

Article

The Effects of Corporate Green Efforts for Sustainability: An Event Study Approach

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Abstract: This study investigates the long-term effects of corporate green efforts on the financial performances of the US public firms by using the ISO 14001 certification. Based on the natural resource based view, the rigorous event study was employed using 174 US public firms on NYSE (New York Stock Exchange) and NASDAQ (National Association of Securities Dealers Automated Quotations) to analyze the pre and post abnormal performances of the certification during the 1996–2010 period. The results indicate that ROI and Tobins's Q showed the immediate positive response after the firms' applying for the certification, implying that the market accepts the announcement of ISO 14001 as a positive signal. Asset turnover also showed positive abnormal performances for the short and long term. The results imply that the corporate green efforts are beneficial to the firm by improving sales and profitability, while the capital market does not clearly respond to these efforts in the long run.

Keywords: environmental management; financial performance; sustainability; ISO 14001

1. Introduction

Environmental management has shown its potential to improve firms' financial benefits beyond corporate social responsibility [1]. Hart [2], in the natural resource based view, stated that environmental management can play a significant role as a key resource for the sustainable competitive advantage. Lee and Klassen [3] stated that green management capabilities are a critical driving force for bringing profits. Some scholars even argue that financial outcome is the main motivation for adopting green processes [4]. If the environmental management capability can be a key driving force to improve a firm's financial performance, more firms can implement an environmental management system, to potentially overcome the scarcity of resources and environmental problems.

However, it is not easy to prove the financial benefits of corporate green efforts. Over the past decades, there have been debates on the financial effects of going green. Some scholars indicated positive financial effects of environmental management, while the other showed negative or at best reserved opinions. In addition, many studies about the financial effects of green management focused on the specific issue or industry, which made it difficult to generalize the results. Various environmental programs implemented by public firms also made it hard to find out an appropriate proxy measure to reflect corporate green efforts. These limitations have been critical obstacles to examine the financial effects of it. Thus, a representative environmental program and proper research methodology should be carefully chosen to measure and generalize the financial effects of corporate green efforts. ISO 14001 and an event study approach have the potential to meet these conditions.

A number of studies about green management have used ISO 14001 as a proxy measure to evaluate how firms implement environmental management practices [5,6]. ISO 14001 is a harmonized environmental standard which has the potential to improve firm performance [7]. Thus, many firms have adopted ISO 14001 to assist in managing their environmental policies and conform to their environmental goals and missions. It covers overall business processes from building environmental policies to environmental auditing [8]. Currently, ISO 14001 is the most widespread

global environmental standard and more than 300,000 organizations in 171 countries have implemented it as of 2019 [9].

While many studies about ISO 14001 have been conducted to evaluate the performance of environmental management, a limited number of studies have used the event study methodology for investigating the impact of ISO 14001. Paulraj and de Jong [10] analyzed the short-term effect of ISO 14001 on stock performance using the event study methodology with the three-day time window. Jacobs et al. [6] also dealt with the short-term stock market reaction to ISO 14001 certification. However, these studies used a single day as a time window for the short-term analysis (1 day before the announcement date through 1 day after the announcement date), presenting a snapshot view of the firm performance. While the short-term analysis is useful to catch the market's immediate response to the announcement, the long-term analysis is also indispensable to measuring the actual financial effects of the certification.

Thus, this study investigates the long-term relationship between ISO 14001, as a proxy measure of environmental management, and firm performance by using the verified financial data of the US public firms. Compared to previous studies, this study used a year as the time window to measure the long-term effects of the certification (two years prior to the certification through two years after the certification). In addition, this study used the actual certification date as the event point, rather than the announcement date as the previous studies did, in order to clearly measure the long-term effect of preparing, receiving and implementing ISO 14001 certification.

This study is organized as follows: Section 2 presents a review of the relevant literature to develop study hypotheses. In Section 3, research methodology is discussed including the process of data collection and the methods used to test the study hypotheses. Section 4 articulates the results of the analysis. Section 5 presents the conclusion and implications of the results. Finally, Section 6 concludes the study with a discussion of the limitations of the study and possible future research.

2. Review of Relevant Literature and Hypothesis Development

2.1. Literature Review

2.1.1. The Effects of Corporate Green Efforts

Over the past decades, environmental management has been one of the emerging topics in the field of operations and supply chain management [11]. The meaning and goal of implementing environmental management have changed from being just eco-friendly to a business sense and better profitability [12]. Traditionally, environmental management has been considered as a cost center but many firms recently regard it as a business value driver to gain a competitive advantage [13]. Reflecting this trend, a growing number of firms have adopted or planned to implement environmental management for their business processes. However, many practitioners still wonder about the actual effectiveness of environmental management in terms of enhancing the firm's financial performance, due to a sizable amount of investment needed for it [7]. From the practitioners' traditional perspective, environmental management is just about keeping up with relevant regulations, which may entail green costs to damage economic outcomes [14]. Recent studies about the economic impact of environmental management have yielded inconsistent results as well. Elsayed and Paton [15] indicated that the heterogeneity of environmental practices implemented by firms might be the main reason why the results from environmental management are so diverse among organizations and industries.

Nonetheless, a number of studies have indicated the positive perspectives of environmental management. Klassen and McLaughlin [16], in their study employing an event study, insisted that a third-party announcement of an environmental award positively impacts stock market returns. According to Florida and Davison [17], organizations can reduce costs and improve production processes by implementing green strategies and the environmental outcome can be created as a byproduct of innovations in cost savings and product improvements. In addition, properly regulated environmental standards would encourage firms to leverage their resources for competitive

advantage [2]. Peng and Lin [18] indicated that environmental management improves firm performance while its implementation is affected by internal resources and local responsiveness pressures. Further, environmental management can lead to better non-financial performance, such as improved corporate reputation and image, which may positively influence the firm's long-term financial performance [19]. Enhanced corporate reputation helps bring new opportunities for attracting valuable resources such as better-skilled workers and expanding market bases [20]. Implementing environmental management usually encourages firms to have proactive expectations about the fast-changing business environment.

Besides in-house effects, a number of studies have indicated the superior performances of corporate green efforts in terms of supply chain management. Zhu and Sarkis [21], by employing over 200 Chinese firms, showed that green supply chain practices are positively related to not only environmental but also the economic performance of firms. Rao and Holt [22], in their study using South East Asian companies, demonstrated that the integrated green supply chain can be created by greening different stages of supply chain and these processes would ultimately lead to improved competitiveness and profits. Green management may have the potential to lead to better environmental and financial performances without losing quality and reliability among supply chain members, suggesting a paradigm shift in supply chain management [12]. Collaboration for environmental management with supply chain partners and customers can enhance manufacturing productivity and environmental outcomes with better quality and flexibility [23,24]. This superior eco-friendly supply chain could be developed by successfully incorporating environmental practices into corporate supply chain strategies [25].

As we have seen, environmental management is associated with ecological, operational, and financial performances, either directly or indirectly. However, many practitioners still appear to have concerns regarding their financial benefits. There are studies which presented negative or at best inconclusive financial impacts of green strategies. Elsayed and Paton [15] stated that environmental performance has a neutral impact on the firm's economic performance and firms would increase environmental investments until the marginal benefit of the investments equals the marginal cost. Boiral [7] found that although rigorous compliance with the environmental standard often resulted in improved operational performance, such improvement was primarily technical and administrative in nature, which leads to decoupled daily practices from the environmental standard. According to Zhu et al. [26], green supply chain management did not improve economic performance while only slightly enhancing environmental and operational performances in the Chinese automobile industry. Jacobs et al. [6] found a negative impact of voluntary emission reduction on the market value of firms, with positive financial impacts of announcements of philanthropic gifts for environmental causes and the adoption of ISO 14001 certification. Other than these studies, many other studies presented negative or inconsistent results regarding the impact of environmental management on firm performance [27–29].

2.1.2. ISO 14001

The ISO 14000 series was developed because of an increasing demand for a certifiable international standard for environmental management [30]. A number of firms have designed, implemented, and been certified for various environmental management systems under the ISO 14000 series, which provides a standard for managing environmental problems [31]. ISO 14000 series covers six subjects: environmental management systems, environmental auditing, environmental performance evaluation, environmental labeling, life-cycle assessment, and environmental aspects in product standards [32]. Thus, with the adoption of ISO 14000, a firm could be recognized as having a capability to implement environmental management. By applying for the certification, a firm can adhere to a set of guidelines by which a facility, either a single plant or even the whole organization, can establish and strengthen its environmental policies to ascertain environmental aspects of its operations, define environmental objectives and targets, implement a program to attain environmental goals, monitor and measure effectiveness, correct deficiencies and problems, and review its management systems to promote continuous improvement [33].

The ISO 14000 series consists of various sets of standards that cover different areas of environmental perspectives. Among them, ISO 14001 regulates the environmental management system which is a core set of standards for designing and implementing environmental management. The ISO 14001 standard is composed of main elements such as environmental policy, plan, implementation and operation of programs to meet objectives and targets [34]. To register for the ISO 14001 certification, a firm must meet the requirements for general guidelines of the environmental management system. Continuous improvement in environmental systems is necessary to maintain the certification, following the plan-do-check-act procedures proposed by Deming [35]. The evaluation is not based on the environmental performance of the firm, because it is a voluntary guideline rather than a mandatory requirement. Instead, it encourages a firm to design and implement its own environmental management system and achieve its own environmental goals [1]. However, a firm should be able to show how it satisfies the criteria of ISO 14001 by establishing, documenting, implementing, and continually improving its environmental management system. Specifically, the accreditation process of ISO 14001 is composed of three major stages—the third-party pre-assessment, desktop audit, and certification audit [36].

The ISO 14001 certified firm should inspect efficiency and underlying operational issues on a regular basis and continually estimate the environmental effects of its operation [37]. During the process, the firm should accumulate more knowledge regarding potential environmental issues and apply this knowledge to improving its operational process. In addition, the firm needs to train and evaluate its workers based on this knowledge [38]. Thus, the certification process enables knowledge creation in process improvement, which can be a source of competitiveness. A number of firms require the supply chain partners to obtain ISO 14001 certification to prove their capacity to make green products [39]. For example, ISO 14001 adoption has been encouraged to become a supplier of Bristol-Myers Squibb, IBM, Xerox, Ford, GM, and Toyota [23].

ISO 14001 not only helps firms abide by governmental regulations but also provides a potential to improve firms' performance in various ways [5]. By engaging in various environmental activities, firms can enhance their sourcing and inventory management processes and reduce wastes in maintenance, repair, and operating materials processes [34]. ISO 14001 also engenders a substantial decrease in production costs associated with scrap and material loss, training expenditures, material handling, and other extra expenses for treating hazardous materials [40]. It can convert wastes into by-products and reduce the use of hazardous materials through more timely and accurate tracking systems [41]. ISO 14001 can help open new opportunities for learning and building strategic capabilities to gain a sustainable competitive advantage [42]. Firms can analyze the cost drivers and evaluate alternative cost-reduction opportunities while preparing for the certification.

2.2. Hypothesis Development

Environmental management has the potential to improve a firm's financial performance while concerns about increased costs for environmental initiatives exist [16]. Among various corporate green practices, ISO 14001 is an overall and representative environmental management standard to serve as a comprehensive framework to obtain substantial environmental, operational, and financial performance [34]. Based on the literature which supports the positive financial effects of environmental management, Hypothesis 1 is proposed. ROI (Return on Investment) is defined as net income divided by total assets to reflect the efficiency of firm assets to create operating and non-operating benefits.

Hypothesis 1. *ISO 14001 certification is positively associated with the firm's ROI.*

A number of scholars argue that one of the main reason to pursue green strategies might be a financial motivation [4]. In terms of the capital market, profits increase a firm's retained earnings and equity capital, thereby decreasing the equity risk of the firm. Furthermore, financial performance can be improved by the firm's decreased equity risk. If the marketplace accepts ISO 14001 as an increase of

capital efficiency, the stock market might positively react, leading to an increase in the market value of equity. Thus, Hypothesis 2 is proposed. Tobin's Q can be used to interpret the stock price movement in terms of equity structure. If Tobin's Q is less than 1, a firm's past performance or future performance is not viewed favorably compared to the invested assets. As the market assigns a higher value on the firm, Tobin's Q will increase. Tobin's Q is defined as follows [43]:

$$\text{Tobin's Q} = \frac{\text{Market value of the outstanding financial claims}}{\text{Current replacement costs of the assets}}. \quad (1)$$

Hypothesis 2. *ISO 14001 certification is positively associated with the firm's Tobin's Q.*

Environmental management has the potential to go beyond the positive valuation in the capital market. A firm can achieve continuous improvement of firm performance through ISO 14001 implementation as it helps change the organizational culture such as employee empowerment and participation [44]. Environmental management enhances a firm's reputation and image, which, in turn, contribute to increasing sales volume and profitability [18]. Thus, Hypothesis 3 is proposed. This study employs the Asset turnover (Sales/Assets) to test the difference in sales efficiency regarding the pre and post ISO 14001 certification [45].

Hypothesis 3. *ISO 14001 certification is positively associated with the firm's asset turnover.*

3. Methodology

An event study is based on the efficient market theory which explains the relatively short-term movements of stock prices [46]. Thus, a long-term analysis using the event study may result in bias. Many scholars have debated about most appropriate way to measure the long-term abnormal returns in the equity market [47–50]. In general, there are two major issues involved in this topic [51]. The first is to identify the factors which should be controlled in the analysis of long-term abnormal returns. Recent studies have indicated that organization size and prior performance are critical factors affecting a firm's financial performance [52,53]. Therefore, this study employed the total asset and ROA as control variables. ROA (Return on Asset) is defined as operating income divided by total assets because operating income is an appropriate measure of operating performance [54]. In addition, this study controlled industry considering that the sample covers diverse industries. The second is cross-sectional dependency which arises during measuring long-term stock prices due to overlapping time periods among the sample firms. Recent simulation studies stated that using one-to-one matching method can be a solution for this problem [47,50].

Based on the literature, this study used the one-to-one matching method, in which each sample firm (ISO 14001 certified firm) is paired with the control firm (Non-ISO 14001 certified firm) with the closest pre-event characteristics to the sample firm. For each sample firm, three different types of control firms were made based on the three criteria (i.e., (i) Industry and ROA; (ii) Industry and Assets; (iii) Industry, ROA, and Assets). Thus, the first control firm is the non-ISO 14001 certified firm with the closest pre-event asset value to the sample firm in the same industry. The second control firm is the non-ISO 14001 certified firm with the closest pre-event ROA value to the sample firm in the same industry. The third control firm is the non-ISO 14001 certified firm with the closest pre-event asset and ROA value to the sample firm in the same industry. By using three different types of control firms, the performances of each ISO 14001 certified firm were compared three times to minimize any bias.

A firm's performance improvement in the event period should be isolated for the implementation of ISO 14001. Firms may implement a variety of environmental practices even before applying for the ISO 14001 certification. Although, theoretically, the sample firms should have investments only for the ISO 14001 certification and the control firms should not have any investment for environmental

practices during the event periods, it is not practically possible to isolate all other types of investments in using the event study methodology. Instead, this study investigated all companies in NYSE (New York Stock Exchange) and NASDAQ to include as many ISO 14001 certified firms (174 certified firms) as possible to minimize bias from these issues. In addition, this study employed three different types of control firms (a total of 522 control firms) to compare with one ISO 14001 certified firm so that the analysis may minimize bias from using only one control firm. All control firms were selected from the firms which did not have ISO 14001 certification history.

Corbett et al. [45] used the data from the World Preferred which shared the information about all ISO 9000 certified firms in the USA to investigate the long-term effect of ISO 9000. However, there exists no publicly available database which contains the information about all ISO 14001 certified firms in the USA, while a number of lists of ISO 14001 certified firms in several other countries were found during the search process. Due to the fact that the goal of this study is to investigate the actual long-term effect of ISO 14001 certification, this study needed not only the lists of the certified firms but also the information of these firms' actual certification dates.

To collect necessary data, we searched articles in the representative media such as The New York Times, The Wall Street Journal, The Washington Post, and Chicago Tribune. In addition, this study searched necessary information from LexisNexis and Internet search engines, employing all US public firms in NYSE and NASDAQ. All corporate websites were scanned to mine the data about whether the firm was certified and the first certification date. If these data were not available on the Internet, the firms were contacted by emails and phone calls to find and confirm the necessary information. The firms whose initial certification date was not found during the search process, were dropped from the sample firms, although the firms were certified. Finally, 331 ISO 14001 certified firms were found during 1996–2010. Among these firms, we could find the initial certification date from 174 firms, which were employed as our study sample.

During this process, we found that many firms have more than one certification at different facilities or even at one site because ISO 14001 certification can be granted to an individual branch or facility of the corporation. In this case, the date of the first certification among all certifications was used for the corporate level, because there was no way to estimate the financial performance of a specific part of a company such as division or facility [55]. In other words, one TIC (ticker symbol to identify a firm in the Compustat) should have one certification date, as the effects of the certification begin to show around the first certification date.

We could not focus on a specific industry (e.g., manufacturing) because the sample of ISO 14001 certified firms in a single industry would be too small to perform a meaningful study. Considering a typical ISO 14001 implementation can take up to 18 months [28], firms may see the benefits of required changes while preparing for the certification. Thus, this study used firms' traits at the $t - 2$ point (2 years before the certification) for the pre-event traits to create control firms. This study used quarterly Compustat data because the financial statements of the listed firms are reported quarterly. To avoid any bias from the stock price fluctuation, we used the average stock price of each quarter.

4. Results

The descriptive information of the sample firms is shown in Table 1. The sample firms represent a mean value of sales \$2695.9 million, operating income as \$407.6 million, net income as \$172.2 million, total asset as \$13,868.5 million, liabilities as \$9932.6 million, and equity market value as \$22,231.9 million. This study employed the parametric *t*-test to test the hypotheses, assuming the null hypothesis of no abnormal performance. In addition, non-parametric tests such as Wilcoxon signed rank test and sign test were used, due to the fact that the parametric test is sensitive to the extreme outliers [56].

Table 1. Sample description (\$ million).

Measure	Mean	Median	Std. Dev.	Max	Min
Sales	2695.9	367.7	6767.9	52,369.5	0.6
Operating Income	407.6	60.6	1069.8	9570.8	−45.0
Net Income	172.2	13.5	576.2	3896.7	−1368.0
Total Asset	13,868.5	1747.4	44,781.6	449,639.8	8.2
Liabilities	9932.6	932.5	40,078.9	431,171.6	0.5
Equity Market Value	22,231.9	1999.7	66,514.0	408,990.0	2.3

The test results are shown in Tables 2–11. Each test variables (ROI, Tobin's Q, and Asset turnover) have three result tables, each of which corresponds to three control groups (i.e., (1) Industry and ROA, (2) Industry and Assets, (3) Industry, ROA, and Assets). The median value, as well as mean value, were calculated with the *p*-values of *t*-test, Wilcoxon signed rank test, and sign test, to provide comprehensive insights regarding the effects of the certification. In each result table, 'N' stands for the number of ISO 14001 certified firms used for the analysis. Year 't' is the firm's certification year, when the ISO 14001 certification was granted. For example, the period t to t + 2 indicates the period from the certification year to two years after the certification year.

Table 2. Abnormal performance in ROI; control for industry and ROA.

Time	N	Mean	Median	t-Test	WSR	Sign
t − 2 to t − 1	172	0.4%	0.3%	0.000 ***	0.000 ***	0.001 ***
t − 1 to t	172	0.1%	0.0%	0.453	0.589	0.541
t to t + 1	159	−0.1%	−0.1%	0.249	0.169	0.428
t + 1 to t + 2	135	0.0%	0.0%	0.923	0.651	1.000
t − 2 to t	172	0.4%	0.5%	0.000 ***	0.000 ***	0.002 ***
t − 1 to t + 1	157	−0.1%	−0.1%	0.615	0.688	0.425
t to t + 2	135	−0.1%	−0.1%	0.295	0.228	0.488
t − 2 to t + 1	157	0.3%	0.4%	0.007 ***	0.014 **	0.110
t − 1 to t + 2	133	−0.1%	−0.2%	0.545	0.331	0.165
t − 2 to t + 2	133	0.3%	0.0%	0.047 **	0.124	0.862

** *p* < 0.05; *** *p* < 0.01.

Table 3. Abnormal performance in ROI; control for industry and assets.

Time	N	Mean	Median	t-Test	WSR	Sign
t − 2 to t − 1	172	0.3%	0.4%	0.001 ***	0.002 ***	0.005 ***
t − 1 to t	172	0.1%	0.1%	0.058 *	0.059 *	0.027 **
t to t + 1	160	0.0%	0.0%	0.692	0.615	0.279
t + 1 to t + 2	137	−0.2%	−0.1%	0.016 **	0.028 **	0.016 **
t − 2 to t	172	0.4%	0.3%	0.000 ***	0.000 ***	0.008 ***
t − 1 to t + 1	158	0.1%	0.2%	0.121	0.112	0.047 **
t to t + 2	137	−0.1%	0.0%	0.102	0.142	0.430
t − 2 to t + 1	158	0.4%	0.4%	0.001 ***	0.001 ***	0.017 **
t − 1 to t + 2	135	−0.1%	−0.1%	0.595	0.501	0.491
t − 2 to t + 2	135	0.2%	0.1%	0.079 *	0.140	0.606

* *p* < 0.1; ** *p* < 0.05; *** *p* < 0.01.

Table 4. Abnormal performance in ROI; control for industry, ROA, and assets.

Time	N	Mean	Median	t-Test	WSR	Sign
t − 2 to t − 1	172	0.3%	0.4%	0.000 ***	0.000 ***	0.000 ***
t − 1 to t	172	0.1%	0.1%	0.039 **	0.050 *	0.027 **
t to t + 1	160	0.0%	0.1%	0.586	0.346	0.014 **
t + 1 to t + 2	137	−0.1%	−0.1%	0.183	0.222	0.049 **
t − 2 to t	172	0.5%	0.4%	0.000 ***	0.000 ***	0.005 ***
t − 1 to t + 1	158	0.1%	0.2%	0.099 *	0.087 *	0.079 *
t to t + 2	137	−0.1%	0.0%	0.363	0.483	1.000
t − 2 to t + 1	158	0.5%	0.5%	0.000 ***	0.000 ***	0.002 ***
t − 1 to t + 2	135	0.0%	−0.1%	0.680	0.953	0.666
t − 2 to t + 2	135	0.4%	0.1%	0.003 ***	0.012 **	0.545

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Abnormal performance in ROI is presented in Tables 2–4. The t -test results of ROI during $t - 2$ to $t + 2$ showed the positive abnormal returns in all three match groups (i.e., (1) Industry and ROA, (2) Industry and Assets, (3) Industry, ROA, and Assets), which implies that the overall profitability was improved around the certification from the long-term perspective. Although not all non-parametric tests showed significant results during $t - 2$ to $t + 2$, all test results which showed significant abnormal returns indicated the positive abnormal performances. These results imply that the corporate green efforts are highly associated with positive abnormal performance in the long run.

In addition, all parametric and non-parametric tests presented positive significant abnormal returns during $t - 2$ to $t - 1$ and $t - 2$ to t periods. All test results reported the significance with the p -value of 0.01. These results imply that the efforts to prepare for environmental management are compensated from the early stage of preparation. In addition, all significant results in both parametric and non-parametric tests in all analysis time windows presented the positive abnormal performance, indicating the high correlation between the corporate green efforts and abnormal returns in firms' profitability.

Table 5. Abnormal performance in Tobin's Q; control for industry and ROA.

Time	N	Mean	Median	t-Test	WSR	Sign
t − 2 to t − 1	150	5.3%	2.7%	0.000 ***	0.000 ***	0.000 ***
t − 1 to t	149	1.0%	−0.2%	0.436	0.959	0.870
t to t + 1	145	−4.1%	−5.1%	0.001 ***	0.000 ***	0.000 ***
t + 1 to t + 2	124	−0.2%	−0.3%	0.911	0.764	0.788
t − 2 to t	148	6.3%	5.0%	0.000 ***	0.001 ***	0.001 ***
t − 1 to t + 1	138	−3.1%	−3.8%	0.093 *	0.063 *	0.106
t to t + 2	120	−4.0%	−3.5%	0.039 **	0.029 **	0.022 **
t − 2 to t + 1	137	1.9%	0.4%	0.360	0.564	0.608
t − 1 to t + 2	114	−2.4%	−2.1%	0.328	0.212	0.399
t − 2 to t + 2	114	2.8%	2.6%	0.306	0.662	0.925

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table 6. Abnormal performance in Tobin's Q; control for industry and assets.

Time	N	Mean	Median	t-Test	WSR	Sign
t − 2 to t − 1	150	9.0%	10.4%	0.000 ***	0.000 ***	0.000 ***
t − 1 to t	153	−1.1%	−2.1%	0.334	0.058 *	0.075 *
t to t + 1	141	0.2%	0.2%	0.886	0.949	1.000
t + 1 to t + 2	118	−0.4%	−1.0%	0.764	0.499	0.782
t − 2 to t	150	8.1%	8.8%	0.000 ***	0.000 ***	0.000 ***
t − 1 to t + 1	137	−1.3%	−2.1%	0.441	0.435	0.305
t to t + 2	116	−0.2%	−2.7%	0.895	0.723	0.114
t − 2 to t + 1	134	8.1%	6.2%	0.000 ***	0.000 ***	0.002 ***
t − 1 to t + 2	113	−2.0%	−4.8%	0.423	0.345	0.347
t − 2 to t + 2	112	6.3%	2.1%	0.025 **	0.057 *	0.395

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.**Table 7.** Abnormal performance in Tobin's Q; control for industry, ROA, and assets.

Time	N	Mean	Median	t-Test	WSR	Sign
t − 2 to t − 1	153	4.4%	5.5%	0.001 ***	0.000 ***	0.000 ***
t − 1 to t	152	1.0%	−0.6%	0.389	0.497	0.570
t to t + 1	142	−0.3%	0.3%	0.801	0.608	0.933
t + 1 to t + 2	119	−2.2%	−1.6%	0.110	0.111	0.463
t − 2 to t	151	5.6%	7.1%	0.001 ***	0.001 ***	0.000 ***
t − 1 to t + 1	137	0.2%	−0.4%	0.888	0.855	0.608
t to t + 2	116	−2.6%	−1.0%	0.157	0.158	0.307
t − 2 to t + 1	136	4.7%	7.6%	0.034 **	0.015**	0.032 **
t − 1 to t + 2	112	−1.8%	−2.7%	0.441	0.275	0.156
t − 2 to t + 2	112	2.5%	2.8%	0.350	0.406	1.000

** $p < 0.05$; *** $p < 0.01$.

The results of abnormal performances in Tobin's Q are provided in Tables 5–7, which show the results corresponding to three control groups (i.e., (1) Industry and ROA, (2) Industry and Assets, (3) Industry, ROA, and Assets), respectively. All parametric and non-parametric tests showed the positive abnormal performance during t − 2 to t − 1 and t − 2 to t periods, implying that the eco-friendly efforts for the certification lead to the positive abnormal returns in the capital market. It is conjectured that the corporate green efforts functioned as a positive signal for investors, as the information of pursuing ISO 14001 certification was announced.

However, the four-year period abnormal performances (t − 2 to t + 2) were not definitely significant in all three match groups. It would be because some of the test periods such t to t + 1 and t + 1 to t + 2 presented the negative abnormal returns. Even the first match group (i.e., the group controlled for industry and ROA) showed the negatively significant abnormal returns during t to t + 1 period in all parametric and non-parametric tests. Investors might interpret the corporate green efforts as a good signal in the preparation stage, but soon recognize the initial positive returns as an overreaction to unproven environmental efforts. These results imply that the investment community does not interpret the ISO 14001 certification as a positive signal in the long run, although short-term abnormal fluctuations in the stock market exist. The possible reasons why the capital market did not show significant abnormal reaction will be precisely discussed in the Conclusion and Discussion Section.

Table 8. Abnormal performance in asset turnover; control for industry and ROA.

Time	N	Mean	Median	t-Test	WSR	Sign
t − 2 to t − 1	163	1.0%	0.9%	0.000 ***	0.000 ***	0.000 ***
t − 1 to t	163	0.9%	0.9%	0.000 ***	0.001 ***	0.001 ***
t to t + 1	161	−0.6%	−0.6%	0.010 **	0.020 **	0.083 *
t + 1 to t + 2	147	0.3%	0.6%	0.177	0.163	0.005 ***
t − 2 to t	161	1.8%	1.7%	0.000 ***	0.000 ***	0.000 ***
t − 1 to t + 1	159	0.3%	0.3%	0.312	0.212	0.204
t to t + 2	145	−0.3%	−0.3%	0.314	0.354	0.506
t − 2 to t + 1	157	1.2%	0.5%	0.004 ***	0.008 ***	0.110
t − 1 to t + 2	143	0.5%	0.4%	0.164	0.180	0.275
t − 2 to t + 2	141	1.5%	1.0%	0.001 ***	0.004 ***	0.178

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.**Table 9.** Abnormal performance in asset turnover; control for industry and assets.

Time	N	Mean	Median	t-Test	WSR	Sign
t − 2 to t − 1	165	0.6%	0.6%	0.005 ***	0.004 ***	0.005 ***
t − 1 to t	165	0.1%	0.0%	0.726	0.988	0.482
t to t + 1	155	0.1%	0.3%	0.787	0.544	0.520
t + 1 to t + 2	141	−0.1%	−0.5%	0.729	0.659	0.052
t − 2 to t	165	0.6%	0.7%	0.030 **	0.043 **	0.062 *
t − 1 to t + 1	154	0.1%	0.1%	0.676	0.858	1.000
t to t + 2	139	0.0%	0.1%	0.894	0.794	0.551
t − 2 to t + 1	154	0.7%	0.6%	0.039 **	0.042 **	0.030 **
t − 1 to t + 2	138	0.0%	−0.3%	0.938	0.730	0.202
t − 2 to t + 2	138	0.7%	0.1%	0.089 *	0.143	0.494

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.**Table 10.** Abnormal performance in asset turnover; control for industry, ROA, and assets.

Time	N	Mean	Median	t-test	WSR	Sign
t − 2 to t − 1	164	0.4%	0.5%	0.040 **	0.017 **	0.051 *
t − 1 to t	165	0.4%	0.3%	0.022 **	0.049 **	0.043 **
t to t + 1	159	0.5%	0.1%	0.007 ***	0.018 **	0.751
t + 1 to t + 2	144	0.5%	0.1%	0.005 ***	0.006 ***	0.002 ***
t − 2 to t	163	0.8%	0.6%	0.002 ***	0.007 ***	0.042 ***
t − 1 to t + 1	158	1.0%	1.0%	0.000 ***	0.000 ***	0.001 ***
t to t + 2	142	1.1%	1.1%	0.000 ***	0.000 ***	0.000 ***
t − 2 to t + 1	156	1.3%	1.2%	0.000 ***	0.000 ***	0.002 ***
t − 1 to t + 2	141	1.3%	1.4%	0.000 ***	0.000 ***	0.003 ***
t − 2 to t + 2	139	1.7%	1.5%	0.000 ***	0.000 ***	0.002 ***

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Abnormal performances in asset turnover (Sales/Assets) are presented in Tables 8–10. All parametric test results and most of the non-parametric test results showed the positive abnormal returns during t − 2 to t + 2 periods, indicating that the corporate green efforts significantly improve the asset turnover in the long run. In addition, all test results in three control groups (i.e., (1) Industry and ROA, (2) Industry and Assets, (3) Industry, ROA, and Assets) during t − 2 to t − 1 showed positively significant abnormal performances. These results presented that the corporate green efforts for the ISO 14001 certification would improve firms' asset efficiency to create sales from the early stage of the preparation.

Table 11. Summary results of abnormal performance (controlled for industry, ROA, and assets).

Time	ROI		Tobin's Q		Asset Turnover	
	N	Sig	N	Sig	N	Sig
t − 2 to t − 1	172	***	153	***	164	**
t − 1 to t	172	**	152		165	**
t to t + 1	160		142		159	***
t + 1 to t + 2	137		119		144	***
t − 2 to t	172	***	151	***	163	***
t − 1 to t + 1	158	*	137		158	***
t to t + 2	137		116		142	***
t − 2 to t + 1	158	***	136	**	156	***
t − 1 to t + 2	135		112		141	***
t − 2 to t + 2	135	***	112		139	***

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Notably, all test periods in the third match group (i.e., the group controlled for Industry, ROA, and Assets) indicated the positively significant abnormal performances in most parametric and non-parametric test results. In addition, many test periods in the first and second match groups (i.e., the group controlled for (1) Industry and ROA, (2) Industry and Assets) presented the positively significant abnormal performances. These results imply that the corporate green efforts improve business processes, customer relationship and sales capacity, leading to an increase in the firms' asset efficiency to respond to the market.

5. Conclusions and Discussion

ISO 14001 has been widely accepted throughout the world as a major environmental management approach. Despite the fact that the ISO 14001 adoption rate of US firms is low in the developed world, a number of firms newly plan to implement environmental management through this certification. However, researchers and practitioners are not still confident with its economic benefits, as there exists no hard evidence regarding the economic effects of the certification. In addition, most prior studies exhibited a limited scope and reliability, since they used subjective survey or interview data, which could cause an extrapolation inference bias. The findings of this study could provide useful insights to managers in deciding whether or not to initiate process innovations in their companies to prepare for ISO 14001 certification.

The summary results of *t*-test (controlled for industry, ROA, and Assets) were described in Table 11. In the study results, ROI showed a significant long-term abnormal performance of ISO 14001 certification and the positive certification effects were observed in many periods (e.g., $t - 2$ to $t - 1$; $t - 1$ to t ; $t - 2$ to t ; $t - 2$ to $t + 1$; $t - 2$ to $t + 2$). While the benefits are differently reflected according to the timeline, the firm's environmental efforts seem to be compensated as improvement of the firm's profitability. In addition, the results showed that the positive abnormal performance was clearly observed before the certification, implying that the firm's environmental efforts were compensated from the early stage of preparation. The assets turnover (sales/assets) also showed positive abnormal performances in a number of periods. It seems that the firm's environmental efforts improved internal business processes and product quality, leading to sales and profitability improvement. In addition, the firms' green efforts for sustainability could be compensated as the improvement of the corporate image, increasing the sales volume.

We observed insignificant abnormal performance in Tobin's Q, especially after the certification. Considering the ROI and Asset turnover improvement, it is expected that Tobin's Q would increase in the long run. However, the stock market did not clearly react as expected, leading to the insignificant long term abnormal performance in Tobin's Q. Therefore, we believe there are other elements that play negatively here. One possible element is the punishment of the firm by shareholders for sinking funds

in the environmental management initiative. Shareholders may expect more profitable projects than the certification. We can also think of possible changes in the equity structure of the firm. Investments in environmental management initiatives may change the composition of assets, liabilities, and equity in the long run. Thus, changes in the equity structure can be a source that increases the equity risk, thereby decreasing the market value of the firm.

The stock market is a very complex place where a variety of information affects the stock price and shareholders also interpret the information in diverse ways. Therefore, the short-term fluctuations in the stock price around the certification can be interpreted in different ways. For example, the initiation of preparing for the ISO 14001 certification can be accepted by shareholders as successful completion of process improvement for environmentalism. Firms with an existing environmental management system might be more likely to initiate preparing for the ISO 14001 certification because they can expect the certification with less effort [57]. In other words, these firms have already invested sizable amounts for environmental management even before the certification. Thus, the announcement of preparing for the certification can be interpreted as the end of long-standing drag on cash flows—a reduced need to pay for additional environmental management initiatives, causing a short-term increase in stock prices. Without a drag on cash, more resources can be available to the firm for other types of investment, thereby driving financial returns. The long-term increase in profitability might be associated with the end of investments in environmental management initiatives.

On the other hand, the announcement of preparing for the ISO 14001 certification can have a negative connotation for shareholders. The preparation process for the certification may require additional cash flow even if firms applying for the certification may already have some types of functioning environmental management systems. The new investment might deteriorate the efficiency of the firm's assets, which could be invested in other more profitable projects. This interpretation can negatively affect the stock market, causing a short-term decrease in the stock price around the certification. The fluctuations in the stock price seem to be influenced by such interpretations of the investment community.

Corporate green efforts can be viewed as representative signals of firms' taking corporate social responsibility. Firms' CSR activities could be highly associated with the abnormal returns of equity values, and investors' evaluation regarding these programs would be changed as time goes on [58]. Although investors do not clearly prefer environmental policy, firms' green efforts have the potential to influence corporate financial performances in various ways. One of the well-known channels is corporate governance. Firms with good corporate governance are usually known to have better operational performances and higher market values [59]. However, the motivation to implement CSR programs might be often associated with executives' personal goal or reputation, causing agency problem [60]. In addition, the executives' preference for a conservative or aggressive decision might be related to conducting environmental program [61]. Thus, a well-established mutual monitoring system would be necessary to achieve the main purpose of CSR programs [62]. Overall, the effects of corporate green efforts on the capital market should be interpreted in a comprehensive way.

6. Limitations and Future Research

There are some limitations and future research needs in this study. First, an issue of endogeneity could still remain, although the one-to-one matching method was applied. Thus, the portfolio match, in which the performance of certified firms is compared to the average performance of multiple firms, would enhance the reliability of future research. Second, if there are many environmental programs implemented by the firm and ISO 14001 is just one of them, the influence of ISO 14001 implementation might be limited. Therefore, the influence of the firm's green history should be incorporated into future study. Third, although the ideal control firms should not have any process improvement practice for environmental management, it was impossible to isolate all other investments in environmental management initiatives in using the data of US public firms. Although we excluded any firm which had ISO 14001 certification history before the event window in selecting the control firms, a more

appropriate method to enhance the robustness of the study results might be considered in the future research. Fourth, considering that it is an emerging practice to link executive incentive and corporate social responsibility, it would be interesting to investigate the financial performances in terms of the relationship between executives' compensation contracts and CSR performances [63,64].

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