing provides general norms for examining the performance of firms in environmental issues. Conversely, he describes external environmental auditing as the procedure of independent agencies to assure that the economic and environmental performance of firms is in accordance with their formal financial reports. Power [37] comments that external environmental auditing from financial auditors limits the reliability of disclosed information due to the auditors' limited knowledge skills and experience of environmental issues.

The absence of comprehensible international standards of environmental auditing leads many different governmental and nongovernmental organizations to produce specific environmental reporting standards with specific environmental and ethical codes such as AccountAbility 1000 (AA1000) and the GRI. This variety of auditing standards is also met in Gray's [38] review work, which classifies environmental auditing schemes in two categories: those compiled and used by external participants (e.g., supplier audits, consumer audits, and image audits) and correspondingly, those that are produced and used by internal participants. However, Watson and MacKay [39] point to the absence of internationally agreed reporting standards as well as an international (or national) auditing certification scheme making environmental auditing a complicated and difficult procedure.

3 The Model

Similar to the example of used cars is the problem of asymmetric information in the financial markets with respect to environmental information disclosures by firms. There are two relevant parties: firms that demand funding (buyers of money) and want to attract investments on one hand and financial institutions (e.g., banking and insurance companies, investors) that want to make investments in firms on the other.

In the ideal case of symmetric information, financial institutions would offer funding (loans, insurance premiums, and buying stocks) at the level where they would maximize their profits, that is where marginal cost equals marginal revenue. This means that firms with higher levels of environmental performance would get higher investment value[1] than firms with lower levels of environmental performance, assuming that an environmentally responsible firm has higher chances of successfully reducing environmental costs such as potential fines and penalties from the government and regulation agencies, the costs of managing pollution, or other kinds of environmental accidents and/or decreased sales due to customer boycotting its products and services.

In other words, the higher the environmental responsibility and performance of a company, the fewer the chances of environmental accidents, pollution, and fines namely, the lower the environmental cost of their operations. Financial institutions fund firms based on many factors (financial performance, for instance) including environmental performance. As mentioned above, the more a firm is environmentally responsible the less the chances of accidents and fines so, the less the chances that the financial institution's investment will fail (lose its value in total or in part). So, based on the information, which in the ideal scenario is perfectly symmetric or, even if asymmetric, that corporate disclosures are trustworthy, financial institutions will allocate their resources in an optimal way maximizing their profits by maximizing the level of return of the investments in the firms given the known probabilities of failure or accident, that is, the risk which is common knowledge.

Given asymmetric information and the incentive for firms to be self-laudatory in their reports [40], there is misallocation of resources and, consequently, a decrease of the total social welfare. An environmentally responsible (ER) firm that incurs the cost of ER action may not get the appropriate amount of funding (highest investment value) because of inadequate information at the financial institution level, and a non-ER firm that does not incur a cost for ER action may get a higher investment value than optimal. This scheme distorts the incentive for good firms to really invest in environmentally responsible activity much as owners of good used cars are not willing to sell them. Just as bad cars drive good cars out of the market, non-ER firms do the same to ER firms.

In order to elaborate on the aforementioned discussion and to better illustrate the problem of inefficiency as a result of the asymmetry of information between firms and financial markets, a simple game-theoretic model adapted from Chymis et al. [41] is used. The model used by Chymis et al. describes the asymmetric information problem in cattle auctions between sellers of cattle (farmers) and buyers (called backgrounders, who keep cattle for a short period of time until they sell them again to feedlots). The authors use a specific action (revaccination of cattle from buyers) as an example to illustrate the problem of asymmetric information. Their point is that the farmers' report on the vaccination regime and condition of the cattle is not necessarily believed by buyers who vaccinate the cattle again after purchase. The reason is that, lacking a third-party certification program, farmers have the incentive to overestimate the quality of the cattle in order to get a higher bid. Of course, buyers

[1] Many financial institutions may offer the same amount of investment but with better crediting conditions–terms such as lower interests rates. We thank an anonymous referee for pointing this out. In both cases, the ultimate result is a higher value of investment for the recipient firm.

know that, offer a pooling price and incur the cost of revaccinating the cattle. This is not efficient. The authors argue that if a credible third-party certification program was in place, farmers who vaccinate their cattle could get a higher auction price and spare the buyer the cost of revaccination. Given that the certification program would come at a cost borne by the sellers, the asymmetric information problem is only partially solved. The authors show that there will always be farmers who, although vaccinate their cattle, find the certification cost higher than the benefit of the higher auction price.

Although there are important differences (explained below) between the case of asymmetric information in cattle auctions and our case of asymmetric information in financial markets, there are equally important similarities, which offer us the opportunity to use the model in order to simply and clearly present the issue of asymmetric information in this case.

Suppose there are two players, firms (*f*) that demand investments and financial institutions (*fn*) that offer investments. The firms may engage in ER activity or not. The problem is how financial institutions can trust firms' claims that they have taken ER actions, given that firms have incentives to claim they are ER even though they are not in order to increase the value of any possible investment.

It is assumed that when a firm has taken an ER action it means it has already estimated and evaluated potential environmental risk associated with its activities and has taken action in limiting this risk to the maximum possible point thus organizing a risk management strategy. If this information can pass to the financial institution, it means the financial institution will not need to re-estimate and re-evaluate the potential environmental risk from the specific firm's activities thus liberating resources to be invested in this or other ER firms.

Otherwise, the financial institution has to incur the costs of searching for relevant information, and redesigning a risk management strategy, that is, of doing the firm's homework (evaluation and estimation of potential environmental risk and design of an environmental risk management strategy). Because financial institutions are held accountable for environmental accidents if firms are not ER, in this case it is the financial institutions that have to act as firms in terms of environmental responsibility.

In the case of an accident (e.g., an environmental problem, unexpected pollution, other environmentally harmful effects from the operations of the firm, for example), there is a cost of remedy that has to be taken otherwise fines may be levied or the market (customers and markets in general) may punish the firm and the financial institution. The chances for an accident as well as the remedy costs vary from industry to industry. It is different for a heavily polluting industry (chemicals, oil, pharmaceuticals,) than the software industry, for example [42–44].

The objective is to examine the conditions under which this game has a separating or a pooling equilibrium, that is, if the financial institutions can identify ER and non-ER firms and offer a separating investment or not and thus offer a pooling investment.

$e(i, r, k)$ Expected value of investment which is an increasing function of i the expected amount of investment, r credit conditions of investment, such as interest rates, and k other market factors affecting the reliability of the firm, such as financial performance indicators and other general market and economic conditions.

c^{er} Cost of per unit environmentally responsible activity, or ER action, by firm. It is expected that an environmentally responsible firm has to take a series of actions. There are firms that are more or less environmentally responsible. In order to model the environmentally responsible activity, this activity per unit is taken, that is, one specific ER action is considered[2].

c^{re} Cost of per unit re-evaluation, re-estimation of environmental risk by financial markets. This corresponds to per unit cost of ER activity.

u Cost of remedy measures taken in case of unexpected event (e.g., environmental accident).

p_u^{er} Probability of an accident when environmentally responsible action has been taken.

p_u^{n} Probability of an accident when environmentally responsible action has not been taken.

p_l^{er} Probability of loss of expected investment value (firm goes bankrupt) when environmentally responsible action has been taken[3].

p_l^{n} Probability of loss of expected investment value (firm goes bankrupt) when environmentally responsible action has not been taken.

We assume that $p_u^n > p_u^{er}$, the probability that an unexpected event, which will incur a remedy cost u, is lower when a firm has taken an ER action than the corresponding probability if the firm has not. Similarly, we assume that $p_l^n > p_l^{er}$, the probability that the value of the

[2] To better visualize this, imagine a checklist that a firm has to complete in order to be considered environmentally responsible. Each tick represents a specific ER action. This way, by breaking down environmentally responsible behavior into a specific series of actions, we simplify and are able to model the complex phenomenon of firm behavior.

[3] In reality, this may be more complicated with different probabilities on different percentages of investment that can be lost. This can be described by an integral containing all possible probabilities for all possible percentages of loss. Without loss of generality and for simplicity reasons, the integral is expressed with the probability of losing the whole investment (firm goes bankrupt).

investment will be lost when the firm has taken an ER action, is lower than the corresponding probability if the firm has not taken the ER action.

Before moving on to analyzing the firm's and financial institution's actions and outcomes, some explanation of the structure and the reasons behind choosing the specific model is needed. In the case of Chymis et al. [41], the asymmetric information problem was simple in that there was a specific action taken by the buyers of cattle (i.e., revaccination), which simply affected the auction price offered by buyers to the farmers. If buyers trusted that vaccination has taken place, they could offer a higher price (separating equilibrium) and not revaccinate the cattle. If not, they would offer a lower (pooling) price and incur the cost of revaccination. In our case, the problem is more complex. We do not have such a specific measure (rather, a continuum of actions) once environmentally responsible behavior encapsulates a series of actions, which actually depend on the industry and the size of the firm [42–44]. Modeling such diversity would be cumbersome, adding much complexity and confusion, and thus distracting from the point of the paper. In reality, there is a continuum of the degree of environmental responsibility. It is not black and white unlike the case of cattle vaccination where cattle have been either vaccinated or not. In order to make the model workable and keep its simplicity and clarity, the continuum of actions included in environmentally responsible behavior is subdivided and we talk in terms of a specific ER measure and the implementation and non-implementation cost for both the firm and the financial institution.

From the side of financial institutions, banks, insurance companies, and stock exchanges, it is true that they have different behavior in lending or investing money in firms. The amount of investment and credit conditions vary and a simple and clear way to model that is needed. This model offers us the opportunity to picture all different financial markets without having to separate possible different investing behaviors. A major difference with the cattle auction case and its model is that the action taken by the sellers and the buyers is the same, that is, cattle vaccination. In our case, it is different. Firms take ER action and financial institutions design, organize, and estimate a risk strategy implementation in case firms have not taken ER actions. This is why in our model, we have two different costs corresponding to these two different actions (c^{er} and c^{re}) rather than one cost (vaccination, c) in the cattle auction model. However, this modification does not change the basic result, which is very similar to all asymmetric information cases; used cars, cattle auctions, or environmentally responsible firms. Indeed, our model resembles more the case of Akerlof's used cars where again there are two different actions taken by sellers (take care of their car) and buyers (pay a mechanic to check the car and probably fix any problems).

Firms' environmentally responsible behavior has also many other positive effects for the firm itself. For example, the revenues of a firm may increase, as consumers may prefer the specific firm or, because of cutting costs through more efficient operation and, thus, productivity increases (i.e., energy or raw material savings, using new environmentally friendly technology)[4]. This reflects directly on the expected value of investment through k, which captures all market conditions and thus all possible positive effects of the environmentally responsible activity of the firm. This model with its cost minimization structure includes any potential benefit both for firms and financial institutions expressed in cost terms.

3.1 ER Action by Firms

A firm is going to take an ER action if doing so is less costly than not doing so. This happens when:

$$c^{er} + p_u^{er} u + p_l^{er} e(i,r,k) \le p_u^n u + p_l^n e(i,r,k) \tag{1}$$

or if

$$c^{er} \le u\left(p_u^n - p_u^{er}\right) + e(i,r,k)\left(p_l^n - p_l^{er}\right) \equiv c^f \tag{2}$$

The left hand side of Eq. (1) shows the per unit expected cost to a firm of taking an ER action and the right hand side, the expected cost of not doing so. The Eq. (2) shows that the firm will take the ER action if the cost of this action does not exceed a maximum value for the firm c^f. Every time c^f increases, it means it is more likely for the firm to take the ER action. The higher the c^f is, the higher the number of firms taking ER actions. This maximum cost increases in e, i, r, k, u, p_u^n, p_l^n and decreases in p_u^{er}, and p_l^{er}. Simply put, the incidence of ER actions will increase if the expected value of the investment, the amount of investment, credit conditions, other market factors such as benefits from increased productivity, cost savings, increased consumer preference, the cost of remedy measures in case of accident, and the probabilities of an accident or loss of investment when an ER action has not been taken, increase. Firms will have a decreased incentive to take an ER action if the probability of an accident and of losing the investment (bankruptcy) when ER action has been taken increases.

So, as investment value increases, a firm has an incentive to engage in ER action. Whether all firms engage in ER action depends on a firm's specific costs as well as industry specific costs. Large firms in heavily polluting industries, which could be expected to have a lot to lose from not engaging in ER activities, will most probably take ER actions. Indeed, research has shown that industry and firm size affects the level of environmental performance [42, 43].

[4] We thank an anonymous referee for making this point clear.

We see clearly the incentive for a firm to be environmentally responsible because the expected value of the investment from the financial institution will be higher as well as because of other factors such as the higher probability of accidents and even loss of the investment value. However, for any given c^f, there will be firms that take an ER action when $c^{er} \leq c^f$ and firms that do not when $c^{er} > c^f$.

There are two possible cases: One is a pooling equilibrium in which—*ceteris paribus*—there is one value of investment (amount or credit conditions considered) offered by the financial institutions regardless of whether the firm has taken the ER action or not and a separating equilibrium where the financial institution—*ceteris paribus*—offers a higher investment value (in terms of amount or credit conditions) for firms that have taken the ER action and a lower one for those that have not. The second case requires that there is no asymmetry of information and that financial institutions know which firm is ER and which is not. What the financial institutions do is discussed in the following section.

In the case of the separating equilibrium, the higher value of investment e increases the cost of not taking the ER action for firms. We denote the new maximum non-ER action cost $\overline{c}^f$. Now, we can expect that more firms will have $c^{er} \leq \overline{c}^f$ but not necessarily all firms. This means that even in the case of a separating equilibrium not all firms will take the ER action. However, the incentive for a firm to take the ER action is now higher once the firm will receive a higher investment from the financial institutions.

Note here that we compare the change in the value of investment $e(i, r, k)$ from the part of the financial institution when it knows that the firm has taken the ER action. Any changes of the investment value, due to productivity increase or other positive effects to the firm itself thanks to the ER activity, are not counted in this comparison because they are extraneous to the specific problem under examination and are included in the term $e(i, r, k)$ through the parameter k.

3.2 Reevaluation by Financial Institutions

Financial institutions have to decide whether to incur costs of re-evaluation and re-estimation of environmental risk from firms' activities. If firms have taken the ER action, financial institutions can evaluate firms without any extra costs of designing a separate risk management strategy of their own. The question is whether to trust firms' environmental reports or not, just like the case of the used cars where the buyer has the choice to either trust the report of the seller about the condition of the car or not to trust and incur the costs of taking the car to a mechanic and revealing the precise condition of the car and also paying to fix any problems. Financial institutions have to either believe the announcements and reports from firms and base their risk management strategy purely on firms' reports without any further costly investigation or, not believe them and incur the costly action of re-evaluation. This is similar to the Chymis et al. case of cattle auctions where buyers either believe farmers have vaccinated cattle or, if no, having to revaccinate.

Financial institutions do not have complete information about whether a firm has taken any ER action. Suppose q, where $0 \leq q \leq 1$ is the perceived probability that the firm has taken the ER action. If $q=1$, then the financial institution knows with certainty that the firm has taken the ER action; if $q=0$, the financial institution knows with certainty the firm has not taken the ER action. Financial institutions will not take the costly action of re-estimating and redesigning an environmental risk strategy when the cost of not re-estimating is less than the cost of re-estimation. This is true if:

$$q\left(p_u^{er}u + p_l^{er}e(i,r,k)\right) + (1-q)\left(p_u^{n}u + p_l^{n}e(i,r,k)\right) \leq c^{re} + p_u^{er}u + p_l^{er}e(i,r,k) \quad (3)$$

or if

$$c^{re} \geq \left[u\left(p_u^{n} - p_u^{er}\right) + e(i,r,k)\left(p_l^{n} - p_l^{er}\right)\right](1-q) \equiv c^{fn} \quad (4)$$

The left hand side of Eq. (3) expresses the expected cost to the financial institution from not re-evaluating the risk management strategy, based on the probability that the firm has taken the ER action (q) and the probability that the firm has not taken the ER action ($1-q$). The right hand side of the same equation represents the expected cost of re-estimation.

Without loss of generality, we assume that after re-estimating, the probabilities of an unexpected event or a loss of the investment are the same as when the firm has taken the ER action. Simplifying (3), we get Eq. (4) which shows that it is inefficient for the financial institution to re-estimate if the expected cost of re-estimation is greater than a maximum condition c^{fn}. This is similar to the condition for the firm c^f; however, in this case, the condition is a function of, q, the perceived probability that the firm has taken the ER action.

We see that as long as $q<1$, that is, if financial institutions cannot know with certainty that a specific firm has taken the ER action, financial institutions will offer a pooled investment value. The inefficiency is clear: Even when a firm has taken ER action and there is no need for the financial institution to re-evaluate and redesign an environmental risk strategy, $c^{fn}=0$ and $c^{re}>0$, due to asymmetry of information we have $q<1$, $c^{nf}>0$ and $c^{re}<c^{nf}$ for some financial institutions, which means that some will incur cost c^{re} although they should not because it is pure waste.

The question is whether financial institutions can know with certainty, which firms have taken an ER action and which have not, so we can have a separating equilibrium solution to the problem of asymmetric information.

3.3 Solution Through a Third-Party Auditing Certification System

Thus far, it has been demonstrated that a firm, depending on its costs and benefits (expressed in our model as costs in the meaning of forgone benefits), might take an ER action if it is profitable for the firm to do so. It may indeed be profitable for the firm to do so even if the financial institution has no way to find out if the specific firm took the ER action and this is the problem under investigation because here lies the inefficiency problem created by the asymmetry of information. A firm that took an ER action in order to reduce costs, penalties, increase productivity, enhance its customer support, etc. may not get a higher investment value from the financial institution if the financial institution does not know for sure if the firms indeed took the ER action.

As previously mentioned, the solution to the asymmetric information as proposed by Michael Spence [17] is a costly signal sent by player 1 (firms) to player 2 (financial institutions). The very nature of this solution makes it partial and not complete. It is a costly solution, so, *ceteris paribus*, if the cost of the solution is higher than the cost of the current situation of asymmetric information, the current situation will persist. The solution is the existence of a separating equilibrium. This can happen when the firm which participates in the certification program (this can be an internationally agreed environmental accounting auditing scheme) gets an official certification that indeed it has taken the ER action claimed.

An official and perfectly credible certification is the costly signal the environmentally responsible firm sends to the financial institutions. Given the assumption the internationally agreed auditing scheme is credible the financial institution can know with certainty which firm is ER and which it is not. So, q, the perceived probability, now becomes certainty and takes the value of 1 or 0 and nothing in between. The financial institution can now offer a separating investment value: Higher in the case of an ER firm and up to the amount of c^{re}, namely, the cost of re-evaluating and reorganizing an environmental management strategy; lower in the case of a non-ER firm because the financial institution needs to take the cost of re-evaluation and organization of a risk management strategy on behalf of the firm.

It is clear that from the financial institutions' point of view, the problem of asymmetric information is solved once a credible auditing certification system is in place. However, from the point of view of the firms, this is not yet clear and this requires further elaboration.

Does every environmentally responsible firm want to participate in the certification program? We assume that non-ER firms will not participate because once they have not taken any ER action they do not want to pay the extra cost to be certified for not taking the ER action, as this would represent a pure cost for them without any benefit of higher investment value. From Eq. 2, we understand that if $c^{er} > c^{f}$, firms will not take the ER action and do not have any incentive to participate in the auditing certification program, which entails a cost c^{c}.

The interesting question to ask is if all ER firms will enter the auditing certification program and thus completely solve the asymmetric information problem. Firms know that if they take the ER action and if get the certification, they will receive a higher investment value from the financial market, but this will happen only when the sum of the cost of the ER action plus the cost of the participation to the auditing certification scheme is less that the maximum non-ER cost, or $c^{er} + c^{c} \leq \overline{c}^{f}$ (recall that $\overline{c}^{f}$ is the maximum non-ER action cost due to the higher investment value firms will receive from the financial institution. It reflects the forgone benefit of getting a higher investment value).

If we combine the two conditions, one for taking the ER action ($c^{er} \leq c^{f}$) and the other of participating in the auditing certification program ($c^{er} + c^{c} \leq \overline{c}^{f}$), we get a new condition $c^{c} \leq \overline{c}^{f} - c^{f}$. Firms will participate in the auditing certification program if this condition is satisfied, namely, if the per unit ER activity cost of getting the certification from the generally agreed auditing scheme is less than the per unit ER activity change of moving from a pooling to a separating equilibrium. In other words, the condition says that the per unit ER activity cost should not exceed the change in the maximum non-ER action cost, a change that takes place due to the financial institution's higher expected investment value to the ER firm.

Consequently, it can be concluded that the implementation of a generally agreed auditing regime will solve the asymmetric information problem but not completely, only partially. The degree of comprehensiveness of the solution depends on the cost of this auditing scheme. Still, there will be firms where the above condition will not be satisfied and the higher the cost of the auditing program the more firms will not participate even though they engage in ER activity

4 Examples

In order to add some empirical evidence to our theoretical model, the chemical industry is presented as an example. Table 1 shows the values of the model's variables and Table 2 shows the final estimations of the two examples. Various sources were used to collect information as close to reality as possible in order to create the specific examples

Table 1 Values of variables (the values are estimated in "Appendix")

Variables	$e(i, r, k)$	c^{er}	c^{re}	u	p_u^{er}	p_u^n	p_l^{er}	p_l^n
Values (US$)	150,000	150,000	90,000	600,000	0.1	0.3	0.01	0.7

that follow. More information is provided in the "Appendix". Note that although arbitrary, the values of the parameters are not far from reality because they are based on real evidence taken from the literature. The example is not to be taken as a real case but only for illustrative purposes and in order to better understand the theoretical model presented.

4.1 Example 1

Two cases are examined when an auditing certification system is not in place, that is, when the problem of asymmetric information exists (Table 2).

C1 Firm (F) has taken ER action and financial institution (FI) believes that the firm has probability $q=0.7$ to have taken the ER action. In this case, the cost for F of taking ER action ($211,500) is lower than the costs of not taking the ER action ($285,000) so F has to continue applying ER actions, while FI does not have the incentive to re-evaluate (RE) as the cost of not doing so ($128,550) is lower than the cost of doing so ($255.000). This shows that, as there is a high level of environmental information regarding ER action, FI has no incentive to RE the environmental status of firm. This case does not negate our asymmetric information model, it just shows a case in the chemical industry where environmental problems are extremely costly and it is almost sure that the firm takes ER actions and financial institutions *know* that. However even in this case, the third-party auditing certification scheme, which totally eliminated asymmetry of information ($q=1$) further reduces the cost considerably of not re-estimating and re-evaluating for the financial institution (61,500 vs. 128,550).

C2 In this case, our point is much clearer: F has taken the ER action (F's cost of taking the ER action, $211,500, is lower than the cost of not taking the ER action, $285,000) and FI believes that F has taken the ER action with probability $q=0.1$. FI has now the incentive to engage in the re-evaluation and re-estimation of its risk management and environmental status of the firm because the expected cost of RE is less ($255,000) than the expected cost of not doing a RE ($256,500), thus incurring an unnecessary cost. This clearly shows the inefficiency stemming from the problem of asymmetric information.

4.2 Example 2

A case is examined when a credible third-party auditing certification system is in place (Table 2).

C1 F has taken ER actions and FI has complete information about it ($q=1$). F's cost of not initiating ER measures ($285,000) is higher than the costs of doing so ($211,500) so the firm has an incentive to implement the ER action. In this case, FI has no incentive to do a RE, as the cost of not doing so ($61,500) is considerably lower than the cost of doing so ($285,500). In this case, it appears that F has an incentive to participate in the certification system, as the cost of the ER action plus the cost of certification ($211,500+$50,000=$261,500) is still lower than the cost of not taking the ER action ($285,500). All this gain that the FI has can be partly

Table 2 Results

		Example 1: Current situation, asymmetric information					Example 2: Asymmetric information alleviated through a credible auditing certification system			
		Firm		Financial institution			Firm		Financial Institution	
		ER[a]	Non-ER[b]	RE not done[c]	RE done[d]		ER[a]	Non-ER[b]	RE not done[c]	RE done[d]
C 1	$q=0.7$	211,500	285,000	128,550	255,000	$q=1$	211,500	285,500	61,500	255,000
C 2	$q=0.1$	211,500	285,000	256,500	255,000					

[a] Costs estimated from the left hand side of formula (1)

[b] It is estimated from the right hand side of formula (1)

[c] It is estimated from the left hand side of formula (3)

[4] It is estimated from the right hand side of formula (4)

offered as an increased investment value to the firm and partly retained by the FI thus increasing the efficiency of the market. Actually, the higher investment value the FI can offer to the firm can be up to $193,500 (the difference between doing an RE and not doing so; $255,000–$61,500).

5 Conclusions

All existing certification schemes such as, GRI, AA1100, GAAP, as well as commissions, associations, and institutions such as the Security Exchange Commission or the Accounting Standards Association, among others, is a reaction of the market to this important problem of information asymmetry and is evidence of its importance. The problem is still far from being completely solved and some reasons for this are: (1) standards vary between countries or groups of countries (local and regional level) and consequently certification schemes vary and cannot be homogeneously applied in many countries; (2) the industrial sector and size of firms makes it hard to have a common denominator for all firms across industries; and lastly, (3) the issue of credibility is of crucial importance in solving the asymmetric information problem.

It was demonstrated that a generally agreed international environmental certification auditing scheme can be a solution to the asymmetric information problem; a program that will take into consideration firm size, industry, country and cultural idiosyncrasies and needs; a program that may have a federated type of organization and which cooperates with and coordinates already existing local, national and even international auditing schemes. This proposal is emerged from the contemporary mainstream idea for an international harmonization of accounting information through the GAAP [45] and a flexible competition among accounting standards through international boundaries [46]. This common strategy seems to be necessary for the modern economic environment as shaped under the phenomenon of globalization, the present economic recession and the character of environmental problems which go beyond the borders of one country and contain hidden financial risks (e.g., water and climate change risks). However, this is not going to solve the asymmetry problem completely because its implementation is costly. Our model shows that the cost of per unit implementation of the program should be less than the extra value of investment the financial institution will offer to the firm.

Empirical research is needed to estimate the cost of the implementation of such a program. It is true that if this cost gets split among all firms that want to participate, it may be relatively low. In our model, we talked about the per unit environmentally responsible activity. This means that the corresponding cost of verification for one ER action may be really low. Of course, a firm which participates in the program will be certified for a series of activities. We can imagine a checklist which includes many boxes to be ticked. It is not impossible that the whole auditing program is less costly that what the current situation in the financial markets is. At this point, it must be again stressed the importance of a general auditing certification scheme, which reflects industry characteristics. In other words, the checklist will be different for, say, a mobile phone company, a software company, and a chemical company. Industries may take the initiative to create such a checklist in collaboration with financial markets. It is possible that financial markets may also want to participate in the creation of such a program and financially contribute to its implementation given that financial markets are also partly responsible for the environmental harm caused by the firms they have invested in.

The fact that asymmetric information is highly costly is manifested in the financial markets with the series of programs that have been in place in order to decrease the asymmetry such as the ISO, GRI, GAAP, and EMAS. However, as mentioned in the first part of the paper, the problem has not been solved in a satisfactory way and financial markets still operate inefficiently due to the persistence of information asymmetry. The many certification and auditing systems have a cost due to their possible incompatibility. Different countries have different auditing schemes thus increasing the cost for big multinational firms which operate in several countries. One homogeneous, credible, and generally accepted auditing scheme would reduce these costs. It is true that the market is moving in this direction (there is an ongoing dialog between countries and industries in order to circumvent the problem of asymmetric information as well as the plethora of auditing schemes) and our paper offers an explanation of why this happens. It is because the parties involved (firms and financial institutions as well as other stakeholders such as governments, local communities, and consumers) want to reduce the cost of the solutions to the problem. Our results are in line with the results of Akerlof [47] and Chymis et al. [41]. A credible third-party certification scheme will partially—not completely—solve the problem because the solution is costly and there are always cases where this cost is higher than the benefit from the solution. However, historically, it has been shown that as technology and institutions improve and the costs of monitoring, auditing, and contracting decrease, the problem of information asymmetry decreases [48].

This study demonstrates the need of a generally agreed and trusted international environmental accounting certification auditing scheme. In accordance with the literature, we propose that the scheme should take into consideration the industry and the size of the firms as well as country specificities. Mining, petroleum, the chemical industry, pharmaceuticals,

food, machinery, and utilities are sectors that by their nature pollute more than those such as retail, software, telecommunications, the banking sector, and financial services. The international auditing scheme should be designed based on industry characteristics. This paper theoretically shows the problem of asymmetry of information and offers some indicative empirical evidence. Further and more thorough empirical evidence is absolutely needed. In order for the empirics to work, it would be necessary to compare similar firms in the same industry. For our theoretical needs here, this is not necessary. However, if we want to be able to talk with specific numbers (investment value change due to a separating equilibrium and not due to other reasons captured by the parameter k) it is imperative to compare similar firms. We know in practice it is impossible to compare identical firms (that would be the ideal scenario) but firms of a similar size in the same industry are sufficiently alike for the empirical study to have important value and shed considerable light on this complex problem.

Appendix

$e(i, r, k)$ The expected value of investment of FI is assumed to be \$150,000.

c^{er} A cost for ER action will occur as the average cost of EMS implementation. For instance, Bansal and Bogner [49] estimated the costs of ISO 14001 as \$20,000 for SMEs and \$200,000 for large firms, while Prakash and Potoski [50] calculated the same cost to range from \$25,000 to \$100,000 correspondingly. For the purpose of our examples, the cost of ER will be \$150,000 (an average value of \$100,000 and \$200,000 for large firms).

c^{re} The lack of an auditing system to assure the reliability of firm's environmental information could be translated by the financial institution as high loan loss provisions to evade the potential financial risks from a future accident. The height of a provision could range from 0 to 100 % of the expected investment. Even though international accounting standards (e.g., SFAS 5) have compelled the banking sector to acknowledge the likelihood of future financial losses by incorporating bad debt expense into its balance sheet, there are no standard methods and percentages to record it. For the purpose our examples, it is assumed as 60 % of investment, namely \$90,000 ($0.6 \times e(i, r, k)$).

u The height of remedy costs is related to the strength of the damages, the severity of legislation and ensuing penalties. For instance, Union Carbide India Limited paid \$3.3 billion for the clean-up costs after the chemical accident at its plant in Bhopal, India in 1984 [51: p. 876]. For the purpose of these examples, based on the work of Kleindorfer et al. [52], the total cost per chemical industry accident will be estimated approximately up to \$600,000 (sum of on-site property damage and of site property damage per accident).

p_u^{er} This probability is estimated by drawing data for the chemical industry from FACTS-Hazardous Materials Accidents Knowledge Base (http://www.factsonline.nl/browse-chemical-accidents-in-database/4). According to the data from the last 5 years, the average probability of an accident taking place in a chemical plant will be approximately 0.161 (as seen in the following table). The lack of information on whether these accidents have occurred by ER chemical firms or not leads to the assumption that the probability for an accident to happen by ER firms should be lower than the average probability (0.161). For the purpose of the examples, the probability is 0.1.

p_u^{n} Given the limitation of the model ($p_u^{er} > p_u^{n}$) and the above judgment, the probability of a firm which has not taken ER to have an accident is 0.3, higher than the average of 0.161.

p_l^{er} The height of this probability is associated with the intensity of environmental accidents, firms' environmental performance and subsequent on-site property damage and of site property damage (including penalties). Sharfman and Fernando [53: pp. 773] stated that "*undertaking environmental risk management activities by improving environmental performance can reduce the likelihood that firms will encounter extreme environmental events that can require heavy cash flows arising from compensation and clean up costs, and thereby make firms more vulnerable to bankruptcy*". The probability is estimated to be near to 0. For the purpose of the examples, it is assumed to be 0.01.

Years	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Number of Accidents	43	60	39	48	33	6
Probabilities	(43/365)=0.117	(60/365)=0.164	(39/365)=0.106	(48/365)=0.131	(33/365)=0.271	(6/365)=0.016
Probability mean	0.117+0.164+0.106+0.131+0.271+0.016=0.161					

p_l^n This probability will be high when the accident is large scale and accompanied by high penalties. The probability may be close to 1. Nevertheless, for the purpose of the examples, it is assumed to be 0.7.

c^c This includes the costs for certification by an external auditing certification system. This may be the sum of the costs of certification of ER action (e.g., ISO 14001) as well as the cost for certification for environmental accounting disclosures. Miles et al. [54] estimated certification fees of ER action to be approximately $30,000, while the certification costs for environmental accounting disclosures is considered to be $20,000 as evidenced by the price lists of charter accountants for conventional accounting auditing. Consequently, the total cost is $50,000.

References

1. O'Dwyer, B. (2005). Stakeholder democracy: challenges and contributions from social accounting. *Business Ethics: A European Review, 14*(1), 28–41.
2. Blowfield, M. (2005). Corporate social responsibility: reinvesting the meaning of development? *International Affairs, 81*(3), 515–524.
3. Gale, R. (2006). Environmental management accounting as a reflexive modernization strategy in cleaner production. *Journal of Cleaner Production, 14*, 1228–1236.
4. Lorraine, N. H. S., Collison, D. J., & Power, D. M. (2004). An analysis of the stock market impact of environmental performance information. *Account Forum, 28*, 7–26.
5. Lanoie, P., Laplante, B., & Roy, M. (1998). Can capital markets create incentives for pollution control? *Ecological Economics, 26*, 31–41.
6. de Beer, P., & Friend, F. (2006). Environmental accounting: a management tool for enhancing corporate environmental and economic performance. *Ecological Economics, 58*, 548–560.
7. Tucker, M. (1997). Climate change and the insurance industry: the cost of increased risk and the impetus for action. *Ecological Economics, 22*, 85–96.
8. Cormier, C., & Magnan, M. (2007). The revisited contribution of environmental reporting to investors' valuation of firm's earnings: an international perspectives. *Ecological Economics, 62*, 613–626.
9. Schaltegger, S. (1997). Information costs, quality of information and stakeholder involvement—the necessity of international standards of ecological accounting. *Eco-Management and Auditing, 4*, 87–97.
10. Dorweiler, P. V., & Yakhou, M. (2005). A perspective on the environment's balance sheet. *Journal American Academy and Business, 7*(2), 16–22.
11. Curran, M. M., & Moran, D. (2007). Impact of the FTSE4Good index on firm price: an event study. *Journal of Environmental Management, 82*, 529–537.
12. Nikolaou, I. E., & Yannacopoulos, N. A. (2009). The effect of environmental accounting on financial risk management of firms via insurance. *International Journal Monetary Economics Finance, 2*(1,8), 1–15.
13. Boyd, J. (1997). 'Green Money' in the bank: firm responses to environmental financial responsibility values. *Management and Decision Economics, 18*, 491–506.
14. Boyer, M., & Laffont, J. J. (1997). Environmental risks and bank liability. *European Economic Review, 41*, 1427–1459.
15. Coase, R. H. (1937). The nature of the firm. *Economica, 4*, 386–405.
16. Williamson, O. E. (1988). The logic of economic organization. *Journal Law Economics Organization, 4*(1), 65–93.
17. Spence, A. M. (1973). Job market signaling. *Quarterly Journal Economics, 87*, 355–374.
18. Hoque, Z. (2005). Linking environmental uncertainty to non-financial performance measures and performance: a research note. *The British Account Review, 37*, 471–481.
19. Healy, M. P., & Palepu, G. K. (2001). Information asymmetry, corporate disclosure, and the capital markets: a review of the empirical disclosure literature. *Journal of Accounting and Economics, 31*(1–3), 405–440.
20. Barth, E. M., Landsman, R. W., & Lang, H. M. (2008). International accounting standards and accounting quality. *Journal of Accounting Research, 46*(3), 467–498.
21. Lam, S.-S., & Du, J. (2004). Information asymmetry and estimation risk: preliminary evidence form Chinese equity markets. *Pacific-Basin Finance Journal, 12*, 311–331.
22. Verrecchia, R. (1983). Discretionary disclosure. *Journal of Accounting and Economics, 5*, 179–194.
23. Suijs, J. (2005). Voluntary disclosure of bad news. *Journal Business Finance and Accounting, 32*(7, 8), 1423–1435.
24. Dye, R. (1985). Disclosure of nonproprietary information. *Journal of Accounting Research, 23*, 123–145.
25. Wagenhofer, A. (1990). Voluntary disclosure with a strategic opponent. *Journal of Accounting and Economics, 12*, 341–363.
26. Skinner, D. (1994). Why firms voluntarily disclose bad news. *Journal of Accounting Research, 32*, 38–61.
27. Berhelot, S., Cormier, D., & Magnan, M. (2003). Environmental disclosure research: review and synthesis. *Journal of Accounting Literature, 22*, 1–44.
28. Neu, D., Warsame, H., & Pedwell, K. (1998). Managing public impressions: environmental disclosures in annual reports. *Accounting, Organizations and Society, 23*(3), 265–282.
29. Bewley, K. (2005). The impact of financial reporting regulation on the market valuation of reported environmental liabilities: preliminary evidence from US and Canadian public companies. *Journal International Finance Management Accounting, 16*(1), 1–48.
30. EC, 2001. Commission recommendation of 30 May on the recognition, Measurement and disclosure of environmental issues in the annual accounts and annual reports of companies, European Commission, 2001/453/EC.
31. Cooper, M. S., & Owen, L. D. (2007). Corporate social reporting and stakeholder accountability: the missing link. *Accounting, Organizations and Society, 32*, 649–667.
32. Gao, S. S., Heravi, S., & Xiao, Z. J. (2005). Determinants of corporate social and environmental reporting in Hong Kong: a research note. *Account Forum, 29*, 233–242.
33. Synnestvedt, T. (2001). Debates over environmental information to stakeholders as a policy instrument. *Eco-Management and Auditing, 8*, 165–178.
34. Nikolaou, E. I. (2007). Environmental accounting as a tool of qualitative improvement of bank's services: the case of Greece. *International Journal Finance Services Management, 2*(1–2), 133–143.
35. Dixon, R., Mousa, A. G., & Woodhead, D. A. (2004). The necessary characteristics of environmental auditors: a review of the contribution of financial auditing profession. *Account Forum, 28*, 119–138.
36. Dittenhofer, M. (1995). Environmental accounting and auditing. *Management Audting Journal, 10*(8), 40–51.
37. Power, M. (1997). Expertise and the construction of relevance: accountants and environmental audit. *Accounting, Organizations and Society, 22*(2), 123–126.
38. Gray, R. (2000). Current developments and trends in social and environmental auditing, reporting and attestation: a review and comment. *International Journal of Auditing, 4*, 247–268.

39. Watson, M., & MacKay, J. (2003). Auditing for the environment. *Managerial Auditing Journal, 18*(8), 625–630.
40. Holder-Webb, L., Cohen, J. R., Nath, L., & Wood, D. (2009). The supply of corporate social responsibility disclosures among U.S. firms. *Journal Business Ethics, 84*, 497–527.
41. Chymis, A. G., James, H. S., Konduru, S., Pierce, V. L., & Larson, R. L. (2007). Asymmetric information in cattle auctions: the problem of revaccinations. *Agricultural Economics, 36*, 79–88.
42. Chymis A.G. 2007. Using Friedman to understand the relationship between market competition and corporate financial performance. Published Dissertation, Department of Agricultural Economics University of Missouri-Columbia.
43. Waddock, S. A., & Graves, S. (2000). Performance characteristics of social and traditional investments. *Journal Investing, 9*(2), 27–38.
44. Griffin, J. J., & Mahon, J. F. (1997). The corporate social performance and corporate financial performance debate: twenty-five years of incomparable research. *Business Social, 36*(1), 5–31.
45. Carmora, S., & Tromberta, M. (2008). On the global acceptance of IAS/IFRS accounting standards: the logic and implications of the principles-based system. *Journal Accounting Public Policy, 27*, 455–461.
46. Sunder, S. (2002). Regulatory competition among accounting standards within and across international boundaries. *Journal Accounting Public Policy, 21*, 219–234.
47. Akerlof, G. A. (1970). The market for "lemons": quality uncertainty and the market mechanism. *Quarterly Journal Economy, 84*, 488–500.
48. North, D. C. (1990). *Institutions, institutional change and economic performance*. Cambridge: Cambridge University Press.
49. Bansal, P., & Bongner, W. C. (2002). Deciding on ISO 14001: economics, institutions, and context. *Long Range Planning, 35*, 269–290.
50. Praksh, A., & Potoski, M. (2007). Investing up: FDI and the cross-country diffusion of ISO 14001 management systems. *International Studies Quarterly, 51*, 723–744.
51. Eckerman, I. (2005). The Bhopal gas leak: analyses of causes and consequences by three different models. *Journal of Loss Prevention in the process industry, 18*, 213–217.
52. Kleindorfer, P. R., Belke, J. C., Elliott, M. R., Lee, K., Lowe, R. A., & Feldman, H. I. (2003). Accident epidemiology and the U.S. chemical industry: accident history and worst-case data form. *RMP*Info, Risk Analysis, 23*(5), 865–881.
53. Sharfman, M. P., & Fernando, C. S. (2008). Environmental risk management and the cost of capital. *Strategic Management Journal, 29*, 569–592.
54. Miles, M. P., Munilla, L. S., & Russel, G. R. (1997). Marketing and environmental registration/certification: what industrial marketers should understand about ISO 14000. *Industrial Marketing Management, 26*, 363–370.