Environ Resource Econ (2009) 44:245–262
DOI 10.1007/s10640-009-9282-8

ISO 14001 Environmental Certification: A Sign Valued by the Market?

Joaquín Cañón-de-Francia · **Concepción Garcés-Ayerbe**

Received: 5 October 2006 / Accepted: 26 March 2009 / Published online: 11 April 2009

Abstract The main purpose of this work is to analyse whether ISO 14001 certification is interpreted by the capital market as a sign of environmental responsibility, modifying long-term efficiency expectations and the profitability of firms. Under competing assumptions that ISO 14001 certification is adopted by firms either proactively or reactively, we test competing hypotheses about how this certification affects the market value of firms. The analysis is based on a sample of 80 environmental certifications of the plant systems or processes of large Spanish firms which traded on the continuous market of the Madrid Stock Exchange from 1996 to 2002. Using event study methodology, we found that ISO 14001 certification has a negative effect on the market value of certain firms. Specifically, the results obtained seem to show that the market negatively views the allocation of resources to ISO 14001 certification in the case of less polluting and less internationalised firms. On the other hand, the results obtained do not suggest clear evidence that the economic impact of ISO 14001 certification is negative for more polluting and more internationalised firms.

Keywords Environmental Management System · Environmental proactiveness · ISO 14001 certification · Market value · Resource-based view · Event study methodology

1 Introduction

In recent years and as a result of growing economic and social pressures, companies have reconsidered their attitude to the environment. A firm's ability to respond to environmental pressure determines its relationship with stakeholders and, therefore, the achievement of sufficient social legitimacy to protect their profits. A valid response to institutional pressure

J. Cañón-de-Francia (✉) · C. Garcés-Ayerbe
Departamento de Economía y Dirección de Empresas, University of Zaragoza (Spain), Gran Vía, 2, 50005 Zaragoza, Spain
e-mail: jcanon@unizar.es

C. Garcés-Ayerbe
e-mail: cgarces@unizar.es

regarding environmental affairs is ISO 14001 certification (Bansal and Bogner 2002). This voluntary, international standard, created in 1996 by the International Organization for Standardization (ISO), enables firms to inform stakeholders of the application of an Environmental Management System (EMS). The ISO 14001 standard defines EMS as "the general part of management that includes the organizational structure, the activity planning, the responsibilities, the practices, the procedures, the processes and the resources to develop, implement, carry out, and revise the environmental policy and keep it up to date." In brief, and according to Boiral (2007), ISO 14001 represents both an internal management tool and a way of advertising an organisation's legitimacy among stakeholders.

Although voluntary ISO 14001 certification does not guarantee a specific level of improvement in environmental performance.[1] there is empirical evidence (for example Potoski and Prakash 2005 or Link and Naveh 2006) that this standard does help to improve the environmental performance of organisations. Indeed, when an organisation obtains ISO 14001 certification, it means that it meets a series of requirements aimed at reducing its impact on the natural environment. According to Link and Naveh (2006), these requirements can be summarised as follows: the development and adoption of an environmental policy to which top management is committed; the design of a planning process that identifies all environmental requirements and defines objectives and targets for environmental improvement; the clear definition and assignment of responsibility for environmental management, in addition to programmes for training, increasing awareness and developing skills among employees; the availability of a system for checking and taking corrective action and a system for monitoring, reporting and prevention; and the establishment of a management review process which guarantees continuous improvement.

Environmental management literature focused on the study of economic repercussions of ISO 14001 certification is usually based either on case studies that are difficult to generalise (as in Darnall et al. 2000; Rondinelli and Vastag 2000 or Boiral 2007) or on subjective measures related to manager perception (as in Delmas 2001; Melnyk et al. 2002; Montabon et al. 2000 or Link and Naveh 2006). However, we have been unable to find studies providing an objective measurement of the impact of ISO 14001 certification on economic performance. This is the purpose of this paper. Indeed, we attempt to gain more objective knowledge of the economic consequences possibly derived from the certification of a firm's Environmental Management System. Specifically, we performed an event study to analyze how ISO 14001 certification affects the market value of certified firms. We therefore analyses whether ISO 14001 certification is interpreted by the capital market as a sign of environmental performance which guarantees a firm's legitimacy and creates expectations of long-term efficiency and profitability.

Although there is extensive theoretical and empirical literature regarding the relationship between environmental and economic performance, there is no consensus regarding the sign of this relationship.[2] Indeed, although a growing movement—under the "It Pays to be Green" hypothesis—(Porter 1991; Porter and Van der Linde 1995; Hart and Ahuja 1996; Russo and Fouts 1997; Konar and Cohen 2001; King and Lenox 2002) replaces the traditional perspective that there is a trade-off between environmental and economic results, recent empirical research still finds a negative or insignificant relationship (e.g. Filbeck and Gorman 2004; Telle 2006 or Ziegler et al. 2007). Therefore, this paper justifies and

[1] The requirements for obtaining ISO 14001 certification basically refer to the process and not to the outcome. In other words, this standard does not require the achievement of specific environmental results beyond compliance with legislation, but it does require having the means available to reach the environmental objectives established by the firm that is applying for certification.

[2] See Wagner et al. (2001) for an overview.

tests competing hypotheses about how ISO 14001 certification affects the market value of firms.

The paper is structured under six headings. In the second section, we review the literature that studies the relationship between environmental and economic performance and present arguments explaining how ISO 14001 certification can modify investors' expectations. The third and fourth sections describe the sample and the methodology. The fifth presents the results. Finally, the sixth section summarises our most significant conclusions.

2 Background

2.1 The Relationship Between Environmental and Economic Performance

The first studies that established a relationship between the environmental and economic performance of firms arose in the seventies when, in the United States, a strict process of environmental regulation of industry coincided with a considerable decrease in growth indicators referring to competitiveness. The studies which analysed the possible causal relationship between these two events, compiled in Christainsen and Haveman (1981) and subsequently in Jaffe et al. (1995), represent what is known as the conventional literature. It concludes that the investment made to comply with environmental regulations improves environmental performance, while reducing the productivity and competitiveness of firms.

The conventional hypothesis that there is a trade-off between environmental and economic performance has been subsequently justified as a possible result of the inflexibility of legislation when imposing terms and forms of compliance (Jaffe et al. 1995). Porter (1991) and subsequently Porter and Van der Linde (1995) , for example, argued that the command-and-control nature of the U.S. environmental regulations of the seventies jeopardised the competitiveness of U.S. firms. According to these authors, this form of regulation (in addition to being very costly) often discourages or prevents innovative solutions.

Based on these arguments, it has been suggested that reactive environmental strategies that are limited to compliance with the most immediate requirements are a way to remedy environmental problems in the short term, which does not improve a firm's competitive position (Russo and Fouts 1997). Many firms, therefore, are channelling their behaviour towards voluntary or proactive pollution prevention strategies by anticipating rather than reacting to requirements and demands. The economic advantages of this kind of environmental strategy have been argued from a theoretical perspective by authors such as Porter (1991), Porter and Van der Linde (1995) or Xepapadeas and Zeeuw (1999). These authors, according to the so-called "Porter Hypothesis," suggest that it is possible to find a "free lunch" in the relationship between proactive environmental investments and firms' results. Indeed, anticipating environmental requirements enables firms to take advantage of the adaptation process to introduce innovations that improve their overall operations. In other words, environmental quality objectives can be achieved while decreasing production costs or improving productivity.

From an empirical perspective, a large number of studies confirm the existence of a positive effect of environmental performance on economic performance. Hart and Ahuja (1996) and Russo and Fouts (1997) , for instance, using regression analyses, find a positive impact of environmental performance on economic performance indicators (return on assets, return on sales and return on equity) net of the control variables traditionally believed to explain firm-level financial results. Using a similar method, Konar and Cohen (2001) and Guenster et al. 2006 find evidence that environmental performance also improve firms' intangible asset value (Tobin's q). The same result was obtained by King and Lenox (2001, 2002) using panel data econometrics, which also control the impact of unmeasured firm and industry characteristics. On other occasions, evidence of the positive consequences of green performance has been deduced from the market's reaction to certain signs of a firm's environmental responsibility – earning awards, the reduction of pollution levels, etc. (Hamilton 1995; Klassen and Mclaughlin 1996; Feldman et al. 1997; Konar and Cohen 1997 or Khanna et al. 1998).

The aforementioned studies suggest that a growing movement—under the "It Pays to be Green" hypothesis—is replacing the traditional perspective that there is a trade-off between environmental and economic results. However, there is still considerable debate about this relationship. Some recent studies find evidence of an insignificant or negative impact of environmental performance on economic performance. Telle (2006), for instance, finds that environmental performance has a positive effect on economic performance (measured by the return on sales ratio) when, as in most of the previous studies, a pooled regression is estimated. However, when the regression model is estimated using panel methodology, which controls for unobserved plant heterogeneity, the effect is no longer statistically significant. Ziegler et al. (2007), on the other hand, consider a two-dimensional measurement of sustainability performance and use a regression analysis to find that, whereas the sustainability performance of the industry in which a corporation operates has a positive impact on stock performance, it is not affected by the relative environmental or social performance of a corporation within a given industry. Furthermore, Filbeck and Gorman (2004) perform both portfolio and regression analyses, finding in both cases evidence of a negative relationship between financial return and a measure of environmental performance.

The lack of consensus concerning the sign of the relationship between green and economic results has been justified in the literature in several ways. Telle (2006), for example, emphasises the importance of the analytical method. According to this author, the conclusion that "It Pays to be Green" has been prematurely reached through unsatisfactory analytical methods with an omitted variable bias problem. The need to address this problem is also clear in King and Lenox (2001). Although they find evidence of an association between lower pollution and higher financial valuation, they find that this association may be derived from a firm's fixed characteristics and strategic position.

Filbeck and Gorman (2004), on the other hand, claim that regulation complicates the relationship between environmental and financial performance. They establish that, in this relationship, the more or less strict nature of the environmental requirements is of some importance. They use this argument to justify the unexpected finding that firms with better environmental performance register worse financial performance. In conjunction with this argument, King and Lenox (2001, 2002) or Guenster et al. (2006) believe that the relationship between environmental and financial results is determined by the conditions in which environmental measures are implemented. In this regard, King and Lenox (2001) argue that "When does it pay to be green?" may be a more important question than "Does it pay to be green?" Also, King and Lenox (2002) find strong evidence that waste prevention leads to financial gains, but "end-of-pipe" pollution treatment does not affect economic performance. Indeed, as Guenster et al. (2006) noted, the financial information related to environmental performance is not evidence in itself. These authors, consistent with other academics such as Hart and Ahuja (1996), King and Lenox (2002) and Russo and Fouts (1997), emphasise that firms can reach environmental results through "end-of-pipe" pollution control—reactive solutions—but that the likelihood of increasing operating efficiency and profitability is less than when implementing proactive pollution prevention techniques.

2.2 The Repercussion of ISO 14001 Certification on the Market Value of Firms

Based on the above arguments, when studying the financial repercussion of ISO 14001 certification, we have to consider whether it is a sign of proactivity in response to environmental requirements. According to Sharma and Vredenburg (1998), environmental responsiveness is proactive if it exhibits a consistent pattern of environmental practices that go beyond compliance with environmental regulations or standard business practices in response to isomorphic pressures within the industry. Considering this definition, and under competing assumptions about whether ISO 14001 certification can be interpreted as a sign of proactivity in environmental management, we pose competing hypotheses about how this standard affects the market value of firms.

We first present arguments in favour of interpreting the standard as a measure of environmental proactivity. Indeed, ISO 14001 certification arose as a self-regulation instrument guiding firms towards achieving environmental management objectives at their production centres. Given that ISO 14001 certification is a voluntarily adopted measure, it is reasonable to believe that a firm's environmental adaptation is being carried out in a flexible manner and in anticipation of demands. According to Porter (1991), Porter and Van der Linde (1995), under these circumstances of flexibility and anticipation, the process of environmental adaptation can be used to improve a firm's overall operations and, consequently, obtain competitive advantages.

The way in which ISO 14001 certification reinforces a firm's competitive position has been studied by some authors from the resource-based view perspective, which assumes that a competitive advantage can only be sustained through scarce, causally ambiguous and socially complex resources and capacities, which are difficult for competitors to copy (Barney 1991; Grant 1991; Rumelt 1984). The main resources and capabilities that have been associated in the literature with the process of implementing the ISO 14001 standard are the following: first of all, it has been verified that the environmental policies on which ISO 14001 is based are intensive in *human capital*, meaning that they depend on tacit skills that can only be acquired through worker involvement and teamwork (Chin and Pun 1999). Under conditions of flexibility and anticipation, ISO 14001 certification can therefore favour the creation of socially complex and causally ambiguous organisational capabilities, which in turn can evolve into a sustainable competitive advantage. Secondly, ISO 14001 involves the development of an *information system* which favours communication and enhances awareness of environmental impact on the value chain, as well as an awareness of the effort to reduce such impact (Melnyk et al. 2002; Sarkis and Kitazawa 2000). Moreover, in multinational firms, it favours the development of global capabilities, thereby allowing standardisation and co-ordination between plants (Bansal and Bogner 2002). Given the complexity and specifics of the development of an information system in every firm, it can represent a valuable and causally ambiguous resource.

Furthermore, ISO 14001 certification can become a valuable tool by favouring the implementation of preventive *technologies* that anticipate future demands (Bansal and Bogner 2002). In this regard, it has been observed that firms which limit themselves to complying with the most immediate requirements do not take the latest technological progress into account. This lack of foresight means that radical changes have to be made in the event of an unexpected change in an environmental regulation, with the ensuing risk of diseconomies (Nehrt 1996; Bansal and Bogner 2002). Anticipation through preventive technologies, in addition to avoiding radical changes, is designed to minimise the consumption of resources and energy, which can decrease production costs and at the same time improve the environmental result (Dowell et al. 2000; Klassen and Whybark 1999). The impact of ISO 14001 certification on the adoption of new technologies has recently been verified by Radonjic and Tominc (2006). These authors find that ISO 14001 is a very useful tool for technological modernisation and for accelerating technological innovation activities.

However, when a company develops an environmental policy, the ultimate objective is to build intangible assets of *reputation* (Arora and Gangopadhyay 1995). Companies attempt to respond to the expectations of all pressure agents through environmental strategy. This strategy is the result of a long history of internal decisions and changes, which make it difficult to observe and evaluate. However, this long history can be measured when a single event is signalled to the market (Klassen and Mclaughlin 1996). Therefore, ISO 14001 certification is especially valuable due to its ability to signal to stakeholders that the firm is implementing a series of internal improvements through an Environmental Management System (Bansal and Bogner 2002; De Backer 1999; Delmas 2001; Montabon et al. 2000). Moreover, firms that carry out an environmental quality signalling strategy will be even more difficult to imitate (Toms 2002). Consequently, from the resource-based view, they reinforce protection of their competitive advantage. This argument is consistent with Bozeman (1987), who affirms that a competitive advantage has to be created within a broad framework of social legitimacy.

If the assumption of rationality is accepted in the capital market, the above arguments lead to the proposal that ISO 14001 certification can improve the long-term profit expectations of investors. This can be expected to be reflected in the value of a firm's share prices, leading to the following hypotheses:

Hypothesis A A firm's ISO 14001 environmental certification is reflected in its share price through abnormal positive returns on the date when certification is granted.

In the justification of Hypothesis A, we assumed that ISO 14001 is a self-regulation instrument which firms voluntarily adopt under flexible conditions. However, there are reasons to believe the competing assumption that ISO 14001 represents a compulsory response to isomorphic pressure within the industry. This argument can be studied according to institutional theory, which analyses the social and cultural pressures that lead firms to become more isomorphic (DiMaggio and Powell 1983; Scott 1992). The degree of institutionalisation reached by ISO 14001 certification in industrialised countries has made this standard a necessary requirement for entering the market. There are arguments in the literature indicating that institutional pressure from regulators and markets may play an important role in encouraging companies to adopt environmental practices similar to ISO 14001 (Darnall 2006; Boiral 2007; Darnall et al. 2007). Indeed, some authors, such as Russo and Harrison (2001), interpret ISO 14001 certification as a symbolic action which improves the firm's legitimacy in the eyes of its stakeholders. Similarly, Boiral (2007) argues that rational structures and practices such as the ISO 14001 system tend to be introduced more by reason of social legitimacy than due to real concerns for efficiency.

The assumption that firms adopt the ISO 14001 Standard in response to institutional pressure leads to the proposal of a competing hypothesis about its impact on economic results. Indeed, applying the arguments of Porter (1991) or Porter and Van der Linde (1995) to the ISO 14001 adoption process, if this standard is adopted reactively, the certification process would not be expected to have the degree of flexibility and necessary anticipation to take advantage of resources such as involving human capital or implementing novel pollution prevention technologies. It is reasonable to expect that the adaptation process for compliance with the standard's requirements would be based fundamentally on reactive types of environmental investment, such as the use of end-of-pipe technologies. These end-of-pipe treatments often lead to unexpected costs (King and Lenox 2002) and represent an additional, not directly productive cost, given that they do not improve the production process and methods and shift other directly competitive investments (Porter and Van der Linde 1995). Numerous authors share these arguments regarding the process of adopting an EMS. For example, Darnall et al. (2007) have recently established that firms motivated by institutional pressures to adopt an EMS present worse business performance than those which are motivated by complementary resources and capabilities. Also, Darnall and Edwards (2006), in an analysis of the factors affecting the cost of EMS adoption, find empirical evidence that firms which do not apply pollution prevention practices have greater adoption costs.

Under the assumption that ISO 14001 is reactively adopted by firms, we pose the hypothesis that obtaining this Standard reduces the long-term profit expectations of investors. The following hypothesis is tested:

Hypothesis B A firm's ISO 14001 environmental certification is reflected in its share price through abnormal negative returns on the date when certification is granted.

3 Methodology

The methodology applied in this study is known as event study. According to the Efficient Market Hypothesis, the information received by investors is continuously evaluated and reflected in share price, which represents the most accurate estimation of the current value of future discounted cash flows (Fama 1970). In other words, share prices reflect investors' expectations regarding a firm's long-term efficiency and profitability. Therefore, by analysing the evolution of the earnings per share of affected firms in a brief period of time around the event day—in this case, when ISO 14001 certification was granted—while isolating other factors, we are able to measure the impact of the event in question on the value of these firms.

An assumption of rational behaviour has often been accepted with reference to the Spanish capital market, the semi-strong efficiency—to use the terminology of Fama (1970)—of which has been confirmed in studies by González (1995), González (1997), Ruiz and Espitia (1996).

There are alternative models for carrying out an event study (Mckinlay 1997). We started by applying the traditional method proposed by Brown and Warner (1985) and based on the market model. This model was recently applied in the study of environmental events by authors such as Gupta and Goldar (2005) or Dasgupta et al. (2006). The market model establishes a linear relationship between the return on each security and the return on the market portfolio (Sharpe 1964).

$$R_{it} = \alpha_i + \beta_i R_{mt} + e_{it}$$

where t is the time index, $i = i, \ldots, N$ represents securities and e_{it} is the error term associated with security i and the time index t (with $E(e_{it}) = 0$ and $Var(e_{it}) = \sigma_{e_i}^2$), R_{it} and R_{mt} are the period-t returns on security i and the market portfolio (measured through the General Index of the Madrid Stock Exchange) respectively. α_i, β_i, and $\sigma_{e_i}^2$ are the parameters of the market model.

Parameters α_i, β_i and $\sigma_{e_i}^2$ have been estimated by Ordinary Least Squares (*OLS*) over a period of 120 days, which includes from day –139 to day –20 prior to the date of certification ($t = 0$). This 120-day period is the length of the estimation period (L). This estimation period ends 20 days before the event in order to exclude abnormal returns due to its announcement.

The relationship between firm returns and market returns should remain unaltered in the absence of unanticipated information. Therefore, with the estimates of α_i and β_i, a normal return can be predicted during the days covered by the event window. The event window is defined as the period from some days prior to the event to some days after the event.

The prediction error, or estimated abnormal return ($A\hat{R}_{it}$), for firm i on day t has been estimated as the difference between the actual return of security i over the event window and the predicted normal return of security i over the event window:

$$A\hat{R}_{it} = R_{it} - \widehat{\alpha}_i - \widehat{\beta}_i R_{mt}$$

In order to draw overall inference about the reaction of capital markets, abnormal returns can be aggregated across a number of events. Hence, for any given subset of N events (or securities), the subset estimated average abnormal returns ($AA\hat{R}_t$)at each day t within the event window is computed as

$$AA\hat{R}_t = \frac{1}{N}\sum_{i=1}^{N} A\hat{R}_{it}$$

For an event period consisting of more than one time period (day), the abnormal return can be added to obtain estimated cumulative abnormal returns. Estimated cumulative abnormal returns ($CA\hat{R}_i(T_1, T_2)$) for security i for the period T_1 to T_2 are given by

$$CA\hat{R}_i(T_1, T_2) = \sum_{t=T_1}^{T_2} A\hat{R}_{it}$$

where $T_a \leq T_1 \leq t \leq T_2 \leq T_b$ and T_a and T_b are the lower and upper limits of the event window, respectively.[3] In this study, abnormal returns have been accumulated in the event windows included in the ($T_a = -1$, $T_b = +1$) interval.

Following the recommendations of McWilliams and Siegel (1997), we decided to analyse a small window. These authors show that a long event window reduces the power of statistical tests and can lead to false conclusions about the event's significance, as it is much more difficult to control for confounding effects when long windows are used.[4] A three-day window is therefore long enough to capture the significant effect of the event (it allows a certain advance in the reflection of the information by the market, as well as a certain delay), but short enough to exclude confounding effects.

The following aggregation is across both time and events. The estimated average cumulative abnormal return for a subset of N events between two dates T_1 and T_2 is defined as:

$$CAA\hat{R}(T_1, T_2) = \frac{1}{N}\sum_{i=1}^{N} CA\hat{R}_i(T_1, T_2)$$

The next step is to test whether the abnormal returns are statistically different from zero. The conventional parametric test described by Brown and Warner (1985) makes the restrictive assumption that abnormal returns should follow a normal distribution. These authors

[3] T_1 and T_2 are thus contained within the event window and the aggregation of the abnormal return takes place between those days within the window. As a possibility, T_1 can coincide with the lower boundary of the event window and T_2 with the upper boundary. In this study the windows analysed are: $(-1, 0)$, $(0, +1)$ and $(-1, +1)$. The effect of the certification's publication on the same day that it is granted (day 0) has also been analysed.

[4] Although the methods developing long-horizon event studies have improved in recent years, serious challenges related to model specification, skewness and cross-correlation remain (see Kothari and Warner 2007, for a review).

therefore propose modifications to the basic approach presented above, involving standardising each abnormal return using an estimator of its standard deviation (Brown and Warner 1985; Mckinlay 1997). The purpose of standardisation is to ensure that each abnormal return will have the same variance (see Patell 1976). Each abnormal return $A\hat{R}_{it}$ is first divided by its estimated standard deviation to yield a estimated standardised abnormal return $SA\hat{R}_{it}$:

$$SA\hat{R}_{it} = \frac{A\hat{R}_{it}}{\widehat{S}_{it}}$$

where

$$\widehat{S}_{it} = \sqrt{\frac{1}{119}\sum_{t=-139}^{-20}\left(AR_{it} - \overline{AR_i}\right)^2},$$

and

$$\overline{AR_i} = \frac{1}{120}\sum_{t=-139}^{-20} AR_{it}$$

Brown and Warner (1985) show that when the cross-sectional independence assumption is valid, such standardisation can lead to more powerful tests. Therefore, considering the following null hypotheses for $AAR_t(H_0 : AAR_t = 0)$, the test statistic for any given day (in this case $t = 0$) is given by

$$Z_1 = \sum_{i=1}^{N} SA\hat{R}_{it}/\sqrt{N} \quad \approx N(0, 1)$$

where N is the number of sample securities at day t. If the standardised abnormal returns are independent and identically distributed with finite variance, in the absence of abnormal performance, the test statistic (Z_1) will be distributed unit normal for large N.

Subsequently, the estimated standardised cumulative abnormal returns $CSA\hat{R}_i(T_1, T_2)$ are calculated over an event interval period (T_1 to T_2) as:

$$CSA\hat{R}_i(T_1, T_2) = \frac{\sum_{t=T_1}^{T_2} SA\hat{R}_{it}}{\sqrt{T_2 - T_1 + 1}}.$$

Under the null hypotheses for $CAAR(T_1, T_2)(H_0 : CAAR(T_1, T_2) = 0)$, the test statistic (Z_2) is calculated as follows:

$$Z_2 = \frac{1}{N}\sum_{i=1}^{N} CSA\hat{R}_i(T_1, T_2)\sqrt{N} \quad \approx N(0, 1)$$

If the estimated standardised cumulative abnormal returns $(CSA\hat{R}_i(T_1, T_2))$ are independent and identically distributed with finite variance, in the absence of abnormal returns the test statistic Z_2 will be distributed unit normal for large N.

However, if this assumption is not met, the sampling distribution of test statistics assumed for the hypothesis tests could differ from actual distribution, resulting in false inferences Brown and Warner (1980). We also use a non-parametric statistic to test the robustness of conclusions based on traditional parametric testing. This approach is free of specific assumptions concerning the distribution of returns and is regularly used in conjunction with its parametric counterparts.

We used the non-parametric rank test proposed by Corrado (1989) in this study. Compared to its parametric counterparts and standard non-parametric tests, this rank test improves specification under the null hypothesis and provides more power under the alternative hypothesis of abnormal returns.[5] Also, the specification of the rank test is less affected by an event-date excess returns variance increase than are parametric tests (Corrado 1989).

According to Corrado, *excess return* is the residual from the standard market model. This term is only used for the returns in the estimation window (L).

In order to calculate Corrado's test, each security's time series of market-model excess returns has to be transformed into its respective ranks. Let K_{it} denote the rank of the excess return. A uniform distribution is thus obtained, where the ranks of each security, i, range from 1 for the smallest excess return to T for the largest excess return (160 in our case).

$$K_{it} = \text{rank}(AR_{it}); \quad i = 1, \ldots, N; \quad t = -139, \ldots, +20\,^{6},$$

where $AR_{it} \geq AR_{ij}$, implying that $K_{it} \geq K_{ij}$ and $160 \geq K_{it} \geq 1$. By construction, the average rank is: $\bar{K} = (T+1)/2 = 80.5$. The rank statistic substitutes $(K_{it} - 80.5)$ for excess return AR_{it}. The rank test therefore uses the fact that the expected rank of the event day is $K_{it} = \bar{K} = (T+1)/2 = 80.5$ under the null hypothesis of no abnormal returns ($H_0 : AAR_t = 0$). The test statistic for the null hypothesis is:

$$Z_3 = \frac{1}{N} \sum_{i=1}^{N} (K_{i0} - 80.5)/S(K) \approx N(0, 1)$$

The standard deviation $S(K)$ is calculated using the entire 160-day sample period:

$$S(K) = \sqrt{\frac{1}{160} \sum_{t=-139}^{+20} \left(\frac{1}{N} \sum_{i=1}^{N} (K_{it} - 80.5) \right)^{2}}$$

Finally, under the null hypotheses for $CAAR(T_1, T_2)(H_0 : CAAR(T_1, T_2) = 0)$, the test statistic will be given by the following expression:

$$Z_4 = \frac{\frac{1}{N}}{\sqrt{T_2 - T_1 + 1}} \sum_{i=1}^{N} \sum_{t=T_1}^{T_2} \frac{(K_{it} - 80.5)}{S(K)} \approx N(0, 1)$$

The ranking procedure transforms the distribution of security excess returns into a uniform distribution across the possible rank values regardless of any asymmetry in the original distribution (Corrado 1989). Therefore, under the assumption of no cross-sectional correlation, the asymptotic null distribution of test statistic Z is distributed unit normal.

We analyse the possible differences between the sub-sample of observations in order to understand the origin of the abnormal returns, considering the variables related to the degree of pressure exercised by stakeholders. Taking the limitations of the available information into account, we selected two variables: degree of pollution and degree of internationalisation.

[5] A problem with previous non-parametric tests, signed rank and sign tests, is the requirement that excess return distributions be symmetrical for correct test specification. The simple rank test studied here is correctly specified no matter how skewed the cross-sectional distribution of excess returns (Corrado 1989).

[6] We have extended the analysis up to day +20 in order to detect possible effects in broader windows. Both the parametric and non-parametric tests were performed in broader windows.

The arguments endorsing the choice of these two variables are found in the fact that the more polluting a firm is and the broader the market in which it operates, the more likely it is to be required to have ISO 14001 certification. Two sub-samples of plants are defined considering the “degree of pollution” variable: a *highly polluting group* (plants operating in the petroleum, energy, paper and chemical industries) and a *moderately polluting group* (plants in all other industries). The criterion applied by Delgado et al. (2004) was used in relation to division into sub-samples according to degree of internationalisation. This criterion distinguishes between firms with at least six subsidiaries outside the country of origin (multinationals) and firms with less than six (non-multinationals). Two sub-samples are defined: multinational and non-multinational group.

4 Sample Selection

The sample studied was based on the total number of ISO 14001 plant certifications that were granted to firms trading on the Madrid Stock Exchange’s Continuous Trading Market from 1996 (the year when the first plant in Spain received environmental certification) to 2002. We therefore used the databases of the three most important certification agencies operating in the country: AENOR, Bureau Veritas and Lloyd’s. The result of the search was 90 plant certification events belonging to 36 different firms trading on the Madrid Stock Exchange’s Continuous Trading Market throughout the considered period.

The second step was to eliminate the facilities for which market value could have been affected by events other than the publication of ISO 14001 on the analysis dates. Thus, events were eliminated when, on nearby dates, the firm announced its acquisition of a shareholding in a joint firm, an increase or decrease in profits, or a change of the par value of its shares, among others.

After the screening, in which 10 events contaminated by one of the above factors were eliminated, the study was carried out with 80 plant certification events belonging to 32 firms from several sectors (see Table 1).

One condition for applying event methodology is that the event must be novel information for the market. As most of the 32 firms considered here have more than one ISO 14001 certification, it is reasonable to consider the possibility that the novelty for the market is less when a second or third certification is obtained than with the first. The event study therefore only

Table 1 Sectoral distribution of plants

Sector description	No. of plants	No. of certifications
Petroleum refining, plastics and energy	6	29
Paper	2	6
Construction	5	12
Hotels and restaurants	1	2
Chemicals	3	11
Metallurgy and metal products	4	6
Food and beverages	5	7
Mechanical, electrical and electronics equipment	2	3
Others	4	4
Total	32	80

Table 2 Estimated abnormal returns derived from first certification sub-sample ($N = 32$)

Window	Estimated average cumulative abnormal return $CAA\hat{R}(T_1, T_2)$ (%)	Brown and Warner test	Corrado test	% Negative abnormal returns
(−1, +1)	−1.71	−2.73***	−2.30**	75.86
(0, +1)	−1.37	−3.14***	−1.92*	65.51
(−1, 0)	−1.36	−2.42**	−2.61***	79.31
Day 0	Estimated average abnormal return ($AA\hat{R}_t$) (%)	Brown and Warner test	Corrado test	% Negative abnormal returns
0	−1.01	−3.14***	−2.41**	72.41

* p-value < 0.1, ** p-value < 0.05, *** p-value < 0.01

considered the 32 events in which plants received their first certification. Subsequently, after finding that the results are significant even when the 80 certification events are considered, we conducted additional event studies to test the hypotheses in different firm portfolios.

5 Results and Discussion

The results when only the first certification sub-sample is considered are shown on Table 2. The first column presents the estimated average cumulative abnormal returns $CAA\hat{R}(T_1, T_2)$ derived from certification for the windows between two dates: $T_a = -1$ and $T_b = +1$ in the entire sample of firms. It also shows the estimated average abnormal returns ($AA\hat{R}_t$) for the day when certification is granted (day 0).

This table also shows the results of the Brown and Warner and Corrado tests. Moreover, and in order to show the possible influence of *outliers* in the sample, the last column shows the percentage of positive or negative abnormal returns in each window.

As we can see from Table 2, the abnormal returns are negative and significant for all windows according to the Brown and Warner and Corrado tests. These results lead us to reject hypothesis A and accept hypothesis B, according to which ISO 14001 certification is reflected in a firm's share price through negative abnormal returns on the date when it is granted.

Abnormal returns continue to be negative and significant when the complete sample of certifications is considered in the event study (see Table 3). According to these two tables, abnormal returns are more significant for the first certification sub-sample than for the complete sample. This shows that first certification provides the market with more information than subsequent certifications and that, as a result, the market's reaction is more moderate after the second certification.

According to the results obtained, the Spanish market does not identify ISO 14001 certification as a sufficiently clear guarantee of use of resources and capabilities to generate expectations of a competitive advantage. On the contrary, investors associate certification with benefit expectations below costs. A possible reason for this would be that the Spanish capital market perceives ISO 14001 certification more as a reactive than as a proactive

Table 3 Estimated abnormal returns derived from the complete sample of certifications ($N = 80$)

Window	Estimated average cumulative abnormal return $CAA\hat{R}(T_1, T_2)(\%)$	Brown and Warner test	Corrado test	% Negative abnormal returns
$(-1, +1)$	−0.60	−2.67***	−1.82*	61.25
$(0, +1)$	−0.73	−2.73***	−1.96*	62.50
$(-1, 0)$	−0.11	−1.89*	−1.43	65.00
Day 0	Estimated average abnormal return $(AA\hat{R}_t)(\%)$	Brown and Warner test	Corrado test	% Negative abnormal returns
0	−0.25	−2.50**	−1.79*	62.50

* p-value < 0.1, ** p-value < 0.05, *** p-value < 0.01

Table 4 Estimated abnormal returns derived from certification in highly polluting sub-sample ($N = 46$)

Window	Estimated average cumulative abnormal return $CAA\hat{R}(T_1, T_2)(\%)$	Brown and Warner test	Corrado test	% Negative abnormal returns
$(-1, +1)$	−0.02	−0.66	−0.42	52.17
$(0, +1)$	−0.45	−1.44	−0.61	54.34
$(-1, 0)$	0.71	0.81	0.22	56.52
Day 0	Estimated average abnormal return $(AA\hat{R}_t)(\%)$	Brown and Warner test	Corrado test	% Negative abnormal returns
0	0.29	0.26	0.18	52.17

* p-value < 0.1, ** p-value < 0.05, *** p-value < 0.01

measure. In other words, certification may be perceived by the market as a measure aimed to respond to stakeholder pressure rather than voluntarily adopted to improve the firm's overall operation and favour its use of resources and generation of capabilities. In these conditions, it could be reasonably considered that establishing a suitable Environmental Management System could be subordinate to having an institutionalised standard but does not distinguish a firm from its competitors.

When analysing the market's reaction in the two subgroups of plants defined according to the degree of pollution (Tables 4 and 5), we did not find conclusive results for highly polluting firms. For this sub-group, the estimated average abnormal returns and the estimated average cumulative abnormal returns are not significantly different from zero. However, for moderately polluting firms, negative and significant abnormal returns are observed in all event windows.

With regards to division into sub-samples according to degree of internationalisation, the results concerning the impact of ISO 14001 certification on the market value of multinational corporations are not conclusive (Table 6). The estimated average abnormal returns for day 0 are significant according to the Brown and Warner test but not according to the Corrado test, leading us to question their statistical significance. Conclusive results are obtained, however,

Table 5 Estimated abnormal returns derived from certification in moderately polluting sub-sample ($N = 34$)

Window	Estimated average cumulative abnormal return $CAA\hat{R}(T_1, T_2)$ (%)	Brown and Warner test	Corrado test	% Negative abnormal returns
(−1, +1)	−0.56	−2.51***	−2.24**	70.58
(0, +1)	−0.87	−2.64***	−2.23**	70.58
(−1, 0)	−0.02	−2.68***	−2.40**	73.52
Day 0	Estimated average abnormal return $(AA\hat{R}_t)$ (%)	Brown and Warner test	Corrado test	% Negative abnormal returns
0	−0.34	−3.00***	−2.67***	73.52

* p-value < 0.1, ** p-value < 0.05, *** p-value < 0.01

Table 6 Estimated abnormal returns derived from certification in multinational sub-sample[a] ($N = 45$)

Window	Estimated average cumulative abnormal return $CAA\hat{R}(T_1, T_2)(\%)$	Brown and Warner test	Corrado test	% Negative abnormal returns
(−1, +1)	−0.26	−1.37	−1.11	57.77
(0, +1)	−0.54	−1.82*	−1.38	53.33
(−1, 0)	−0.16	−1.14	−0.45	62.22
Day 0	Estimated Average Abnormal Return $(AA\hat{R}_t)(\%)$	Brown and Warner test	Corrado test	% Negative abnormal returns
0	−0.11	−1.82*	−0.66	60.00

[a] Firms with more than six subsidiaries outside the country of origin
* p-value < 0.1, ** p-value < 0.05, *** p-value < 0.01

when non-multinationals are analysed (Table 7). In this case, significant negative average abnormal returns are found on day 0 according to both tests. We can therefore conclude that ISO 14001 certification generates negative abnormal returns in non-multinational firms.

The results obtained lead us to reject hypothesis A and accept hypothesis B in the sub-samples of firms subject to relatively minor institutional pressure (moderately polluting and non-internationalised firms). In this case, the capital market does not expect ISO 14001 certification to generate the economic advantages that could be associated with this standard. Indeed, the results show an adverse reaction of the market to certification.

However, the detection of an effect not significantly different from zero in the sub-samples of highly polluting and multinational firms, means than none of the competing hypotheses are accepted for the firms in these sub-samples. It is reasonable to say that, in these two sub-samples, the impact of ISO 14001 is neither clearly positive nor clearly negative.

There are arguments in the literature which could justify obtaining more optimistic results for the sub-samples of highly polluting and multinational firms. According to the literature, the fact that more polluting firms are subject to stricter regulation and to more acute external pressures leads them to be more receptive to adopting ISO 14001 (Bansal and Bogner 2002;

Table 7 Estimated abnormal returns derived from certification in non-multinational sub-sample ($N = 35$)

Window	Estimated average cumulative abnormal return $CAA\hat{R}(T_1, T_2)(\%)$	Brown and Warner test	Corrado test	% Negative abnormal returns
$(-1, +1)$	-0.91	-1.96^{**}	-1.54	65.71
$(0, +1)$	-0.81	-2.53^{***}	-1.44	74.28
$(-1, 0)$	-0.79	-2.36^{**}	-1.71^{*}	68.57
Day 0	**Estimated average abnormal return $(AA\hat{R}_t)(\%)$**	**Brown and Warner test**	**Corrado test**	**% Negative abnormal returns**
0	-0.59	-1.99^{**}	-1.78^{*}	65.71

* p-value < 0.1, ** p-value < 0.05, *** p-value < 0.01

De Backer 1999). Similar arguments can be applied in relation to firms operating in several markets on an international scale. Indeed, in the case of multinational firms, ISO 14001 certification much more clearly improves the firm's external image, thus facilitating their entry into markets with restrictive environmental legislation (Bansal and Bogner 2002; Noci and Verganti 1999).

Furthermore, according to Bansal and Bogner (2002), while it is recognised that polluting firms need an environmental response to external pressures, firms whose environmental impacts are scarcely perceived by stakeholders will have difficulties justifying their investment in ISO 14001 certification. In conjunction with these arguments, Russo and Harrison (2001) establish that when the environment is increasingly vigilant of environmental management, the concern about reputation is even more pressing, and symbols showing greater conformity with society's expectations, such as ISO 14001, acquire greater value (Russo and Harrison 2001).

Considering these authors' arguments, ISO 14001 certification could be interpreted as a "sign" of environmental compliance that highly polluting firms and multinational firms are bound to adopt. Nevertheless, firms which are not under examination by stakeholders but adopt the sign pushed by industry trends (band-wagon effect), will have difficulties justifying the cost of certification to the capital markets. Therefore, the results invite investigators to explore, with regards to firms more highly exposed to scrutiny, whether the market interprets certification as a necessary cost to show that they act responsibly with the environment.

6 Conclusions

The economic impact of environmental certification has been discussed little by academics. This is the source of this study's originality, as it attempts to advance in the knowledge of the economic effects of ISO 14001, using an objective measurement of performance.

The impact of a firm's announcement of ISO 14001 certification on its market value has been empirically verified in the study. The results of the analysis, based on an event study, lead us to accept the hypothesis that ISO 14001 certification generates negative abnormal returns in the share price of certified firms. In other words, the profit expectations that investors associate with the ISO 14001 standard do not compensate implementation cost. This means that the capital market does not expect the certification process to make it easier to obtain resources and capabilities to create a competitive advantage. Conversely, the market interprets the ISO 14001 Standard as a compulsory response measure to isomorphic pressures within industry.

Although ISO 14001 certification is voluntary, the results obtained show that this standard could be being perceived by the market as a reactive rather than a proactive investment. According to this interpretation, the market may view ISO 14001 certification as a standard adopted in response to institutional pressure rather than a self-regulation standard guaranteeing flexibility and anticipation in the environmental adaptation process. In sum, the results suggest that it would be a good idea to explore whether the level of institutionalisation of ISO 14001 certification makes it a sign of reputation which legitimates a firm, but fails to distinguish it from its competitors.

Several questions arise from this research: is ISO 14001 certification a sign attempting to ensure a firm's social legitimacy without producing significant internal changes? Can the cost of ISO 14001 certification be seen as a transaction cost (rather than a production cost) which solves an asymmetric information problem but does not generate expectations of additional profits? In which conditions does the market see adoption of the ISO 14001 standard as legitimate? Given the relevance of this issue, it would be of great interest to continue to study the economic consequences of environmental management system certification.

Acknowledgements This paper was developed under the objectives of the CREVALOR Research Group (DGA-Spain). It was financed by MEC-FEDER Research Project SEJ2005-07341. The authors thank an anonymous referee for his recommendations.

References

Arora S, Gangopadhyay S (1995) Toward a theoretical model of voluntary overcompliance. J Econ Behav Organ 28:298–309

Bansal P, Bogner W (2002) Deciding on ISO 14001: economics institutions and context. Long Range Plan 35:269–290

Barney J (1991) Firm resources and sustained competitive advantage. J Manag 17:99–120

Boiral O (2007) Corporate greening through ISO 14001: a rational myth? Organ Sci 18:127–146

Bozeman B (1987) All organizations are public. Jossey-Bass, San Francisco

Brown SJ, Warner JB (1980) Measuring security price performance. J Finan Econ 8:205–258

Brown SJ, Warner JB (1985) Using daily stock returns: the case of event studies. J Finan Econ 14:3–31

Chin K, Pun K (1999) Factors influencing ISO 14000 implementation in printed circuit board manufacturing industry in Hong Kong. J Environ Plan Manag 42:123–134

Corrado C (1989) A non parametric test for abnormal security price performance in event studies. J Finan Econ 23:385–395

Christainsen GB, Haveman RH (1981) The contribution of environmental regulations to the slowdown in productivity growth. J Environ Econ Manag 8:381–390

Darnall N (2006) Why firms mandate ISO 14001 certification. Bus Soc 45:354–381

Darnall N, Edwards D (2006) Predicting the cost of environmental management system adoption: the role of capabilities resources and ownership structure. Strateg Manag J 27:301–320

Darnall N, Ringling D, Andrews R, Amaral D (2000) Environmental management systems: opportunities for improved environmental and business strategy? Environ Qual Manag 9:1–9

Darnall N, Henriques I, Sadorsky P (2007) Do environmental systems improve business performance in an international setting? J Int Manag 14(4):364–376

Dasgupta S, Ho Hong J, Laplante B, Mamingi N (2006) Disclosure of environmental violations and stock market in the Republic of Korea. Ecol Econ 58:759–777

De Backer P (1999) L'impact économique et l'efficacité environnementale de la certification ISO 14001/EMAS des entreprises industrielles. ADEME, Paris

Delgado JM, Ramírez M, Espitia M (2004) Intangible resources as a key factor in the internationalisation of Spanish firms. J Econ Behav Organ 53:477–494

Delmas M (2001) Stakeholders and competitive advantage: the case of ISO 14001. Prod Oper Manag 10:343–358
DiMaggio PW, Powell W (1983) The iron cage revisited: institutional isomorphism and collective rationality in organizational fields. Am Sociol Rev 48:147–160
Dowell G, Hart S, Yeung B (2000) Do corporate global environmental standards create or destroy market value? Manag Sci 46:1059–1074
Fama E (1970) Efficient capital markets: a review of theory and empirical work. J Finan 25:383–417
Feldman SJ, Soyka P, Ameer P (1997) Does improving a firm's environmental management system and environmental performance result in a Higher stock price? J Invest 6:87–97
Filbeck G, Gorman RF (2004) The relationship between the environmental and financial performance of public utilities. Environ Res Econ 29:137–157
González F (1995) La reacción de los precios de las acciones ante anuncios de dividendos: la evidencia empírica en el mercado español de valores. Investig Econ 2:249–268
González V (1997) La valoración por el mercado de capitales español de la financiación bancaria y de las emisiones de obligaciones. Investig Econ 82:111–128
Grant R (1991) The resource based theory of competitive advantage: implications for strategy formulation. Calif Manag Rev 33:114–135
Guenster N, Derwall J, Bauer R, Koedijk K (2006) The economic value of corporate eco-efficiency. Working paper. http://ssrn.com/abstract=675628
Gupta S, Goldar B (2005) Do stock markets penalize environment-unfriendly behaviour? Evidence from India. Ecol Econ 52:81–95
Hamilton JT (1995) Pollution as news: media and stock market reactions to the toxics release inventory data. J Environ Econ Manag 28:98–113
Hart S, Ahuja G (1996) Does it pay to be green? An empirical examination of the relationship between emission reduction and firm performance. Bus Strategy Environ 5:30–37
Jaffe A, Peterson S, Portney P, Stavins R (1995) Environmental regulation and the competitiveness of U.S. manufacturing: what does the evidence tell us? J Econ Lit 33:132–163
Khanna M, Quimio W, Bojilova D (1998) Toxic release information: a policy tool for environmental protection. J Environ Econ Manag 36:243–266
Kothari SP, Warner J (2007) Econometrics of even studies. In: Espen Eckbo B (ed) Handbook of corporate finance. North-Holland, Elsevier, pp 3–36
King A, Lenox M (2001) Does it really pay to be green? An empirical study of firm environmental and financial performance. J Ind Ecol 5:105–116
King A, Lenox M (2002) Exploring the locus of profitable pollution reduction. Manag Sci 48:289–299
Klassen T, Mclaughlin C (1996) The impact of environmental management on firm performance. Manag Sci 42:1199–1214
Klassen R, Whybark D (1999) The impact of environmental technologies on manufacturing performance. Acad Manag J 42:599–615
Konar S, Cohen MA (1997) Information as regulation: the effect of community right to know laws on toxic emissions. J Environ Econ Manag 32:109–124
Konar S, Cohen MA (2001) Does the market value environmental performance. Rev Econ Stat 83:281–289
Link S, Naveh E (2006) Standardization and discretion: does the environmental standard ISO 14001 lead to performance benefits? IEEE Trans Eng Manag 53:508–519
Mckinlay A (1997) Event studies in economics and finance. J Econ Lit 35: 13–39
McWilliams A, Siegel D (1997) Event studies in management research: theoretical and empirical issues. Acad Manag J 40:626–658
Melnyk S, Sroufe R, Calantone R (2002) Assessing the impact of environmental management systems on corporate and environmental performance. J Oper Manag 336:1–23
Montabon F, Melnyk S, Sroufe R, Calantone R (2000) ISO 14000: assessing its perceived impact on corporate purchasing performance. J Supply Chain Manag 36:4–15
Nehrt C (1996) Timing and intensity effects of environmental investments. Strateg Manag J 17:535–547
Noci G, Verganti R (1999) Managing green product innovation and small firms. R&D Manag 29:3–15
Patell J (1976) Corporate forecast of earnings per share and stock price behavior: empirical tests. J Account Res autumn 246–274
Porter M (1991) America's green strategy. Sci Am 264:168
Porter M, Van der Linde C (1995) Green and competitive: ending the stalemate. Harv Bus Rev 73:120–134
Potoski M, Prakash A (2005) with weak swords: ISO 14001 and facilities' environmental performance. J Policy Anal Manag 24:745–770
Radonjic G, Tominc P (2006) The impact and significance of ISO 14001 certification on the adoption of new technologies; the case of Slovenia. Manag Environ Qual 17:707–727

Rondinelli D, Vastag G (2000) Panacea, common sense, or just a label? The value of ISO 14001 Environmental Management Systems. Eur Manag J 18:499–510
Ruiz FJ, Espitia M (1996) La formación de precios de las acciones alrededor del pago de dividendos en el Mercado de capitales español. R Esp de Fin y contab 25:179–198
Rumelt R (1984) Towards a strategic theory of the firm. In: Lamb RB (ed) Competitive strategic management. Prentice-Hall, Englewood Cliffs, NJ, pp 556–570
Russo M, Fouts P (1997) A resource-based perspective on corporate environmental performance and profitability. Acad Manag J 40:534–559
Russo M, Harrison N (2001) An empirical study of the impact of ISO 14001 registration on emissions performance, Paper presented at the Ninth greening of industry network annual conference, Bangkok, Thailand. http://lcb1.uoregon.edu/mrusso/Text-GINa.htm
Sarkis J, Kitazawa S (2000) The relationship between ISO14001 and continuous source reduction programs. Int J Oper Prod Manag 20:225–248
Scott WR (1992) Organizations: rational natural and open systems. Prentice Hall, Englewood Cliffs, NJ
Sharma S, Vredenburg H (1998) Proactive corporate environmental strategy and the development of competitively valuable organizational capabilities. Strateg Manag J 19:729–753
Sharpe W (1964) Capital asset prices: A theory of market equilibrium under conditions of risk. J Finan 19(3):425–442
Telle K (2006) It pays to be green—a premature conclusion? Environ Resour Econ 35:195–220
Toms JS (2002) Firms resources, quality signals and the determinants of corporate environmental reputation: some UK evidence. Br Account Rev 34:257–282
Wagner M, Schaltegger S, Wehrmeyer W (2001) The relationship between the environmental and economic performance of firms: what does theory propose and what does empirical evidence tell us? Greener Manag Int 34:95–108
Xepapadeas A, Zeeuw A (1999) Environmental policy and competitiveness: the porter hypothesis and the composition of capital. J Environ Econ Manag 37:165–182
Ziegler A, Schröder M, Rennings K (2007) The effect of environmental and social performance on the stock performance of European corporations. Environ Resour Econ 37:661–680