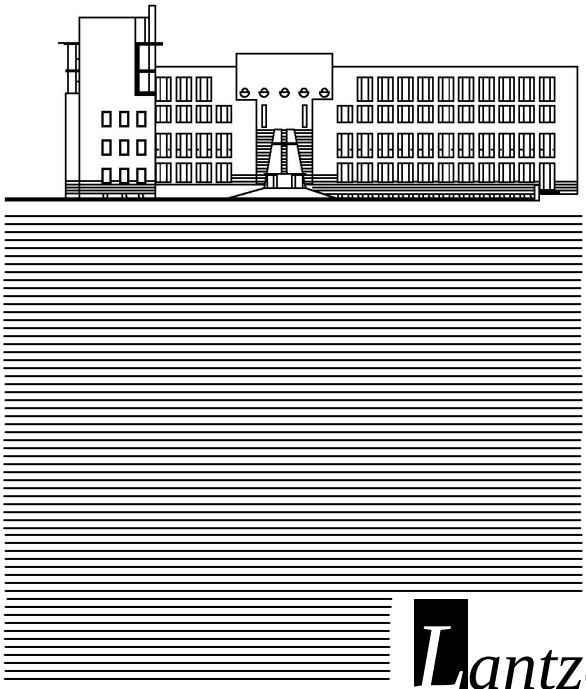


Lantze-bidean
Documentos de trabajo
Documents de travail
Working Papers

2008/02

eman ta zabal zazu

Universidad del País Vasco
Euskal Herriko Unibertsitatea

www.enpresa-donostia.ehu.es

Documento de Trabajo 2008-02 *Lantze-bidean*
E.U.E. Empresariales – Enpresa Ikasketen U.E.
Donostia-San Sebastián
Euskal Herriko Unibertsitatea – Universidad del País Vasco

ISO 14001 certification and the bottom line: a comparative study of the profiability of Basque region companies[*]

This working papers is in draft form, please do not cite or quote

Iñaki Heras[♣]
University of the Basque Country
iheras@ehu.es

José F. Molina-Azorín
Department of Management/University of Alicante
jf.molina@ua.es

Gavin P. M. Dick
Kent Business School/University of Kent
g.dick@kent.ac.uk

[*] This working paper has been drafted as part of a Research Project titled "Analysis of the implementation of Environmental Management Systems in companies from the CAPV: generation of innovative proposals for their organizational integration," funded by the UPV-EHU in its 2006 general official announcement for Research Projects. Acknowledgments: the cuantitative data for this research was provided by the Basque Institute of Competitiveness (IVC) in the Basque Autonomous Region in Spain. The Institute is a member of the worldwide network of competitiveness centres of the Harvard Institute for Strategy and Competitiveness. Our most sincere thanks go to the Institute for the support it has shown.
[♣] Contact author.

Abstract: The paper analyses the relationship between ISO 14001 certification and financial performance with the aim of understanding the causal influence of selection and treatment effects. The empirical data was collected from a sample of 268 certified firms and 7,232 non-certified firms in Spain between 2000 and 2005. Using a longitudinal methodology that measures the financial performance of the firms before and after certification, the paper finds the differences in performance between certified companies and non-certified firms prior to certification are greater than the differences that exist in the years following certification. Although the performance of certified companies is superior to that of non-certified firms, there is no evidence of improved performance after registration in the certified firms studied. The authors conclude that the superior performance found in certified firms is due to firms with superior performance having a greater propensity to pursue ISO 14001 registrations. The findings suggest that zealous inference of environmental variables being the cause of improved in financial performance may be unwise, as this better performance may be due to *selection-effect*s rather than *treatment-effect*s.

Keywords: Environmental management; Certification; ISO 14001; Financial performance; Causation.

1. Introduction

Commitment to the natural environment has become an important variable within current competitive scenarios (Graff, 1997). "Business-led" initiatives such as development of firm-structured environmental management systems (EMSs), participation in trade association programs emphasizing codes of environmental management, and adoption of international certification standards for environmental management are becoming widespread (Anton *et al.*, 2004; Nakamura *et al.*, 2001).

Registrations to the ISO 14001 Environmental Management System (EMS) standard have grown by 50 per cent in recent years with 129,199 firms in 140 countries registered at the end of 2006 (ISO, 2007). This suggests that there is a wide spread belief in the international business community of the benefits of ISO 14001 registration.

Although there is a plethora of research articles that study ISO 14001 EMS standard and their association with environmental performance improvement (Barla, 2007; Dahlström and Skea, 2002; Florida *et al.*, 2001; King and Lenox, 2002; King *et al.*, 2005; NDEMS, 2003; Potoski and Prakash, 2005; Russo and Harrison, 2001; Szymanski and Tiwari, 2004; Schaltegger and Synnestvedt, 2002), there are few articles that examine the relationship between ISO 14001 and financial performance, and there is little of this research that can attribute causality. The inference often drawn is that ISO accreditation leads to higher levels of performance. What tends to be forgotten is that the opposite direction of causality could be true, i.e., that successful firms may well have a propensity to pursue certification. Thus, environmental performance and/or its acreditation could be a kind of luxury good for a company when it has reached a certain level of economic performance (Schaltegger and Synnestvedt, 2002). In other words, financial performance may influence environmental management (Wagner *et al.*, 2002) because a firm with a good financial performance can allocate more resources to environmental initiatives.

The aim of this article is to examine this question of causality. We do this by comparing the actual sales and profitability of ISO 14001 accredited firms with their performance prior to registration.

Furthermore, most quantitative studies are based on surveys in which the ratings were given by respondents that had taken part in the EMS introduction process (e.g. Sulaiman *et al.*, 2002; Hamschmidt and Dyllick, 2001; Summers, 2002; Schylander and Martinuzzi, 2007). Any analyses of the effect of EMSs conducted in this way are subject to possible weakness and methodological distortion so to avoid this problem this paper uses only objective variables for analyses.

The paper is structured as follows. First, we present a review of literature that considers environmental management, certification and performance. This is then followed by a description of our research methodology and presentation of our findings. These are then discussed and conclusions drawn.

2. Literature review

Some authors see corporate environmental strategy as a tool which helps organisations gain competitive advantage and improve performance levels (Hart, 1997; Porter and

Van der Linde, 1995a; Shrivastava, 1995a; Trung and Kumar, 2005). Advocates suggest that the influence exerted by environmental management on a firm's performance results from the positive impact on costs and differentiation levels. Preventing pollution may enable the firm both to save control costs, input, and energy consumption, and to reuse materials through recycling (Greeno and Robinson, 1992; Hart, 1997; Shrivastava, 1995b; Taylor, 1992). Thus, eco-efficiency involves producing and delivering goods while simultaneously reducing the ecological impact and use of resources (Knight, 1995; Schmidheiny, 1992; Starik and Marcus, 2000). Advocates suggest that the generation of pollution is a sign of inefficiency (Kleiner, 1991; Porter and Van der Linde, 1995a), so companies must learn to view environmental improvement in terms of resource productivity and pay attention to the opportunity costs of pollution (wasted resources, wasted effort, and diminished product value to the customer), so that at the level of resource productivity, environmental improvement and competitiveness come together (Porter and Van der Linde, 1995a). As for differentiation, reducing pollution may result in increased demand from environmentally sensitive consumers, because the ecological characteristics of products are likely to be appreciated by 'green' customers (Elkington, 1994). Moreover, a firm that shows good environmental initiatives is likely to acquire a good ecological reputation (Miles and Covin, 2000; Shrivastava, 1995b) that can provide differentiation against rivals. Consequently, pollution prevention can help firms to reach a situation where both the firm and the environment will benefit; a win-win situation referred to in the literature as the 'Porter hypothesis' (Porter and Van der Linde, 1995a; Porter and Van der Linde, 1995b).

Others, however, have questioned the optimism of environmental advocates (Jaffe *et al.*, 1995; Walley and Whitehead, 1994). This traditional stance postulates that any improvement in the environmental impact caused by an enterprise leads to a reduction in its profitability. These authors suggest that compliance with environmental regulations incurs significant costs, reducing the capacity to compete (Jaffe *et al.*, 1995). Furthermore, this traditional view critiques the claims made by the supporters of 'the Porter Hypothesis' by saying that, although cost savings can easily be obtained with a number of simple prevention measures, the most ambitious prevention measures may involve costs that exceed the savings to be derived from them (Walley and Whitehead, 1994).

Our literature review database is founded on a computer search of the ABI Inform, Emerald and Science Direct databases. The computer search was made for works that related the expressions environmental management, ISO 14000, or ISO 14001 to performance (and results and profitability) in the title of the paper. The list of references given in seminal papers was also reviewed. We exclude the many articles that are anecdotal (e.g. Graff, 1997; Davies and Webber, 1998; Balta and Woodside, 1999, Wilson, 2001). We also exclude the many case study based articles (e.g. Chin and Pun, 1999; Rondinelli and Vastag, 2000; Morrow and Rondinelli, 2002; Cushing, 2005; Claver *et al.*, 2006; Zobel, 2007; Wu *et al.*, 2007); although, these case studies are an ideal way of illustrating success stories and the realities of implementation they cannot provide quantifiable statistical evidence. Thus, we focus our review on the growing body of recent studies that have tested this linkage between environmental proactivity and a firms' performance using statistical data analysis methods.

We summarise these in Table 1 and 2. The studies cover a wide range of industries most of whom are in the manufacturing sector. The environmental variables are also diverse with the majority of studies using environmental performance, both positive (emission reduction) and negative (emissions generated); with the remaining studies using environmental management variables (practices, initiatives, technologies, pollution reduction means or methods, ISO 14001 certification). For the financial performance variables, some studies have used objective measures (for example accounting performance), while others resort to perceptual measures. As far as the type of analysis is concerned, regression methods are the most common; while a minority use event studies, the analysis of differences between groups and structural equation modelling.

In these studies that have tested the linkage between environmental proactivity and firms' performance some fourteen find a positive relationship; their research details and major findings are summarised in Table 1.

Insert Table 1

In contrast Table 2 shows a summary of the eleven studies that identify a negative or a neutral relationship of environmental proactivity on firms' performance. Of these six report negative performance associations while five report no proof of benefits. So overall the results are mixed, but predominant are studies where a significant positive relationship between environment and firm performance are found. If we view changes in business performance as a 'treatment effect' of environmental proactivity, then clearly the overall conclusion from the research summarised in Table 1 and 2 is that changes in business performance are a likely but uncertain effect as there are fourteen positive and six negative performance effects reported.

Insert Table 2

In the studies we have just summarised there are only a few that analyse the relationship between ISO 14001 certified firms and financial performance. Yet, studies that use registration to ISO 14001 as their environmental variable have the substantial advantage that the registration requires third party auditing of the firm's EMS as meeting the standard, thus avoiding the difficulties associated with judging the actual degree of environmental management undertaken in voluntary programs. The advocates of ISO 14001 claim similar operational, managerial and competitive benefits for organizations as the advocates of the Porter Hypothesis. These include reduced costs of waste management, savings in the consumption of energy and materials, an enhanced corporate image, regulatory cost savings, and improved customer and other stakeholder relationships. Furthermore, those authors who have analysed the content, scope and depth of the ISO 14001 standard have highlight the potential positive impact of introducing the standard in reducing costs and in improving the economic and financial performance of the firms involved (e.g. Cascio, 1996; Marcus and Willig, 1997; Sheldon, 1997; Woodside, 2000; Cheremisinoff and Bendavid-Val, 2001; Morris, 2003).

However, although there are many academic studies that have analysed the motivation for and positive benefits that might result from accreditation to the ISO 14001 standard (e.g. van der Veldt, 1997; Sulaiman and Ahmad, 2002; Hamschmidt, 2002; Summers,

2002; Morrow and Rondinelli, 2002; Schylander and Martinuzzi, 2007; Fryxell and Szeto 2002; Gavronski, Ferrer and Paiva 2008; Poksinska, Dahlgaard and Eklund 2003; Rondinelli and Vastag 2000; Zutshi and Sohal 2004; Zutshi and Sohal 2005) these tend to be small scale studies or based on surveys using personal ratings for performance improvement by managers who themselves have taken part in the EMS introduction process. This self-reporting introduces the bias problem that Wayhan *et al.* (2002; 2007) and Heras *et al.* (2002) have pointed out. That performance variables based on managers ratings or on data supplied by the companies themselves, can be biased due to the person providing the information having a personal interest in overvaluing it. Thus, these authors suggest that for financial variables it is better to use objective data on firms by using data or indicators from existing records (for instance, commercial databases containing economic and financial information).

At the time of writing there are few studies that combine the desirable properties we seek of objective financial performance variables and the ISO 14001 EMS accreditation variable. Watson *et al.* (2004) analyse how the ratios of ROA, business margins and other similar ratios varied in the case of those companies that had introduced a certified EMS and companies that had not, finding that there were no significant differences between them across different economic sectors. Similar lack of proof of performance change is reported by Cañón and Garcés (2006) who assessed the economic impact of ISO 14001 certification by studying whether announcement of ISO 14001 certification of 80 large Spanish companies was interpreted by the stock market as a sign of environmental pro-activity, that would generate market expectations of improved efficiency leading to improved market values (Hart, 1995).

There remains one more aspect that we need to explore; the literature we have explored is dominated by studies that imply forward causation (a treatment effect) between environmental proactivity and changes in performance but what is rarely discussed is the possible influence of reverse causation –a self-selection mechanism see Dick *et al* (Dick, *et al.*, 2008) –. Therefore, caution is needed in inferring a positive direction of causation as the possibility of reverse attribution also exists; where better performance precedes the initiative and if not controlled for can be incorrectly attributed to the initiative.

To help our explanation we draw on the contribution from Toffel (2006), who explicitly set out in his research to find whether there is a positive *ex ante* selection effect on companies that decide to become certified to ISO 14001 (*positive selection-effect*) or whether there is an *ex post* improvement effect due to the treatment that certification entails (*treatment-effect*) which results in a greater environmental impact. He finds that ISO 14001 registration has attracted companies with better environmental performance or results – measured in terms of base TRI emissions – and that the introduction and certifications to the standard has in turn lead to such companies improving their environmental performance compared to non-certified ones. In short, he proves the existence of a selection effect (reverse causation) and a treatment effect (forward causation).

Unlike Toffel (2006), who focuses mainly on the relationship between ISO 14001 and environmental performance, our study focuses on the linkage between ISO 14001 and financial performance. Other authors who accept the need to control for *selection-effect*s have used methodologies to control for its influence (Corbett, *et al.*, 2005; Naveh

and Marcus, 2005; Rivera *et al.*, 2006; Terlaak and King, 2006). However, we believe like Toffel (2006) that it is advantageous to report on the performance that can be attributed to the ISO 14001 EMS effect and the proportion that may be due to prior better than average performance. Thus, we will be attempting to test whether there exists an *ex-ante* selection mechanism where better performing firms have a greater propensity to become certified, a *positive selection effect*, to use Toffel's terminology (2006), and whether there is an *ex-post* improvement effect on financial performance due to the treatment that certification entails (*treatment effect*).

Based on the literature we have reviewed and on the theoretical contributions that we have synthesized we derive two hypotheses that we will test on our longitudinal data whose source we detail in the next section:

A: There exists an ex-ante positive selection effect on companies that decide to become certified in accordance with the ISO 14001 standard (positive selection effect), with the effect being measured in terms of profitability and sales growth.

B: There exists an ex-post improvement effect due to the influence of the ISO certified Environmental Management System (treatment effect) which results in better profitability and sales growth of the certified firms.

3. Methodology

3.1. Sample and data collection

The research analysed in this paper, studies the comparative financial performance of ISO 14001 certified firms before and after certification, and compares them with a control group of firms without certification over a six-year period.

The research was undertaken in the Basque Autonomous region, which is considered to be one of the regions in Spain where ISO 14001 registrations are concentrated (Heras *et al.*, 2008). The ISO 14001 certification data was gathered from the Catálogo Industrial Vasco y de Exportadores de 2006, the database of certified firms of the Basque Government that is maintained by Ihobe, the publicly owned Basque Agency of Environmental Management. Our financial performance data was gathered from the SABI[1] database that is one of the most complete for Spanish firms' economic and financial information. Altogether we have access to performance information from 268 ISO 14001 certified companies that we will be contrast with performance information from the 7,232 companies that are not-certified. The resulting financial data set was analysed to identify outliers and these were removed so that data fitted a normal distribution.

3.2. Variables

Data was available for the years 2000, 2001, 2002, 2003, 2004, and 2005, and included the sales revenue for each accounting year, as well as the profitability ratio (ROA, the ratio of net profit before interest and tax on total assets). In addition, for the certified

[1] SABI (*Sistema Anual de Balances Ibéricos*) data elaborated by Bureau Van Dick.

companies, the data set included information on their last certification registration date. This information on registration dates was checked with the registration bodies and where necessary with the companies to ensure that the date we recorded was the true date of the firm's initial registration to ISO 14001. Although, the sample distributions of the ISO 14001 certified companies were not balanced across the sectors (manufacturing, construction, trade and services) their profile was similar to that previously reported for the total population of certified companies (Heras *et al.*, 2008) so we are confident that they are representative of the population as a whole.

Possible sources of bias in the two samples were checked. Firstly, we noted that the two samples were not homogenous. ISO 14001 certified firms had on average larger sales turnovers than non-certified firms did, which is also true for the total population of certified companies in the Basque Autonomous Community (Heras *et al.*, 2008). To test that any difference in profitability of the certified companies is not a direct result of their larger sales we used the z-test of proportions, with a level of significance set at 0.05, as well as a t-test for differences in means. Both these calculations indicate that there was no statistically significant effect of turnover on ROA. This is confirmed by the correlation coefficient between firms' sales revenue and the ROA. Likewise, to see if industry selection *effects* existed for ISO 14001 the average profitability ratio for all the sectors (manufacturing, construction, trade and services) for all years was calculated to establish if whether any sector differences between the certified sample and control that were creating a bias in the results. No statistically significant differences were identified using t-tests (level of significance set at 0.05). Therefore, we may be confident that any differences found between ISO 14001 certified and non-certified companies are not related to the firms' size or sector distribution of the two samples.

In the study we use the registration year to split the not-yet-certified from the certified companies since we found no evidence of any increase in firms' performance in the one or two years prior to certification in our earlier work that used an event-study method on similar data concerning quality control system certification to ISO 9001 (Heras, *et al.*, 2002). In summary, the research design consists of three samples of firms: certified, not-yet-certified and non-certified for each of the six years, and two variables, sales growth, and return on total assets employed (ROA).

4. Results

4.1. Testing for *treatment-effect* and *selection-effect*

We start by presenting the findings of our longitudinal study using a *treatment-effect* assumption i.e. where performance differences in return on assets employed (ROA) and sales growth between certified and non-certified firms are assumed to be due to adoption of an ISO 14001 EMS. These findings then provide a starting point that allows later comparison with the *selection-effect* results. For the *treatment-effect* results we use a dichotomous split between certified and non-certified firms (not-yet-certified firms being excluded from the analysis). The results for the two samples ROA over the years 2000 to 2005 are presented in Table 3. The findings indicate that certified firms achieved a better average ROA (5.91%) than non-certified firms (4.32%) during the six years, with three out of the six years being statistically significant.

Insert Table 3

A similar picture emerges for sales growth (Table 4) with certified firms enjoying better average sales growth than non-certified firms over the six years with their average sales growth being 50.1% for certified firms compared to non-certified firms' 36.9%. Here, three out of the six years show statistically significant differences.

Insert Table 4

These sales and profitability results provide good evidence for sustainable improved performance being associated with accreditation to ISO 14001 (given that the tests for company size bias and industrial sector selection *effects* showed these had no influence). However, all that we have actually found is an association betweens ISO 14001 accreditation and the improved performance. If the better performance found in Tables 1 and 2 is to be claimed for ISO 14001 it required that we know that not-yet-certified firms have similar performance to non-certified firms. This will provide evidence that there are no *selection-effects*.

Insert Table 5

To see if these implications are valid we now examine the same data set but include in our findings the results for not-yet-certified firms. These are firms that are not yet certified in the beginning of the year that is mentioned in the column (all the certification data is by 12/31 of each year), but will be certified before the 31st of December 2005, which is the end year of our longitudinal analysis.
The findings for profitability of the not-yet-certified firms are shown in Table 5; alongside the ROA are the significance level results for t-tests of difference compared to the control group of non-certified firms. Overall, the period average ROA for the years 2000 to 2005 is significantly better for certified (5.56%) and not-yet-certified (6.17%) than non-certified firms (4.32%). The better performance of not-yet-certified (6.17%) than certified firms (5.56%) shows that it is *selection-effects* not *treatment-effects* that are the cause of the better returns found in the certified firms. Thus, the findings show that firms had greater ROA than their peers before certification but show no additional profitability gains from it (given that the tests for company size bias and industrial sector differences showed that these were not an influence).

Insert Table 6

The findings for year-on-year per cent sales growth are shown in Table 6. Overall sales growth is significantly better for certified (43.5%) and not-yet-certified (61.1%) than non-certified firms (36.9%). The better sales growth in not-yet-certified firms (61.1%) than certified firms (43.5%) shows that it is *selection-effects* rather than *treatment-effects* that are the cause of the better returns found in certified firms. Thus, the findings show that firms had better sales growth prior to certification and show no additional sales growth after it.

If we contrast these results with those in Table 3 and 4 that use a *treatment-effect* assumption we see a very different interpretation of the better financial performance results of the ISO 14001 accredited firms. Consistently over the six years of the study it seems that there are *selection-effects* where firms with better than average profitability

and sales growth become accredited to ISO 14001. After accreditation this better financial performance continues but is not enhanced by any ISO 14001 *treatment-effect*.

4.2. Analysis by certification event

However, a case can be made that the implementation of ISO 14001 tends to pay off in the long, rather than the shot term, so certification is most unlikely to cause a swift change in a company's financial results. To check whether this is the case the data was set to allow an analysis with year '0' being the ISO 14001 accreditation year; a mean weighted deviation as a per cent of the ROA ratio was obtained for the sample of ISO 14001 certified companies, against the sample of non-certified ones. These abnormal returns were calculated for a series of fictitious financial years (from year -9 to year +5), corresponding to a "before" and an "after" certification, in which "the year 0" refers to the year when certification was obtained.

The results are shown in table 7 and figure 1. In figure 1 we can see that differences in returns between certified companies and non-certified ones over the periods prior to certification are broadly speaking much greater than the differences that exist after certification. Specifically we can calculate from table 3 that in the years prior to certification (-9 to -1 in table 7) there is a 124.5 % difference in the means compared to a mean difference of 26.6% in the years subsequent to the date of certification (period 1 to 5 in table 7). Figure 1 clearly shows that there is no evidence of any *treatment-effect* from ISO 14001 accreditation around the period of certification or any subsequent gains in the years following accreditation. We must therefore conclude that there is no evidence of long run or short run gains due to the *treatment-effect* of accreditation to ISO 14001 EMS.

Insert Table 7

Insert Figure 1

We summarise the findings and relate this to other research by revisiting our two hypotheses.

There exists an ex-ante positive selection effect on companies that decide to become certified in accordance with the ISO 14001 standard (positive selection-effect), with the effect being measured in terms of profitability and sales growth.

Our findings provide strong support for this hypothesis since we have found over a five year period that the performance of firms that will become accredited to ISO 14001 have superior profitability and higher sales growth than firms that will not become certified.

There exists an ex-post improvement effect due to the influence of the ISO certified Environmental Management System (treatment-effect) which results in better profitability and sales growth of the certified firms.

Our findings disconfirm this hypothesis since we have found that there is no evidence of better sales or greater profitability in certified firms compared to not-yet-certified firms. Our event analysis indicates that in the short term and longer term no ex-post superior profitability after accreditation is achieved.

5. Conclusions

5.1. Summary

Our findings of the dominance of a *selection-effect* over a *treatment-effect* in explaining the better than average profitability and sales growth of ISO 14001 certified firms has also been found in research looking at longitudinal analyses of performance achievements in firms who are pursuing ISO 9001 Quality Management System accreditation in the USA, Spain and Denmark ─for a review see Dick, Heras and Casadesús (2008)─. Although the dominance of *selection-effect*s over *treatment-effect*s appears to be counterintuitive, the similar findings for ISO 9001 to those for ISO 14001 indicate that this phenomenon is unlikely to be unique to Spain.

Our *selection-effect* findings are echoed in the analysis carried out on US companies by Toffel (2006) who refers in his research to the existence of a *selection-effect* in US companies that become certified to ISO 14001. He finds that certification appears to attract companies who already have better environmental performance than their peers. However, he does find that there is some incremental improvement in environmental performance after accreditation. This would be consistent with our finding if this extra environmental performance produced financial gains only sufficient to offset the cost of obtaining and maintaining ISO 14001 EMS.

5.2. Theoretical and practical considerations

In the empirical literature that we reviewed earlier (Table 1 and 2 provides a summary) we concluded that overall there was stronger evidence for a positive relationship between environmental management initiatives and firms' performance than for neutral or negative results. Generally the assumption made in this research is that environmental proactivity is an independent variable with performance benefits being the dependent variable. Our findings suggest that it may be equally valid to consider a counterintuitive causation path were pursuit of environmental initiatives such as adoption of ISO 14001 Environmental Management Systems being dependent on a firm having better than average performance. We believe that co-causation models where *selection* and *treatment effects* are considered deserve wider consideration in the development of explanatory models. We suggest that by adopting research designs that can explicitly measure both effects a broader understanding of the role of *selection-effects* can be established.

For practitioners, our findings should give pause for thought. It is indeed tempting for managers to believe that ISO 14001 certification will lead to business benefits. After all firms that they would like to emulate in terms of performance often have it! This is then reinforced by the seemingly pervasive believe (often quoted as supported by research) that an environmental management system certified to ISO 14001 will reduce cost and increase sales. However, our findings, and the parallel findings for ISO 9001 adoption (Heras *et al.*, 2002), indicate that it might be a wise decision to only pursue

accreditation if there is a demand from customers for it, since we have found no sales or profitability improvements after certification. However, our findings indicate that the money spent on certification has not adversely affected the profitability of firms. This does suggest that cost benefits arising from certification are on average sufficient to offset the investment. Therefore, we are not suggesting to practitioners that certification to ISO 14001 is a bad investment, rather that inflated expectations of financial performance improvement are likely to be unfounded.

5.3. Limitations and future work

Although we have used objective variables in our research which have the advantage of avoiding respondent bias, we accept that financial performance depends on many other variables than the existence of an ISO 14001 accredited EMS and these latent variables may themselves be the drivers influencing our variables. Although we have controlled for firm's size and economic sector differences it remains a possibility that our control group is unrepresentative in other ways that could lead to a distortion in the absolute level of abnormal ROA and sales growth we report. However, our study has used repeated measures so any distortions due to the method of selection of the control group are consistent across the years so the year-by-year differences within the study can be viewed as reliable indicators as they are unlikely to be affected significantly by the choice of control group construction method.

Although our research is based on data from Spain, we believe that the *selection-effect* is not just a national phenomenon because there are indications from the research of Toffel (2006) and from the parallel field of ISO 9001 research that *selection-effect*s are found elsewhere in Europe and the USA (Dick, *et al.*, 2008). However, given that over 140 countries with varied cultural and economic regimes have firms registered to ISO 14001 standards we accept that this *selection-effect* may not be universal.

We hope that others will join us to extend our research on *treatment* vs. *selection effects* into other countries where ISO 14001 accreditation has become popular so that the influence of the *selection-effect* can be better understood. Such research could provide the justification for future research into exploration of possible underlying causes. This in turn could lead to the development of broader theory that will enrich our understanding of the complexity of attributing performance in environmental research.

6. References

Al-Tuwaijri, S., Christensen, T., Hughes, K., 2004. The relations among environmental disclosure, environmental performance, and economic performance: a simultaneous equations approach. Accounting, Organizations and Society 29, 447-471.

Anton, WRQ., Deltas, G., Khanna, M., 2004. Incentives for environmental self-regulation and implications for environmental performance. Journal of Environmental Economics and Management 48 , 632-654.

Balta, W., Woodside, G., 1999. IBM's experience implementing ISO 14001 on a global basis: Does ISO 14001 achieve its intended goals? Journal of the Forum for Environmental Law, Science, Engineering and Finance 3 (9), 1-10.

Barla, P., 2007. ISO 14001 certification and environmental performance in Quebec's pulp and paper industry, Journal of Environmental Economics and Management 53, 291-306.

Cañón, J., Garcés, C., 2006. Repercusión económica de la certificación medioambiental ISO 14001, Cuadernos de Gestión 6 (1), 45-62.

Cascio, J., 1996. The ISO 14000 Handbook, CEEM Information Services, New York.

Cheremisinoff, N.P., Bendavid-Val, A., 2001. Green Profits: The Manager's Handbook for ISO 14001 and Pollution Prevention, Butterworth-Heinemann, Boston.

Chin, K.S., Pun, K-F., 1999. Factors influencing ISO 14000 implementation in printed circuit board manufacturing industry in Hong Kong, Journal of Environmental Planning and Management 42 (1) 123-134.

Christmann, P., 2000. Effects of "best practices" of environmental management on cost advantage: The role of complementary assets, Academy of Management Journal 43, 663-680.

Claver, E., López, M.D., Molina, J.F., Tarí, J.J., 2007. Environmental management and firm performance: A case study, Journal of Environmental Management 84 (4), 606-619.

Cohen, M., Fenn, S., Naimon, J., 1995. Environmental and financial performance: are they related? Working paper, Vanderbilt University, Nashville.

Corbett, C.J., Montes-Sancho, M.J., Kirsch, D.A., 2005. The financial impact of ISO 9000 Certification in the United States: An empirical analysis, Management Science 51 (7), 1046-1059.

Cordeiro, J., Sarkis, J., 1997. Environmental proactivism and firm performance: evidence from security analyst earnings forecasts, Business Strategy and the Environment 6, 104-114.

Cushing, K.K., 2005. Understanding ISO 14001 Adoption and Implementation in China, International Journal of Environment and Sustainable Development 4 (3), 246-268.

Davies, C., Webber, P., 1998. ISO 14001 registration: The process, the benefits, and the choice of registrar**,** Environmental Quality Management 8 (2), 55-65.

Dahlström, K., Skea, J., 2002. Environmental Management Systems and Operator Performance at Sites Regulated Under Integrated Pollution Control, Draft Research & Development Technical Report P6/TR, prepared by the Policy Studies Institute, United Kingdom Environmental Agency, Bristol, England.

Dick, G.P.M., Heras, I., Casadesús, M., 2008. Shedding light on causations between ISO 9001 and improved business performance, International Journal of Operations and Production Management 28 (9), 687–708.

De Burgos, J., Céspedes, J., 2001. La protección ambiental y el resultado. Un análisis crítico de su relación, Investigaciones Europeas de Dirección y Economía de la Empresa 7, 93-108.

Edwards, D., 1998. The Link between Company Environmental and Financial Performance, Earthscan Publications, London.

Elkington, J., 1994. Towards the sustainable corporation: win-win-win business strategies for sustainable development, California Management Review 36, 90-100.

Florida, R., Davidson, D., 2001. Gaining from green management: Environmental management systems inside and outside the factory, California Management Review 43 (3), 64–84.

Fryxell, G.E., Szeto, A., 2002. The influence of motivations for seeking ISO 14001 certification: an empirical study of ISO 14001 certified facilities in Hong Kong, Journal of Environmental Management 65 (3), 223-238.

Gavronski, I., Ferrer, G., Paiva, E., 2008. ISO 14001 certification in Brazil: motivations and benefits, Journal of Cleaner Production 16, 87-94.

Gilley, K., Worrell, D., El-Jelly, A., 2000. Corporate environmental initiatives and anticipated firm performance: the differential effects of process-driven versus product-driven greening initiatives, Journal of Management 26, 1199-1216.

González-Benito, J., González-Benito, O., 2006. A review of determinant factors of environmental proactivity, Business Strategy and the Environment 15 (2), 87-102.

González-Benito, J., González-Benito, O., 2005. Environmental proactivity and business performance: an empirical analysis, Omega 33, 1-15.

Graff, S., 1997. ISO 14000: Should your Company Develop an Environmental management System?, Industrial Management /November-December, 19-22.

Greeno, J., Robinson, S., 1992. Rethinking corporate environmental management, The Columbia Journal of World Business /Autumn-Winter, 222-232.

Hamilton, J., 1995. Pollution as news: media and stock market reactions to the Toxics Release Inventory Data, Journal of Environmental Economics and Management 28, 98-113.

Hamschmidt, J., Dyllick, T., 2001. ISO 14001: profitable? Yes! but is it eco-effective?, Greener Management International 36, 43-54.

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

Hart, S., 1997. Beyond greening: strategies for a sustainable world, Harvard Business Review 75, 66-76.

Hart, S., Ahuja, G., 1996. Does it pay to be green? An empirical examination of the relationship between emission reduction and firm performance, Business Strategy and the Environment 5, 30-37.

Heras, I., Arana, G., Camisón, C., Casadesus, M., Martiarena, A., 2008 Gestión de la Calidad y competitividad de las empresas de la CAPV, Instituto Vasco de Competitividad, Donostia-San Sebastián, 2008.

Heras, I., Dick, G.P.M., Casadesus, M., 2002. ISO 9000 registration's impact on sales and profitability. A longitudinal analysis of performance before and after accreditation, International Journal of Quality and Reliability Management 19 (6), 774-791.

ISO, 2007. The ISO survey of ISO 9000 and ISO 14000 Certifications: 16th cycle, ISO, Geneva.

Jaffe, A., Peterson, S., Portney, P., Stavins, R., 1995. Environmental regulation and the competitiveness of U.S. manufacturing: What does the evidence tell us?, Journal of Economic Literature 33 (1), 132-163.

Judge, W., Douglas, T., 1998. Performance implications of incorporating natural environmental issues into the strategic planning process: an empirical assessment, Journal of Management Studies 35, 241-262.

Khanna, M., Damon, L., 1999. EPA's Voluntary 33/50 Program: impact on toxic releases and economic performance of firms, Journal of Environmental Economics and Management 37, 1-25.

King, A., Lenox, M., 2002. Exploring the locus of profitable pollution reduction, Management Science 48, 289-299.

King, A., Lenox, M., Terlaak, A.K., 2005. The strategic use of decentralized institutions: Exploring certification with the ISO 14001 management standard, Academy of Management Journal 48 (6), 1091-1106.

Klassen, R., McLaughlin, C., 1996. The impact of environmental management on firm performance, Management Science 42 , 1199-1214.

Klassen, R.D., Whybark, D.C., 1999. The impact of environmental technologies on manufacturing performance, Academy of Management Journal 42, 599-615.

Kleiner, A., 1991. What does it mean to be green? Harvard Business Review 69, 38-47.

Knight, C., 1995. Pollution prevention, technology challenges, and competitive advantage in the process industries, Total Quality and Environmental Management /Autumn, 87-92.

Lima, M.A.M., Resende, M., Hasenclever, L., 2000. Quality certification and performance of Brazilian firms: an empirical study, International Journal of Production Economics 66 (2), 143-147.

Link, S., Naveh, E., 2006. Standardization and discretion: does the environmental standard ISO 14001 lead to performance benefits? IEEE Transactions on Engineering Management 53, 508-519.

Marcus, P.A., Willig, J.T., 1997. Moving Ahead with ISO 14001: Improving Environmental Management and Advancing Sustainable Development, John Wiley, New York.

Melnyk, S., Sroufe, R., Calantone, R., 2003. Assessing the impact of environmental management systems on corporate and environmental performance, Journal of Operations Management 21, 329-351.

Menguc, B., Ozanne, L., 2005. Challenges of the "green imperative": a natural resource-based approach to the environmental orientation-business performance relationship, Journal of Business Research 58, 430-438.

Miles, M., Covin, J., 2000. Environmental marketing: a source of reputational, competitive, and financial advantage, Journal of Business Ethics 23, 299-311.

Morris, A.S., 2003. ISO 14000 Environmental Management Standards: Engineering and Financial Aspects, John Wiley, London.

Morrow, D., Rondinelli, D., 2002, Adopting corporate environmental management systems: Motivations and results of ISO 14001 and EMAS certification**,** European Management. Journal 20 (2), 159-171.

Nakamura, M., Takahashi, T., Vertinsky, I., 2001. Why Japanese firms chose to certify: a study of managerial responses to environmental issues, Journal of Environmental Economics and Management 42, 23-52.

Naveh, E., Marcus, A., 2005. Achieving competitive advantage through implementing a replicable management standard: Installing and using ISO 9000, Journal of Operations Management 24 (1), 1-26.

NDEMS, 2003. Environmental Management Systems: Do They Improve Performance?, NDEMS, National Database on Environmental Management Systems, University of North Carolina at Chapel Hill, North Carolina.

Porter, M. Van der Linde, C., 1995a. Green and competitive: ending the stalemate, Harvard Business Review 73, 120-134.

Porter, M. Van der Linde, C., 1995b. Towards a new conception of the environment-competitiveness relationship, Journal of Economic Perspectives 9, 97-118.

Poksinska, B., Dahlgaard, J., 2003. Eklund, Implementing ISO 14000 in Sweden: motives, benefits and comparisons with ISO 9000, International Journal of Quality and Reliability Management 20 (5), 585-606.

Potoski, M., Prakash, A., 2005. Covenants with Weak Swords: ISO 14001 and Facilities' Environmental Performance, Journal of Policy Analysis and Management 24 (4), 745-769.

Przasnyski, Z.H. Tai, L.S., 1999. Stock market reaction to Malcolm Baldridge National Quality Award announcements: does quality pay?, Total Quality Management 10 (3), 391-400.

Rivera, J., de Leon, P., Koerber, C., 2006. Is Greener Whiter Yet? The Sustainable Slopes Program after Five Years, Political Studies Journal 34 (2), 195-221.

Rondinelli, D.A. Vastag, G., 2000. Panacea common sense or just a label? The value of ISO 14001 environmental management systems, European Management Journal 18 (5), 499-510.

Russo, M., Fouts, P., 1997. A resource-based perspective on corporate environmental performance and profitability, Academy of Management Journal 40, 534-559.

Russo, M., Harrison, A., 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.

Schaltegger, S., Synnestvedt, T., 2002. The link between `green' and economic success: environmental management as the crucial trigger between environmental and economic performance, Journal of Environmental Management 65, 339-346.

Schmidheiny, S., 1992. Changing Course: A Global Business Perspective on Development and the Environment, MIT Press, Cambridge.

Schylander, E., Martinuzzi, A., 2007. ISO 14001 - experiences, effects and future challenges: a national study in Austria, Business Strategy and the Environment 16 (2), 133-147.

Sharma, S., Vredenburg, H., 1998. Proactive corporate environmental strategy and the development of competitively valuable organizational capabilities, Strategic Management Journal 19, 729-753.

Sheldon, C., 1997. ISO 14001 and Beyond: Environmental Management Systems in the Real World, Greanleaf, Sheffield.

Shrivastava, P., 1995a. Environmental technologies and competitive advantage, Strategic Management Journal 16 (Summer Special Issue), 183-200.

Shrivastava, P., 1995b. The role of corporations in achieving ecological sustainability, Academy of Management Review 20, 936-960.

Simmons, B.L., White, M.A., 1999. The relationship between ISO 9000 and business performance: does registration really matter? Journal of Managerial Issues 11(3), 330-343.

Starik, M., Marcus, A., 2000. Introduction to the Special Research Forum on the Management of Organizations in the Natural Environment: a field emerging from multiple paths, with many challenges ahead, Academy of Management Journal 43, 539-546.

Sulaiman, M., Ahmad, N.N., Alwi, N., 2002. Management accounting practices in Malaysia: a survey of the industrial and consumer products sectors, Unpublished research report International Islamic University, Kuala Lumpur, Malaysia.

Summers, S., 2002. Implementing ISO 14001: an international survey assessing the benefits of certification, Corporate Environmental Strategy 9 (4), 418-427.

Szymanski, M., Tiwari, P., 2004. ISO 14001 and the Reduction of Toxic Emissions, Political Reform 7(1), 31-42.

Taylor, S., 1992. Green management: the next competitive weapon, Futures, September , 669-680.

Terlaak, A., King, A., 2006. The effect of certification with ISO 9000 Quality Management Standards: A signalling approach, Journal of Economic Behaviour and Organization 60 (4), 5279-602.

Toffel, M.W., 2006. Resolving Information Asymmetries in Markets: The Role of Certified Management Programs, Harvard Business School Working Paper (No. 07-023).

Trung, D.N., Kumar, S., 2005. Resource use and waste management in Vietman hotel industry, Journal of Cleaner Production 13, 109-116.

Van Der Veldt, D., 1997. Case Studies of ISO 14001: A New Business Guide for Global Environmental Protection, Environmental Quality Management 7 (1), 1-19.

Wagner, M., 2005. How to reconcile environmental and economic performance to improve corporate sustainability: corporate environmental strategies in the European paper industry, Journal of Environmental Management 76, 105-118.

Wagner, M., Van Phu, N., Azomahou, T., Wehrmeyer, W., 2002. The relationship between the environmental and economic performance of firms: an empirical analysis of the European paper industry, Corporate Social-Responsibility and Environmental Management 9, 133-146.

Wahba, H., 2007. Does the market value corporate environmental responsibility? An empirical examination, Corporate Social-Responsibility and Environmental Management in press.

Walley, N., Whitehead, B., 1994. It´s not easy being green, Harvard Business Review 72 (3), 46-52.

Watson, K., Klingenberg, B., Polito, T., Geurts, T.G., 2004. Impact of environmental management system implementation on financial performance, Management of Environmental Quality 15, 622-628.

Wilson, R.C., 2001. Ford spreads the word about its EMS success, Pollution Engineering 33 (6) , 32-33.

Wu, S.Y., Chu, P.Y., Liu, T.Y., 2007. Determinants of a firm's ISO 14001 certification: an empirical study of Taiwan, Pacific Economic Review 12 (4), 467–487.

Wayhan, V.B., Kirche, E.T., Khumawala, B.M., 2002. ISO 9000 certification: The financial performance implications, Total Quality Management and Business Excellence 13, 217-231.

Wayhan, V.B., Balderson, E.L., 2007. TQM and Financial Performance: A Research Standard", Total Quality Management and Business Excellence 18 (4), 393-401.

Woodside, G., 2000. ISO 14001 Auditing Manual, McGraw-Hill. NewYork.

Zobel, T., 2007. The ‘Pros’ and ‘Cons’ of joint EMS and group certification: A Swedish case Study, Corporate Social-Responsibility and Environmental Management 14, 152-166.

Zutshi, A., Sohal, A., 2004. Environmental management system adoption by Australasian organizations: part 1: reasons, benefits and impediments, Technovation 24, 335-357.

Zutshi, A., Sohal, A., 2005. Integrated management system. The experiences of three Australian organisations, Journal of Manufacturing Technology Management 16 (2), 211-232.

Table 1. Summary of studies linking environmental variables to improved financial performance

Study	Sample	Environmental variables	Financial performance variables	Main analysis	Major findings
Cohen *et al.* (1995)	S&P 500 US firms with environmental data available	TRI emissions, oil spills, chemical spills, environmental litigation cases	ROA, return on equity (ROE), total return to common shareholders (Compustat)	Groups, t-test	The group of low-polluting firms had better economic performance (not always at a significant level).
Hart *et al.* (1996)	127 US firms in SIC listed in S&P 500	Emission reductions based on TRI from the IRRC Corporate Environmental Profile data	ROA, ROE, return on sales (ROS) (Compustat)	Regression analysis	Pollution prevention activities have a positive influence on financial performance within 1-2 years. ROE takes longer to be affected.
Klassen *et al.* (1996)	US firms with environmental awards and crises	Environmental awards in the NEXIS database; chemical/oil spills, gas leaks or explosions	Stock market returns (NYSE, AMEX, CRSP)	Event study	Environmental awards (crises) led to significant, positive (negative) changes in market valuation.
Russo *et al.* (1997)	243 US firms (several sectors)	Environmental ratings (FRDC): compliance, expenditures, waste reduction	ROA	Regression analysis	Positive and significant impact of environmental performance on ROA.
Judge *et al.* (1998)	196 US firms (World Environmental Directory)	Integration of environmental issues into the strategic planning process (perceptual measures)	ROI, earnings growth, sales growth, market share change (percept. measures)	Structural equation model	Positive and significant impact of environmental issue integration on financial performance.
Sharma *et al.* (1998)	99 Canadian firms (oil and gas)	Proactive environmental strategy (perceptual measures)	Organisational benefits (perceptual measures)	Regression analysis	Positive and significant influence of proactive practices on organisational capabilities and of the latter on organisational benefits.
Edwards (1998)	51 environmental. leaders in 8 UK sectors	Assessment of aspects of each firm's environmental performance. and management	Return on capital employed (ROCE), ROE	Groups	In several comparisons, environmental high-performing firms perform better.
Klassen *et al.* (1999)	69 US firms in the furniture industry	Environmental technology portfolio	Manufacturing performance measures	Regression analysis	Positive and significant impact of environmental technology portfolio on manufacturing performance.
Christmann (2000)	88 US chemical companies	Envir. Management "best practices": use of pollution prevention technology. (PPT),	Cost advantage (perceptual measures)	Regression analysis	Positive and significant effect of proprietary PPT innovation. Capabilities for process innovation are complementary assets that moderate the relationship.
De Burgos *et al.* (2001)	Data by Judge and Douglas (1998)	Data by Judge and Douglas (1998)	Data by Judge and Douglas (1998)	Data by Judge and Douglas (1998)	Positive impact of environmental issue integration on financial performance. Positive and significant impact of environmental performance on financial performance.
King *et al.* (2002)	614 US manufacturing firms (Compustat and TRI)	Total emissions, pollution reduction means or methods (waste generation, waste prevention, waste treatment, waste transfer)	ROA, Tobin's q	Regression analysis	Lower emissions (in t) are significantly associated with higher financial performance (in t+1). Significant and positive relationship of waste prevention with ROA and Tobin's q.
Melnyk *et al.* (2003)	1 222 manufacturing firm managers	State of the environmental management system (EMS	Ten corporate performance perceptual measures	Regression analysis	Positive and significant impact of EMS state on the ten corporate performance measures. Positive and significant impact of EMS state on environmental options.
Al-Tuwaijri *et al.* (2004)	198 firms included in the IRRC Environmental Profiles Directory	Ratio of toxic waste recycled to total toxic waste generated	Stock price	Simultaneous equation model	Significantly positive relation between environmental and economic performance. Good environmental performers disclose more pollution-related environmental information than poor performers.
Wahba (2007)	156 Egyptian firms in several sectors (84 certified)	ISO 14001 certification	Tobin's q ratio	Correlation and regression analysis	ISO 14001 exert a positive and significant impact on the firm market value measured by Tobin's q ratio

Summary compiled by the authors. Full citations for the studies' authors can be found in the references.

Table 2. Summary of studies linking environmental variables to negative financial performance or showing no proof of improvement

Study	**Sample**	**Environmental variables**	**Financial performance variables**	**Main analysis**	**Major findings**
Hamilton (1995)	463 US firms	TRI (Toxic Release Inventory) emissions	Returns (stock price reaction)	Event study	Significant negative returns on the day TRI emissions data were first announced.
Cordeiro *et al*. (1997)	523 US firms in SIC codes 2,000-3,999	TRI releases that are recovered, treated or recycled on-site	Industry analyst earnings-per-share growth forecasts	Regression analysis	High environmental performance is significantly negative in relation to earnings-per-share growth forecasts.
Khanna *et al*. (1999)	123 US firms in the chemical industry	EPA's Voluntary 33/50 Program (emissions of toxic chemicals)	ROI	Regression analysis	Statistically significant negative impact on the current ROI, but its impact on the expected long run profitability was positive and statistically significant.
Gilley *et al*.,(2000)	71 announcements of corporate environmental initiatives	Two types of environmental. initiatives: 39 process-driven and 32 product-driven	Anticipated firm performance (stock returns)	Event study	No significant effect of greening on performance. Different types of environmental initiatives have unique implications.
Wagner *et al*. (2002)	37 firms in the European paper industry (Germany, Italy, UK, Holland)	Environmental index integrating SO_2 emissions, NO_x emissions and COD emissions	ROS, ROE and ROCE	Simultaneous equation system	Negative and significant effect of environmental performance on ROCE. No evidence of significant impact of any economic performance variable on environmental performance.
Watson *et al*. (2004)	Companies with Corporate Self-Greenewal approach ten with EMS vs. ten no EMS.	Environmental management system adoption	ROA, profit margin and other measures	Wilcoxon signed-rank test	Results do not show any significant difference in financial performance between EMS adopters and non-EMS adopters.
González-Benito *et al*. (2005)	186 Spanish firms (chemical sector 63), (electronic-electric, 96) (furniture, 27)	27 environmental management practices	ROA (objective)	Regression analysis	Environmental management can bring about competitive opportunities for companies, although some environmental practices produce negative effects.
Menguc *et al*. (2005)	140 Australian manufacturing firms	Higher order construct of natural environment orientation (NEO)	Market share; sales growth, profit over 2 years (objective performance measures).	Path analysis	NEO is positively and significantly related to profit after tax and market share but is negatively related to sales growth.
Wagner (2005)	Firms from four European countries in the pulp and paper-manufacturing sector	Input-oriented index (energy and water input) and output-oriented index (SO_2 NO_x and COD emissions) of environmental performance.	ROCE, ROE and ROS	Regression analysis	A largely negative relationship between the output-based index of environmental performance and financial performance. For the input-based index, the relationship is generally non-significant.
Cañón *et al*. (2006)	80 ISO 14001 certified plants of 34 Spanish firms	ISO 14001 certification	Stock price	Event study	Negative impact of certification on pioneer, middle-polluting and lower size firms.
Link *et al*. (2006)	77 ISO 14001 certified organisations in Israel	ISO 14001 rules, policies and procedures. Emission of pollutions, use of recycled materials and other environmental aspects	Gross profit margin	Regression analysis	The higher the standardisation in ISO 14001 certified organisations, the better the environmental performance. Environmental performance does not influence business performance.

Summary compiled by the authors. Full citations for the studies' authors can be found in the references.

Table 3. Average profitability (ROA) of ISO 14001certified and non-certified companies

	2000	2001	2002	2003	2004	2005	Period average
Certified (%)	7.80*	5.73	5.41	5.19	5.86**	6.11**	5.91*
Non-certified (%)	5.61	5.27	4.38	4.05	3.45	3.16	4.32

Note: t-test differences between certified and non-certified ** α=0.01; * α=0.05. ROA is defined as profit before tax as a proportion of total assets.

Table 4. Average sales growth of ISO 14001 certified and non-certified companies

	2000-1	2001-2	2002-3	2003-4	2004-5	Period Cumulative
Certified (%)	13.35	8.60	7.30	10.5*	10.4*	50.1
Non-certified (%)	13.0	6.17	5.78	6.44	5.48	36.9

Note: t-test differences between certified and non-certified ** α=0.01; * α=0.05.

Table 5. Average profitability (ROA) of ISO 14001certified not-yet-certified and non-certified companies

	2000	2001	2002	2003	2004	2005	Period average
Certified (%)	5.64	6.02	5.51	4.28	5.88*	6.02**	5.56
Not-yet-certified (%)	7.28*	5.89	5.58	6.28*	6.46**	5.74	6.21*
Non-certified (%)	5.61	5.27	4.38	4.05	3.45	3.16	4.32

Note: t-test differences between certified and non-yet-certified compared to the non-certified ** α=0.01; * α=0.05.

Table 6. Average sales growth of ISO 14001 certified, not-yet certified and non-certified companies

	2000-1	2001-2	2002-3	2003-4	2004-5	Period Cumulative
Certified (%)	11.1	8.61	5.05	9.56*	9.12*	43.5
Not-yet-certified (%)	14.1	7.84	9.65	12.8*	16.7*	61.1*
Non-certified (%)	13.0	6.17	5.78	6.44	5.48	36.9

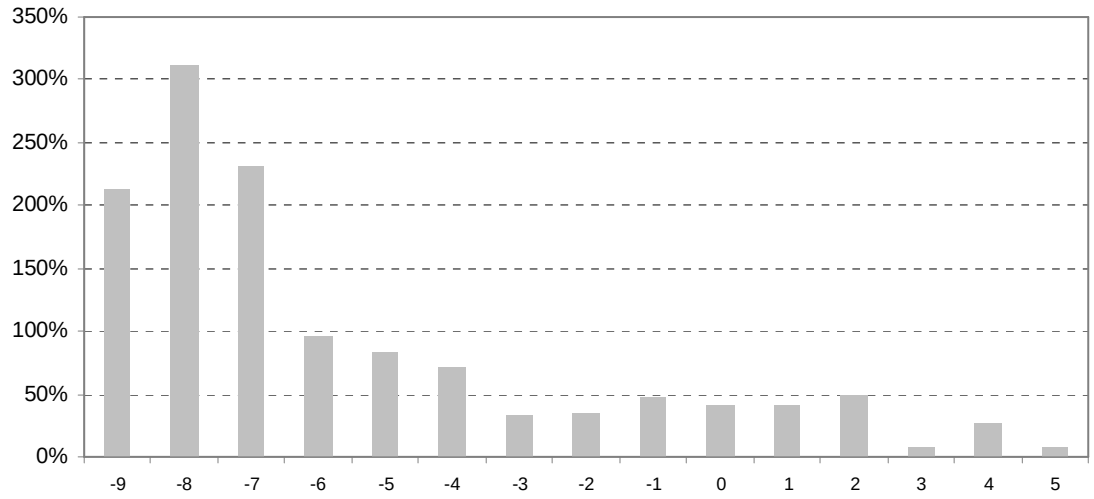
Note: t-test differences between certified and non-yet-certified compared to the non-certified ** α=0.01; * α=0.05.

Table 7. Average per cent deviation in returns (ROA) between ISO 14001 certified and non-certified companies in the years before and after certification

Year	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5
1997	213,7	91,4	36,6	267,3	166,4	213,5									
1998		421,9	519,8	233,3	235,1	65,4	-29,7								
1999			37,3	72,8	37,0	48,3	11,2	17,8							
2000				52,5	-2,9	-88,0	-73,3	-38,8	-19,3						
2001					113,1	112,0	108,4	59,2	28,9	45,6					
2002						98,1	61,9	19,0	13,6	25,4	71,6				
2003							0,9	11,6	-58,1	4,7	-1,5	10,9			
2004								79,6	102,4	32,6	0,2	44,1	1,6		
2005									160,7	72,7	53,4	66,4	-15,0	44,7	
2006										81,7	106,6	89,0	44,8	2,0	7,7
Deviation %	213,7	311,7	230,2	95,1	83,2	71,6	33,2	34,5	47,5	41,9	41,8	50,1	7,3	26,3	7,7
N certified firms	2	6	10	29	64	119	174	231	284	308	275	218	161	100	43

Note: Year 0 refers to the year of certification.

Figure 1. Average deviation of returns between ISO 14001 certified companies and non-certified companies in the years prior to after certification



Note: the year 0 refers to the year of certification.