Efficiency of Management System Certification: Evidence from the Chinese Manufacturing Industry

by

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AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Abstract

Implementation and certification of management systems represented by ISO 9001, ISO 14001, and OHSAS 18001 have been major activities of organizations motivated by both internal incentives and external pressures. Nevertheless, studies on the effectiveness of such certifications in fostering corporate sustainable development have revealed mixed and ambiguous findings. In addition, most research in this field remains focused on specific performance indicators while ignoring other criteria, especially the factors pertaining to the Triple Bottom Line concept. Lack of a unified evaluation framework also leads to divergent views on the true benefits of certification.

Grounded in the dynamic capability theory and the corporate sustainable development concept, this study provides insights into the efficiency evaluation of certified management systems in a Chinese context, by developing a heterogeneous inputs-outputs analytical framework. Comprehensive comparisons among firms with various certification statuses are conducted to observe the effects of certified management systems in facilitating corporate sustainable development. This study further sheds light on the assimilation, integration, synergetic, and cumulative effects of certification by taking temporal and spatial factors into account.

With the help of a Data Envelopment Analysis (DEA)-based nonparametric approach and Tobit estimation technique, the hypotheses are tested using longitudinal data of 73 Chinese-listed firms from the manufacturing industry between 2009 and 2012. The findings reveal that the firms increasingly certified their management systems and preferred to obtain multiple management system standards during these four years. Certifications, especially the

integrated ones, served as effective approaches to facilitate the firms to become efficient by exerting assimilation and integration effects. Additionally, the synergetic and cumulative effects of certification in improving corporate sustainable efficiency both appeared in the sample. The findings imply that firms in China that need to grow in a green way can identify multiple certified management system standards as effective approaches to achieve corporate sustainable development.

Keywords: ISO 9001, ISO 14001, OHSAS 18001; dynamic capabilities view; Corporate Sustainable Development (CSD); Corporate Sustainable Efficiency (CSE); Management Systems (MSs); Management Systems Standards (MSSs)

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Note: All listed names are sorted in alphabetical order.

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List of Abbreviations and Acronyms

3BL: Triple Bottom Line

CASS: the Chinese Academy of Social Sciences

CIP: Continual Improvement Process

CNCA: Certification and Accreditation Administration of the People's Republic of China

CSD: Corporate Sustainable Development

CSE: Corporate Sustainable Efficiency

CSR: Corporate Social Responsibility

DEA: Data Envelopment Analysis

DMU: Decision-Making Unit

EPI: Environmental Performance Index

ESIs: Environmentally Sensitive Industries

GRI: Global Reporting Initiative

IMS: Integrated Management System

ISO 14001: Environmental Management System Standards

ISO 9001: Quality Management System Standards

ISO: International Organization for Standardization

MS: Management System

MSS: Management System Standard

NDRS: Non-Decreasing Returns-to-Scale

OHSAS 18001: Occupational, Health and Safety Management System Standards

PDCA: Plan-Do-Check-Act

RMI: Responsibility Management Index

SIC: Standard Industrial Classification

SME: Small and Medium-sized Enterprises

SPI: Social Performance Index

Chapter 1 Introduction

This chapter introduces the research background, motives, objectives, and structure of the study, which provides an abstract, clear, and comprehensive description about the research question and design of the thesis. It also sets up the tone and theoretical context of this study, allowing readers to understand the rationales and reasoning behind the work.

1.1 Research Background

As micro-level sustainable development practical subjects, firms are challenged to meet the Triple Bottom Line (3BL) to accommodate external and internal expectations by addressing their efforts to harmonize social, economic, and environmental development (Elkington, 1997). Against this background, the concept of Corporate Sustainable Development (CSD), introduced by the World Commission on Environment and Development (WCED), is now being promoted to address firms' responsibilities for their stakeholders instead of stockholders. It is widely acknowledged that corporate social responsibility (CSR) nowadays is much more than a managerial option but a strategy for business (Werther & Chandler, 2006). Strategic goals and tactics have been deliberately adopted by firms to incorporate social and environmental sustainability into their business practices (Lee & Farzipoor, 2012).

Against this background, a set of process-focused international management systems standards (MSSs), such as ISO 14001, ISO 9001, and OHSAS 18001, have been widely promoted and registered globally to pinpoint corporate economic, environmental, and social aspects (Biquand & Zittel, 2012; Noronha et al., 2013). Here, ISO 9001, first released in 1991,

addresses various aspects of quality management; ISO 14001, first issued in 1996, sets out the criteria for an environmental management system; the Occupational Health and Safety Assessment Series 18001(OHSAS 18001), first published in 1999, exist to help all kinds of organizations put in place demonstrably sound occupational health and safety performance.

The goal of such certifications is to provide firms with various contexts or backgrounds with standards on a worldwide basis in order to facilitate cross boarder trading to transcend national boundaries, and help to make industry more efficient and effective; in turn, participants receive more trust and satisfaction from various stakeholders, especially the external stakeholders who cannot otherwise fully observe the companies' managerial practice through the certification (Darnall & Carmin, 2005). They serve as both an internal management tool and an external demonstration of an organization's compliance with a management and process system by establishing the documentation and procedural standards that must be met to address the information asymmetry problem in inter- and intra-national trade (Boiral, 2007; Potoski & Prakash, 2013). Although the standards (e.g., ISO 9001, ISO 14001, and OHSAS 18001) address different issues (such as quality, environment, and occupational health & safety), they share similar management techniques and a common underlying theoretical principle based on Plan-Do-Check-Act (PDCA) cycle that allows the standards to be compatible with each other and to be integrated together (Ejdys & Matuszak-Flejszman, 2010; Zwetsloot, 2003).

1.2 Motivations of the Study

From the stakeholder perspective, firms are embedded in society, which provides them with necessary resources to survive, and they have corresponding responsibilities to keep all stakeholders in mind instead of focusing on stockholders alone. Conversely, external pressures from stakeholders including customers, suppliers, governments, and local communities, with bargaining powers, convince firms to adopt certain standards (Delmas & Montiel, 2009; Qi et al., 2011). Moreover, driven by coercive, mimetic, and normative forces, firms tend to behave in an isomorphic way to gain high legitimacy and comply with social expectations by homogenizing their organizational practices (Prajogo, Tang, & Lai, 2012).

External pressures and internal incentives, including the needs to enter the global marketplace, improve customer satisfaction, and comply with regulations, have formed important drivers for firms to implement and certify their environmental, quality, and/or social management systems (Terziovski et al., 1997; Welch et al., 2002; Turk, 2009). Additionally, empirical research has proved that organisations tend to integrate[①] rather than de-integrate their MSs to gain costs savings, minimisation of financial loss, better external image, improved technology development, better joint operational performance, improved internal management, higher staff motivation and lower inter-functional conflicts (Zeng et al., 2011).

However, despite the likely benefits of certification, it is not a risk-free undertaking (Chang & Lo, 2005). Unlike other voluntary programmes, such certifications require

[①] To integrate management system goals, documentation and human resources, and procedures of different management systems

participants to implement standard management systems before receiving an initial certification audit and subsequent annual recertification audits to gain verification (Hockman et al., 1994; Delmas, 2001), leading to substantial expenses and commitments that participants must address (Joubert, 1998). Continuing, fluctuating, and invisible costs associated with certifications are inevitable and remarkable, and, in turn, cause high operating investments and risks. Additionally, paperwork, superficial implementation, different meanings for various subjects[②], lack of internal motivation are also identified as persuasive pitfalls of certification, which introduce significant challenges for decision-makers (Boiral, 2003, 2007, 2011). Thus, the implementation costs therefore can exceed the certification benefits in some cases (Martinez-Costa & Martinez-Lorente, 2007).

What is more, implementing multiple standards in parallel demands many duplicate management tasks and incur problems due to their differences in perceived stakeholders and operational management methods (Zeng, Shi, & Lou, 2007). The integration level thus can range from no integration, partial integration, to full integration due to various challenges, such as lack of human resources, specialized support, institutional support, differences among standards, and internal organisational issues like departmentalisation of functions (Karapetrovic & Willborn, 1998; Karapetrovic et al., 2006; Castillo-Rojas et al., 2012). With this regard, the outcome of certification varies as it may lead to extraordinary successes, or merely to a weighty workload and "cost of doing business" (Terziovski et al., 2003).

[②] Despite their consensual appearance, management standards are not clear-cut systems encouraging excellence and having the same meaning for everyone. Instead, they represent flexible guidelines that may be viewed and managed quite differently.

Additionally, managerial activities are very context-specified as the nature and outcomes of such programs vary in divergent settings. Although management system certification has raised a great deal of attention around the world, little research has been done for developing countries. As the second-largest, biggest emerging and export-oriented economy in the world, China has seen rapid growth in organizations registering for ISO 9001, ISO 14001, and/or OHSAS 18001 both in absolute number and percentage of the world's total (Qi et al., 2013). At the micro level, Chinese companies need to prove that their organizational behaviors meet requirements of social and environmental standards to gain business opportunities; at the macro-level, China has to respond to the CSR demand in the global market in order to retain economic growth (Lin, 2010).With its particular social, cultural, and political pattern as well as social and environmental issues caused by economic activities, China has raised increasing interest from researchers and is expected to be a good sample to expand the existing literature.

1.3 Objectives of the Study

In line with the 3BL and CSD concept, a unified comprehensive framework is proposed from a systematic perspective in this study to facilitate efficiency evaluation of management system certification.

This study sets out to develop a framework with clear principles, goals, and scopes in order to measure the sustainable efficiency of management system certification in a Chinese context, where the firms are categorized by three groups based on their standard management systems' features, and the corporate sustainability performance is measured based on multi-

faceted dimensions of Triple Bottom Line (3BL). From an optimizing and efficiency perspective, which implies that more output is supposed to derive from less input if certification activities are processed efficiently, this study investigates whether firms with certification(s) will gain higher sustainable efficiency than firms without certification, and whether firms with more certifications and longer registration history will gain higher efficiency than others.

By exploring the questions that have been missing in prior studies, this study contributes to the literature in several ways: 1) a unified multi-dimensional evaluating framework is set up to measure the relative efficiency of a firm's ability to achieve high sustainable (social, environmental, and financial) benefits; 2) an efficiency comparison between firms with multi-, single-, and no management system standards (MSSs); 3) an identification of the relationship among certification numbers, registration history, and corporate sustainable efficiency; 4) benchmarking identification and optimization suggestions are then provided from an optimizing and efficiency perspective; and 5) the characteristics of Chinese management system certification activity are revealed to enrich the understanding of certification practice in a different context.

1.4 Structure of the Thesis

The remainder of the thesis is organized as follows:

Chapter 2 reviews a variety of previous studies regarding the topic and proposes the research question that has not been answered in depth;

Chapter 3 proposes a conceptual framework from a dynamic capability view and the corresponding hypotheses that need to be tested in the following parts of the study;

Chapter 4 explains the rationales of the selected methodology and the specific approaches utilized to address the study objectives from both technical and practical perspectives. It also explains the considerations for choosing the particular sample and data sources;

Chapter 5 presents and compares the detailed results obtained from the quantitative analysis using the sample, followed by the corresponding explanations for the outcomes;

Chapter 6 draws comprehensive conclusions and implications based on the findings, lists the corresponding uncertainties and limitations of the study, and makes recommendations for the future research.

Chapter 2 Literature Review

Whether "doing-good" leads to "doing-well" for business is still a heated argument as firms that behave in a "socially responsible" manner are not guaranteed with better performance than firms that only focus on their stockholders' interests (Margolis & Walsh, 2003; Vitaliano & Stella, 2006). Certifying a management system may introduce the external benefits of higher quality, greater market share, and/or more competitive edge, as well as the internal benefits of better employee engagement, improved communication, more cost savings, and/or higher process efficiency (Shih et al., 1996; Huarng et al., 1999). Nevertheless, whether the triple bottom line benefits are linked to the underlying organizational motives for certification is not evident (Gavronski et al., 2008). Controversial outcomes have been found in the literature regarding the relationship between certification and corporate performance. While some studies demonstrate a positive effect of certification on an organization's financial, social, and/or environmental promotion, others indicate negative or even no link among them.

2.1 The Impact of Certification on Organizations' Environmental Performance

Some studies have questioned the effectiveness of the standards and their impacts on environmental performance (Boiral & Sala, 1998; Andrews & Amaral, 2003; King et al., 2005; Barla, 2007; Gomez & Rodriguez, 2011). Whether the environmental performance improvement was derived from the ISO 14001 adoption or the greenness of the organizations themselves is not clear yet (Welch et al., 2002; 2003).

In contrast, others have shown positive relationship between management system certification and corporate environmental benefits: an early report conducted for the Environmental Protection Agency (EPA) (EPA, 1998) shows that several certified facilities experienced environmental improvements. However, the conclusion has been challenged for its small amount of sample and the validity of its methodology. By using structural equation modeling to analyze questionnaire data collected from ISO 14001 registrants, Rao and Hamner (1999) found significant reductions in a number of waste products and in resource usage occurred within the sampled firms. Montabon et al. (2000) manifest that moving farther through the ISO adoption process helps the improvement of environmental performance. Melnyk et al. (2002), and Potoski and Prakash (2004) also uncover the evidence that ISO 14001 is significantly associated with waste reduction and emissions mitigation. That is to say, proponents of certification engagement have identified certified MSs as an effective approach to facilitate an organization to be environmental friendly.

2.2 The Impact of Certification on Organizations' Financial Performance

Proponents of certification cite expectations of improved quality and efficiency that lead to financial advantages such as increased revenue, reduced costs, and higher profits through greater quality awareness, enhanced employee productivity, better quality control, improved internal auditing, and clear managerial responsibility (Winter, 1994; Garvin, 1995; Hammer & Champy, 1993; Nicolau &Sellers, 2002; McAdam & McKeown, 1999; Van der Wiele & Brown, 1997). Some empirical research on the performance implications from the

adoption practices supports such expectations (Hendricks & Singhal, 1997; Easton & Jarrell, 1998; Corbett et al., 2005; Ittner & Larcker, 1997).

However, despite the widespread assumption that organizations will benefit from registration activities, not all results show better business performance associated with certifications (Powell, 1995; Staw & Epstein, 2000; Terziovski et al., 1997; Samson & Terziovski, 1999) since it is still a risk-increasing activity as managers need to take into account all stakeholders' requirements, which may lead to low operational efficiency of firms (Ogden & Watson, 1999).

Some researchers find no financial performance benefits related to ISO certification (Morris, 2006; Heras et al., 2002; Lima et al., 2000; Surroca, Tribo, & Waddock, 2010); others indicate that although certain improvements in operational efficiency resulted from ISO 9000 adoption, these benefits do not translate into financial performance improvements (Naveh &Marcus, 2005). Further, the performance benefits of ISO adoption are moderated by firm-specific technological coherence in some cases (Benner & Veloso, 2008). Weber (2007) also noticed that some environmental management systems are implemented due to the firms' self-commitment and management reasons. Such firms are not interested in attracting investors who expect higher financial performance because of the implementation of an environmental management system.

Likewise, positive, negative, or even no linkage between certification and both environmental and financial performance of organizations have been found in the existing literature (Jiang & Bansal, 2003; King et al., 2005). In other words, whether the firms who

have certified management systems (MSs) are more sustainable than firms without one is still not clear.

2.3 The Impact of Certification on Organizations' Social Performance

Social performance promotes a vision of business accountability to a wide range of stakeholders, besides shareholders and investors, and is commonly used to demonstrate an organization's concern for the wellbeing of its employees, the community and civil society in general (Wood, 1991; Carroll, 1979; 1991).

Advocates of certification assert that both ISO 9001 and ISO 14001 have contributed to greater customer satisfaction by providing greener products and higher quality service (Poksinska et al., 2006; Petroni, 2001). Meanwhile, OHSAS 18001 helps firms to eliminate or minimize OH&S risks to employees and other interested parties, and thus is considered as targeting more on the social dimension of sustainability (Chen et al., 2009; Zwetsloot, 2003). Positive effects of OHSAS implementation on organizations' improvement including better safety climate, more organizational action taken on OH&S issues, decrease in injury rates, decrease in disability-related costs, and increase in work-place productivity, as indicated by Robson et al. (2007).

Nevertheless, compared to the economic and environmental pillars, fewer studies, especially empirical ones, have been conducted regarding the social performance in a narrow sense (i.e., social justice and equity) due to the lacking of consensus on relevant criteria (Geibler, 2006).

2.4 The Impact of Registration Experience on Organizations' Performance

Controversial conclusions are also found in the existing literature regarding this topic.

Some studies report a positive relation between registration duration and firms' environmental and/or quality performance (Russo, 2009). The study by Benner and Veloso (2008) also shows that early adopters obtain some benefits from ISO 9000, whereas later adopters only gain legitimacy.

An alternative point of view argues that massive implementation of the ISO standards has led to an inability to differentiate the companies that benefit from implementation (Karapetrovic, Casadesús, & Saizarbitoria, 2010; Kuo, Chang, Hung, & Lin, 2009), or that the benefits of ISO certification have faded over time (Wayhan et al., 2002; Casadesus & Karapetrovic, 2005).

2.5 Summary of the Chapter

Based on the integrative review of the multifaceted literature on single and integrated standards, the following section offers a comprehensive summary and identifies several research gaps in the literature.

First, despite plausible calls for ISO 9001, ISO 14001, and OHSAS 18001, the effects of registration practices on firms' performance have not reached consensus (Dick et al., 2008; Martínez-Costa et al., 2009; Prajogo, 2011). Although some studies have found advantages in certification fulfillment (Corbett et al., 2005; Easton & Jarrell, 1998); others indicate that the benefits do not necessarily translate into improvements in corporate environmental, social, or financial performance as such practice remains more superficial than effective (Figge et al.,

2002; Sterman, Repenning, & Kofman, 1997; Wruck & Jensen, 1994) or help firms in all contexts (Ittner & Larcker, 1997). Some findings further demonstrate that the benefits of process management practices dissipate in an industry as the majority of firms adopt similar techniques (Benner & Veloso, 2008). Moreover, seldom are effective appraisal tools available to provide sufficient information for decision makers regarding the efficiency of certification undertaking (Briassoulis, 2001). In other words, whether the benefits of certification outweigh the expenses of business operation and will further improve a firm's sustainable productivity is still ambiguous and needs to be explored in depth.

Second, previous research sheds considerable light on the link between certification and environmental and/or financial performance instead of focusing on the inter-relationship among the corporate sustainability performance measures (environmental, social, and market benefits) (Boiral, 2007; Prajogo, Tang, & Lai, 2012). More attention is given to either environmental benefits and/or market rewards of certified management system(s) instead of a sustainable performance rating. Quantitative and qualitative variables, such as reduced pollution, reduced energy use, material consumption, reduced risks of environmental hazards, improving relations with stakeholders, improving public image, customer satisfaction, market opportunities, sales (or revenue), net income (or profit), shareholders equity, capital expenditures, saved cost are indicators used to evaluate a firm's environmental, social, and financial performance (Benner & Veloso, 2008; Lee, 2005; Montabon et al., 2007; Zhu et al., 2007; Prajogo, Tang, & Lai, 2012). Nevertheless, the measurement index differs greatly when

it comes to various subjects, and thus have not formed any standard evaluating framework for measuring certification efficiency.

Further, there is not yet standard definition of "efficient" in the business management field (Vitaliano & Stella, 2006). Many studies use a multiple input-output analytical approach to measure the relative efficiency of certification (Analysis, 2003; Schoenherr & Talluri, 2013; Joo et al., 2010). The term "relative" implies those efficient subjects achieving maximum benefits with less effort than their peers or minimizing the inputs needed to achieve the given outputs (Chang & Lo, 2005). However, there is no uniform analytic framework, and the multiple input-output indicators change greatly with divergent views, while the findings do not support any consistent conclusions regarding adoption efficiency either.

Attaining sustainable development requires not only an examination of the impacts of certified environmental, quality, and/or social management systems on financial outcomes, but also requires a good understanding of the comprehensive impacts of managerial engagement. Therefore, there is an urgent need to develop a framework for multi-dimensional efficiency evaluation of certification to provide decision-makers with easily accessible and reliable references (Lee & Farzipoor, 2012).

Chapter 3 Conceptual Framework and Hypotheses

In line with the Triple Bottom Line (3BL) concept, a unified comprehensive framework is proposed from a systematic perspective to facilitate efficiency evaluation of management system certification. It sets out to develop a framework with clear principles, goals, and scopes in order to measure the sustainable efficiency of management system certification in a Chinese context. The correlated hypotheses are posited from the dynamic capability view.

3.1 Conceptual Framework

It is argued that corporate sustainable development is geared toward the triple bottom line, namely people, planet, and profit. In other words, a firm is supposed to harmonize and balance its social, environmental, and financial development simultaneously to become sustainable (Elkington, 1997). The 3BL thus sets out the goal as well as the way of thinking for firms to achieve sustainable development at the same time (Vanclay, 2004). It is further argued that an organization's responsibility management capacity, including its responsibility strategy, governance, integration, and communication, is the core of corporate sustainable development as well (CASS, 2009).

Different from relying on protecting and leveraging existing resources of the resource-based theory (Wernerfelt, 1984; Barney, 1991), the dynamic capability is identified as "the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments" from a change-orientated perspective (Teece et al., 1997). It

focuses on the alteration and integration of acquired resources to recreate and regenerate new value by keeping optimizing organizational and strategic routines (Eisenhardt & Martin, 2000).

Certain characteristics make MS certifications a prime example of the application and development of dynamic capabilities theory (Zhu, Cordeiro, & Sarkis, 2013): 1) the implementation and integration of MSs need to utilize, exploit, integrate, and adjust a great deal of organizational resources from different systems and departments; 2) as opposed to target-oriented systems, ISO 9001, ISO 14001, and OHSAS 18001 are featured and identified as a dynamic process-focused engagement by following the "Plan-Do-Check-Act (PDCA)" model (Lopez-Fernandez & Serrano-Bedia, 2007); 3) design of certifications is flexible and, therefore, can be changed quickly to adapt to various settings and subjects; 4)in order to secure continuous improvements of performance, to bring about competitive advantage as well as to move towards sustainable development, a certified management system has to be embedded throughout the organization and in all stakeholder relations.

Certification activities also demonstrate a firm's concerns about the sustainability of internal and external stakeholders' benefits. In particular, the motivation and effort of people in an organization are important factors in the successful implementation of a management system (MS) (Wilkinson & Dale, 2001; Asif et al., 2010). In this regard, firms that certify their management systems tend to be responsible in terms of employee training and treatment, quality, and/or environmental engagement.

Therefore, this study argues that effective quality, environmental, and safety management will improve a firm's dynamic capability through resources acquisition and

reconfiguration, and further enhance its competitive advantages through customers' loyalty, legislation risk mitigation, and stakeholder relation improvement. These potential benefits facilitate a firm gain high responsibility management capacity and its social, environmental, and market benefits to be sustainable.

An efficiency evaluation framework (Figure 3.1) has been constructed by referencing the structures from related studies as well as the idea of total-factor production. In it, labor, capital, and non-production cost are identified as a firm's operational inputs to generate the corresponding multi-level outputs, including a firm's responsibility management, social, environmental, and financial performance that are critical for sustainable development. Since the total costs of certification-related activities are hard to determine, a categorical variable is introduced to capture the feature of a firm's certification statuses.

Under this multi-dimensional analytical framework, homogeneous firms are considered as Decision-Making Units (DMUs). With the idea of Pareto optimality, the distance from the location of a firm's relative efficiency to the efficient frontier is identified before a comparative analysis is conducted, followed by benchmarking pinpointed from a relative, systematic, and dynamic perspective.

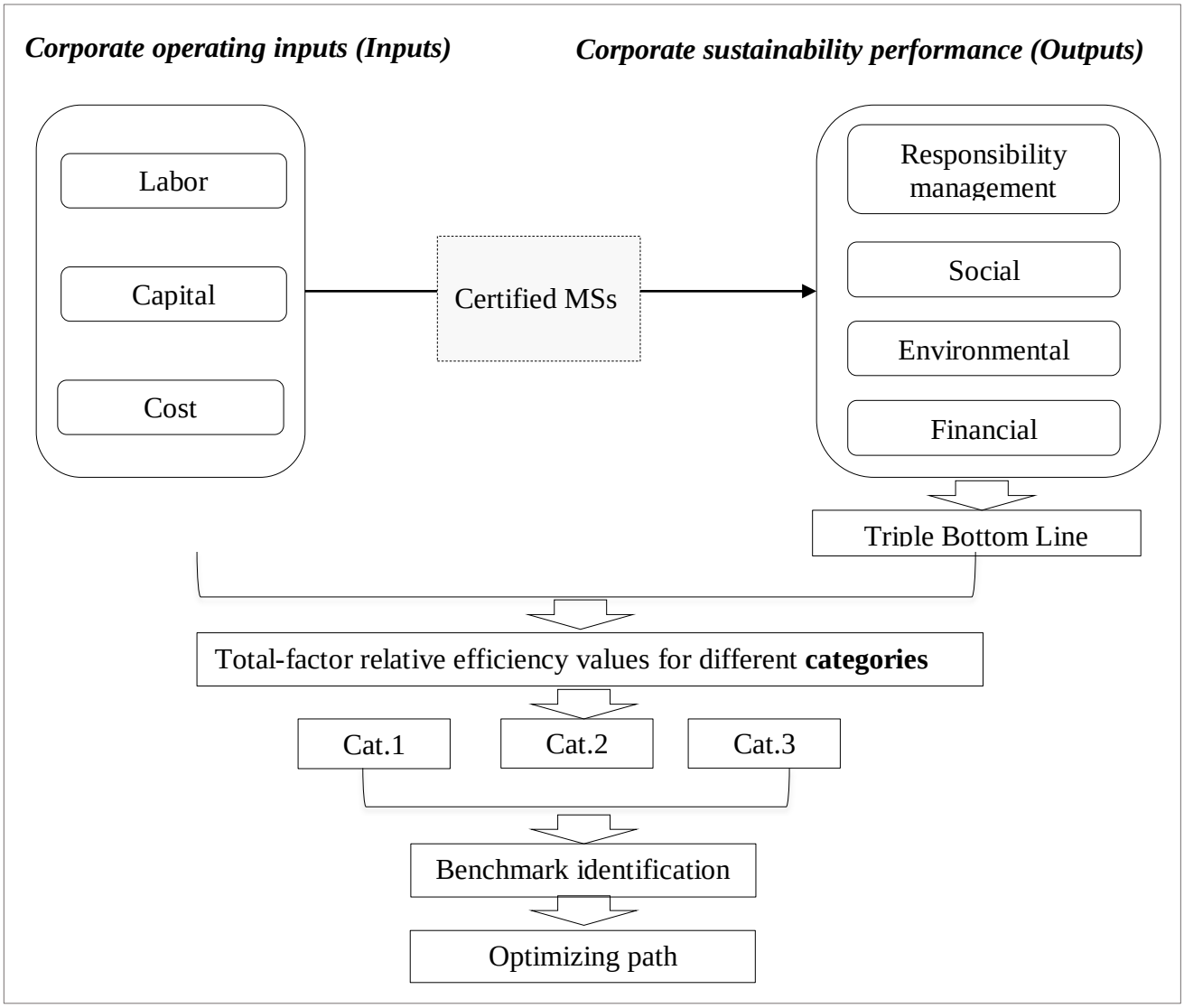

Figure 3.1 Conceptual Framework

In this study, the initial meanings of economic efficiency (Farrell, 1957) and sustainable efficiency[③] (Hoang & Rao, 2010) are combined and adjusted under a new term

[③] Sustainable efficiency was firstly used in the ecological study and was *defined as the ratio of feasible minimum total amount of cumulative exergy to the aggregate cumulative exergy in the observed input vector*.

called Corporate Sustainable Efficiency (CSE). CSE is coined in this study to demonstrate a firm's ability in achieving the given sustainability performance (i.e., responsibility management capacity and social, environmental, and market benefits) with less input composition (i.e., labor, capital, and operational expenses) than its peers in a more productive way. Therefore, CSE reflects a firm's ability to utilize its finite resources through internal management to be sustainable.

3.2 Hypotheses

First, the procedure of certification helps a firm, especially its managers and executives, to be fully aware of its environmental and social impacts derived from its activities, and its subsequent responsibilities for divergent stakeholders instead of limited shareholders. This effect contains special meanings for Chinese companies that are relatively new to the concept and practice of CSR and CSD. A certified organization therefore will update and innovate its business pattern and strategy to comply with all kinds of requirements and expectations from both internal and external stakeholders. Its sustainable organizational advantages can be built with tacit assets that derive from developing relationships with key primary and public stakeholders: customers, employees, suppliers, governments, and communities where businesses operate.

Second, a successfully implemented MS or IMS requires high employee engagement, which in turn, urges a firm to pay close attention to its employee training and human resources governance. This process contributes to a firm's continuing competitiveness via improving its resources configuration, organizational learning, and managerial decision-making.

Thirdly, a certified MS is not just a strategic and inherent management approach, but also a dynamic and lasting mechanism that adapts to, becomes embedded in, or even changes an organization's culture gradually and innovatively. A certified organization's culture has to be coordinated and harmonized with its certifications to make the whole process smooth and effective.

Last but not least, management system certification is featured as process-focused practices that give rise to improved corporate dynamic capability to perform well in a changing environment. Arguably, organizations would like to improve their dynamic capabilities in terms of managerial quality, stakeholder relationships, and employee engagement through the implementation and auditing of their management systems.

Nonetheless, all the aforementioned benefits can only be obtained when a certified MS is properly and successfully assimilated by an organisation. The formulation and consolidation of the assimilation effects will make certification an important basis and approach to help a firm to be sustainable efficient.

Therefore:

H1. Firms with certificate(s) tend to be more efficient than firms without certificate(s).

If an organization implements and registers to multiple (two or more) management system standards (MSSs), such as ISO 9001 and ISO 14001, ISO 9001 and OHSAS 18001, ISO 14001 and OHSAS 18001, or all of the three (Figure 3.2), the activity can help the organization to capture various aspects of corporate sustainable development (i.e.,

environmental, social, and market) at one time. More importantly, when these standards are integrated smoothly and fully, more benefits that are related to integrated standardized MSs may come into play to address organizations' objectives jointly, such as reduced paperwork and training, decreased management cost, lowered complexity of internal management, simplified certification process, avoided duplication of effort, improved learning processes, and facilitated continuous improvement (Salomone et al., 2008; Zeng et al., 2011).

Evidence also shows enhanced corporate image and improved organisational performance (financial and operational) after integrating (Gagnier et al., 2005). Products and services can be delivered best when all of an organization's systems are integrated and focus on the same target (Alice & James, 1997; Karapetrovic et al., 2006). Moreover, an integrated management system, also seen as a type of organizational innovation itself, will help a firm to improve customer satisfaction through increased product innovation, which in turn leads to maximized sales (Simon & Yaya, 2012).

Therefore:

H2. Firms with integrated certifications (i.e., multiple MSSs) tend to have higher efficiency than firms without integrated certification.

The importance of synergies among multiple MSs has been stressed by related studies (Zwetsloot, 1995; Pun & Hui, 2002; Karapetrovic et al., 2006; Bernardo et al., 2010). Synergies occur among different MSSs on multiple levels of a certified organization, running from the top-management level (i.e., strategic synergetic) to second (i.e., resources, structural, and cultural synergetic) and third (i.e., documentation synergetic) levels. Advantages that are

generated from the synergetic effects among certifications should translate into high corporate sustainability performance, and lead to a decrease in operational costs associated with certification (Benner & Tushman, 2003). By referencing the literature as well as the initial meaning of the synergetic effects, this study expands the content of the synergetic effects and further posits that the synergetic effects should be happening among all MSs that are certified to all facilities or sites of a firm.

What is more, it is usually easier for organizations with certifications to adopt and assimilate another new practice as costs are lower for organizations that have developed ingrained routines for integrating and combining resources (Russo, 2009). It is further proposed that firms with more certifications are likely to become efficient and gain high sustainable performance due to the synergetic effects among certifications.

Therefore:

H3. Firms with more active certificates tend to have higher efficiency.

Dynamic mechanisms such as "learning by doing", "learn by using", and "learn by searching" tend to be strengthened, and subsequently introduce incremental benefits for organizations during repetition of standard routines. It is then argued that organizations with a longer registration experience would gain superior multiple benefits to that of late adopters as speedy initial movement can easily translate the associated opportunities or benefits into a firm's reconfigured resources (Eisenhardt & Martin, 2000). Benefits would be higher for early adopters because integration is likely to be more complete and efficiencies maximized. This assumption has been tested by several studies showing that early adoption of ISO fosters

salutary outcomes as the organizations change their routines over time to gain more dynamic capability (Christmann, 2000).

Additionally, MSs are identified as having long-term benefits. Once standard management systems are set up, the initial expense of system operation (marginal cost) is expected to decrease over time, and the effectiveness of these management systems is likely to improve through continual improvement as well. It is also been noticed that a successfully implemented MS has to adapt to and fit into an organization's culture. Conversely, a firm's original environment is likely to be changed and developed during the course of certification (Jørgensen, 2008).

This study then proposed that enterprises earlier engaged in certification will gain more cumulative capabilities and are likely to be characterized by a greater level of efficiency.

Therefore:

H4. Firms with longer certification history tend to have higher efficiency than those with shorter certification history.

Figure 3.2 Schematic Representation of an Integrated Management System (Source: Santos, Mendes, & Barbosa, 2011)

3.3 Summary of the Chapter

This study argues that implementation of and registration for MSs plays a key role in cogenerating maximum environmental, social, and market benefits with minimum cost for a firm through dynamic capability building, which in turn, will facilitate a firm in achieving sustainable development.

Motived by internal incentives (e.g., gaining business opportunities) and external pressures from powerful shareholders (e.g., government regulations and supply chain requirements), firms tend to register to various MSSs. In addition to the function of demonstrating the legitimacy of a firm's activities and the degree of a firm's CSR engagement

and commitment, which can be seen as the external effects of labelling, MSs also serve as critical strategic management approaches to help firms become sustainable.

The implementation and maintenance of MSs is a multi-level, multi-dimensional, and multi-sectorial dynamic process that must be assimilated into the administrative, entrepreneurial, and engineering dimensions of a firm (Aragon-Correa & Sharma, 2003). When two or more MSs with different functions are undertaken by an organization, they are suggested and supposed to be fully and smoothly integrated with each other to address objects jointly. Meanwhile, an organization can benefit from certification activities if the synergetic effects occur among its various MSSs. Additionally, the temporal cumulative effects are also expected to arise from certification activities over time. All the preceding effects are positively related to a firm's continuing improvement and organizational learning through acquisition, reconfiguration, and integration of organizational human, information, knowledge, technological, and managerial resources.

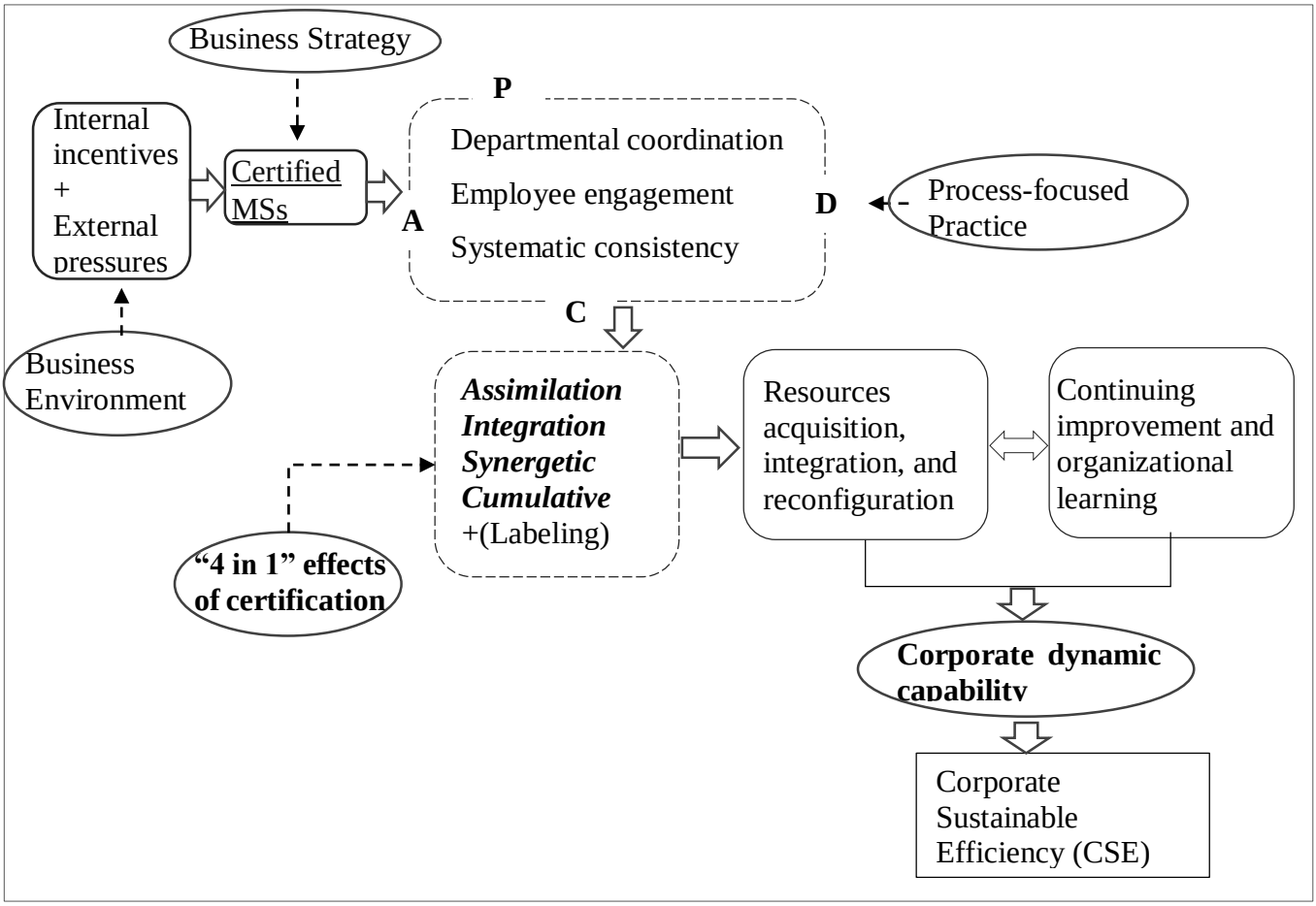

Figure 3.3 Flow chart of the "4 in 1" effects model of certifications

Chapter 4 Method and Database

In line with the research purpose, this chapter identifies the main methodologies, specific approaches, and related tests, and explains the rationales from both theoretical and practical perspectives. The appropriate variables and indicators are selected by taking account of the research purpose as well as data availability, and referencing the related literature. Further, the representative sample and the authoritative data sources are designated to improve the reliability and validity of the analyses.

4.1 Methods

The Data Envelopment Analysis (DEA) approach and panel Tobit regression technique are selected as the main tools according to their applicability in testing the hypotheses in the study. Additionally, some related tests including the Pearson correlation matrix, Wilcoxon rank-sum test, Kruskal-Wallis equality-of-populations rank test, Harris-Tzavalis and Hadri Lagrange multiplier (LM) technique, and Hausman test are used to improve the accuracy of the findings.

4.1.1 Data Envelopment Analysis

Grounded in total factor productivity conception and optimizing theory, the Data Envelopment Analysis (DEA) approach, a non-parametric linear programming method is employed to finish the efficiency evaluation due to the particular features: it is an effective as well as flexible tool for evaluating the relative efficiency of homogeneous subjects with multiple heterogeneous performance measures; it avoids the shortcoming of subjective

estimates when a priori weighting and aggregating for inputs or outputs are eliminated; and it has a number of specified models that can be used and modified for various purposes (Lee & Farzipoor, 2012).

The DEA approach was firstly introduced by Charnes et al. in 1978, and is based on the concept of Pareto optimum under the assumption of constant return to scale with the help of linear programming techniques. Based on the simultaneous consideration of total factor productivity function, the relative efficiencies of Decision-Making Units (DMUs, the term is loosely used for organizations, plants, or firms, etc.) are evaluated based on the ratio of weighted outputs to weighted inputs. A nonparametric frontier set, also identified as the envelope frontier, is then formed to indicate the efficiency level of each DMU. Here, DMUs on the set are considered efficient, whereas others located under the frontier are inefficient (Charnes, Cooper, & Rhodes, 1978) (Figure 4.1).

More techniques within the scope of DEA have been developed and applied to a great extent due to the development of algorithm and/or analytic lenses, such as the various return to scale model (also identified as the BCC model that is named after Banker et al. in 1984), recently developed non-decreasing return to scale (NDRS, also called increasing return to scale model, IRS), non-increasing return to scale (NIRS, also called decreasing return to scale model, DRS), and generalized return to scale model (GRS). These hypotheses are based on the economic concept of Returns to Scale (RTS) in the context of a firm's production function. Increasing RTS happens if a proportional increase in all the inputs results in a more than proportional increase in the single output (Banker et al., 2004).

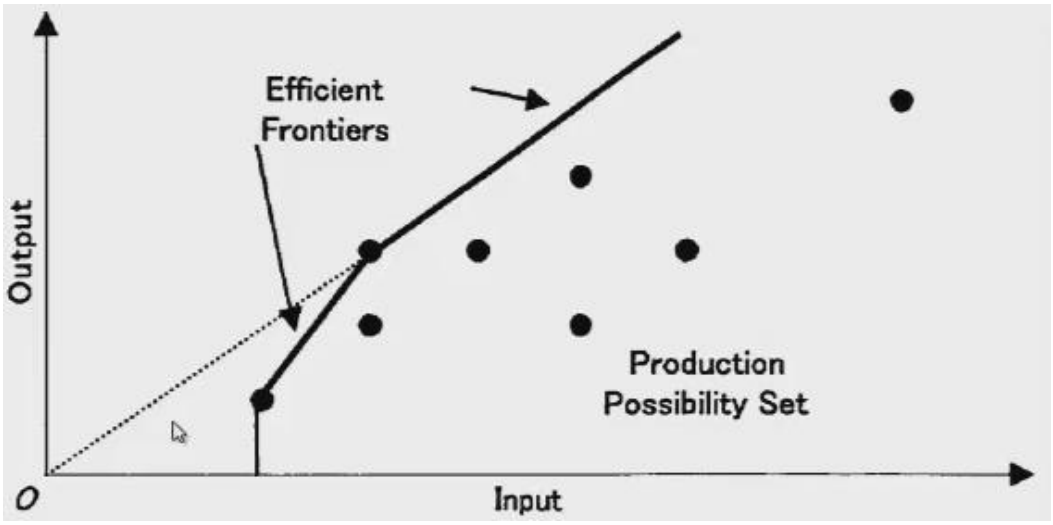

Figure 4.1 Graphical Explanation of the NDRS-DEA

(Source: Cooper, Seiford, &Tone, 2007)

Since its development, DEA has become one of the most popular and powerful methods to estimate relative efficiency among various observations on various levels from various perspectives in various disciplines (Emrouznejad et al., 2008; Lee & Farzipoor, 2012). It has also fostered numerous applications in the environmental and quality management fields. The following sections provide some examples:

Chang and Lo's (2005) employed a CCR model to estimate the relative efficiency of ISO 9001 adoption, as the participants were asked to rate the degree of continuous efforts (as the inputs), and the external and internal organizational benefits (as the outputs) after certification. The encouraging and positive results were found in the sample; Schoenherr and Talluri (2013) conducted a comparative analysis of the power plant efficiencies of

Environmental Sustainability Initiatives (ESI) engagement in Europe and the U.S with the help of the BCC model. They noticed that not all ESI would lead to efficiency gains in all cases; after classifying outputs into a desirable output (the amount of electricity) and three undesirable outputs (the amount of CO_2, NOx and SO2), Sueyoshi et al. (2010) investigate the operational, environmental, and both-unified performance measures of coal-fired power plants in the United States using a new DEA approach called Range-Adjusted Measure (RAM). A positive link was found between the strong environmental policy and the plants' environmental performance that subsequently improved the firms' unified (operational and environmental) efficiency.

One important assumption in the traditional DEA models is that all subjects have a consistent operating environment, which is difficult to achieve in the real world where decision-makers are facing various controllable choices and non-controllable situations. To tackle this challenge, categorical variables were promoted to alleviate both internal and external environmental differences among DMUs by grouping them logically so that their efficiencies can be evaluated more fairly. Furthermore, the categorical approach can be incorporated into any basic DEA model, and adapted to specific research purpose and design (Cooper, Seiford, & Tone, 2007).

In our case, firms with certification intend to and are expected to provide "good" service and/or products as opposed to "average" or "poor" ones, and subsequently become benchmarks and references for other firms especially within the same or relevant industries. Moreover, although management systems are voluntarily certified, registration engagement

will certainly cause considerable and unexpected burden for organizations in terms of human, physical, and financial costs, and will set out much more strict requirements for firms with certification(s) compared with those without. It leads to different levels of operational costs and benefits among firms within the same industry. This reality challenges the traditional methods of applying DEA theory to real-world cases.

In order to make a fair comparison, a categorical variable is introduced to a traditional DEA model as all qualified observations with integrated certificates, single certificate, and no certificate are classified into category 1, 2, and 3. The efficiency of firms in category 1 are estimated within the group; the efficiency of firms in category 2 are estimated by referencing firms in categories 1 and 2; and the efficiency of firms in category 3 are estimated by referencing the firms in all categories (Figure 4.2). In so doing, fairness is considered as different operational environments are taken into account when estimating the relative efficiency of groups with various features.

Suppose we have n independent homogeneous decision making units (DMUs), where DMUj (j=1, 2, …, n) has m inputs ($x_{ij} = x_{1j,} \dots, x_{mj}$), s outputs ($y_{rj} = y_{1j}, \dots, y_{sj}$) , and are grouped into g (g $= 1, 2, \dots$ k) categories. Then we get n_1 , n_2 , …. n_g DMUs for category 1, 2, …, and k, respectively.

The relative efficiency of a specific DMU_o in category g (g $= 1, 2, \dots,$ k) can be evaluated using an output-oriented NDRS model as follows:

$\max \theta_0$

Subject to:

$$\sum_{j=1}^{n} x_{ij}\,\lambda_j \le x_{i0} \quad i = 1,2,\dots,m$$

$$\sum_{j=1}^{n} y_{rj}\lambda_j \ge \theta y_{ro} \quad r = 1,2,\dots,s$$

$$\lambda_i \ge 0,$$

$$\sum_{j=1}^{n} \lambda_j \ge 1,$$

$$n1 + n2 + \cdots + ng = n \text{ g} = 1,2,\dots,\text{k}$$

$$i = 1,2,\dots,\sum_{g=1}^{k} n_g \qquad (4.1)$$

where, $1/\theta_0$ is the efficiency score of DMU_o and λ_j are the weight coefficients (linear combination of coefficients). Correspondingly y_{rj} and $x_{ij}$are s- and m-dimensional vectors representing the levels of each output and input produced by DMUj, respectively. A DMU is considered as efficient when its efficiency score reaches 1, and is inefficient if its score falls between (0, 1). The lower the score is, the more inefficient a DMU is.

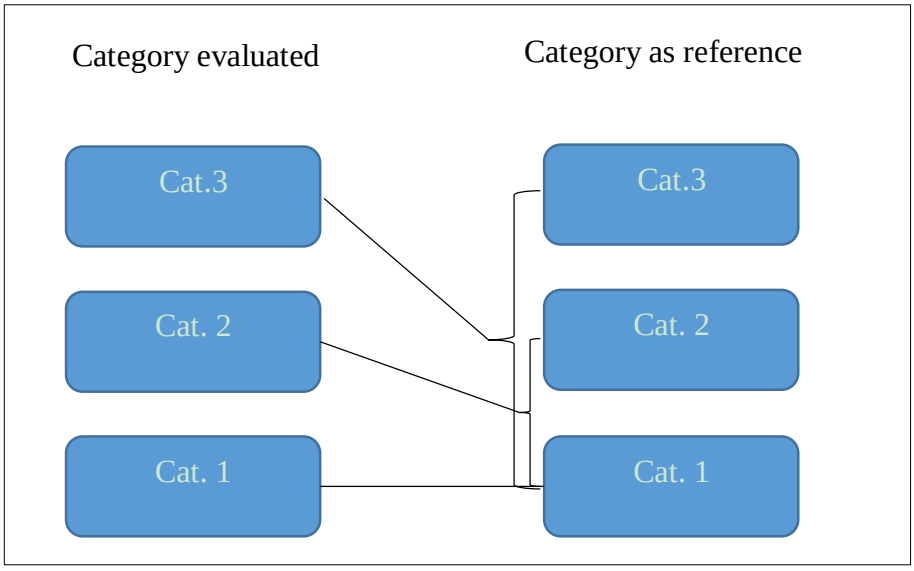

Figure 4.2 DEA Evaluation Process with Categorical Variables

With the help of the categorical DEA evaluation technique, distance from the location of a firm's relative efficiency to the efficient frontier is identified and forecasted before a verdict is drawn from a comprehensive, systematic and dynamic efficiency perspective.

4.1.2 Panel Tobit Regression

Regression approaches are used to test hypotheses 3 and 4 by explaining the observed relationships among corporate efficiency score, certification level, and certification history during the sample period.

Since the dependent variable (i.e., the efficiency scores derived from model 4.1) in this case is bounded between zero and one, the Tobit regression method promoted by Tobin (1958) is therefore identified as the most appropriate method of analysis with its theoretical infrastructure that can deal with dependent variables with limited values (i.e., censored or truncated data).

The standard censored regression model for a panel dataset[④] is listed below by introducing a latent variable y_{it}^* (Heckman & Ma Curdy, 1980):

$$y_{it}^* = x_{it}\beta + u_i + \varepsilon_{it} \quad u_i, \varepsilon_{it} \sim (0, \sigma^2) \tag{4.2}$$

$$y_{it} = \max\{y_{it}^*, c\}$$

where, $u_{i,}\ \varepsilon_{it} \sim (0, \sigma^2)$, and y_{it}^* is a latent variable that is observed for values greater than c and censored otherwise.

[④] Panel data, also called longitudinal data or cross-sectional time series data, are data where multiple cases (people, firms, countries etc.) were observed at two or more time periods. (Available at http://dss.princeton.edu/online_help/stats_packages/stata/panel.htm)

4.1.3 Related Statistical Tests

Due to the characteristics of the sample, certain statistical tests are conducted to improve the validity and reliability of the models as well as the results:

(1) The Pearson correlation approach is employed to test the isotonicity premise of a DEA model, where all inputs should be positively correlated with the outputs;

(2) The non-parametric Mann-Whitney U test (also called the Mann–Whitney–Wilcoxon (MWW) test), and Kruskal-Wallis equality-of-populations rank test that are applicable for limited samples where population data may not follow normal distribution patterns are performed to observe the differences between two and three groups, respectively (Sheskin, 2003);

(3) The Harris-Tzavalis and Hadri Lagrange multiplier (LM) tests that are suitable for a small sample size are utilized to evaluate the existence of unit roots for a panel dataset;

(4) The Hausman test is conducted to observe the random or fixed effects of the panel data set.

4.2 Variables and Indicators

Fixed or total assets, labour capital, and costs of goods sold, sales, general, and administrative expenses (SG&A) are typical input indicators (Vitaliano & Stella, 2006; Joo et al., 2010; Joo, Min, Kwon, & Kwon, 2010; Schoenherr & Talluri, 2013), while sales (or revenue), net income (or profit), pollution and emission mitigation, environmental protection measures, and CSR index are typical outcomes used in the related studies for corporate efficiency evaluation (Tsai, Chen, & Tzeng, 2006; Sueyoshi et al., 2010; Belu & Manescu,

2013). Nevertheless, indicators vary greatly with different subjects and analytical lenses. In addition, most scholars employ qualitative approaches as opposed to quantitative methods when evaluating the "before-and-after" effect of management system implementation, certification, or other CSR-related engagement (Chang & Lo, 2005; Analysis, 2003; Lu, Wang, & Lee, 2013).

Consistent with the prior research and certain requirements of DEA, this study carefully identifies, measures, and calculates the input and output variables to capture the underlying principles, multiple dimensions, and critical factors of certification.

By taking into account the logicality, conciseness, representativeness, reliability, and availability of indicators and raw data, this study uses employee number, fixed assets, and selling, general and administrative expenses (SG&A) to measure the inputs of each firm, and identifies responsibility management index (RMI), total sales, environmental performance index (EPI), social performance index (SPI) as corresponding outputs to measure corporate managerial capacity and its market, environmental, and social performance (Table 4.1).

Table 4.1 List of Variables

#	Variable types	Indicator
1	Input variable	Employee number
		Fixed assets
		Selling, General and Administrative expenses (SG&A)
2	Output variable	Responsibility Management Index (RMI)
		Environmental Performance Index (EPI)
		Social Performance Index (SPI)
		Total sales
3	Categorical variable	Cat. 1,2, and 3
4	Dependent variable	Corporate Sustainable Efficiency (y)
5	Independent variable	# of active certification (x1)
		# of accumulate certified years (x2)

The responsibility management index (RMI), also identified as the core as well as the baseline of a firm's CSR performance, is directly derived from the Research Report on Corporate Social Responsibility of China (2010-2013), in which, a specific firm's ability and commitment to be "responsible" is evaluated by a hierarchical analytical framework (Table 4.2) based on the information collected from the its annual reports, CSR reports, and websites during 2009-2012 (CASS, 2013).

Total sales (revenue) is an important metric for business owners/managers and investors alike as it provides a reasonably accurate projection of the near-term performance of the business. Sales is also a major indicator that reflects a firm's ability to affect a market especially for the market of similar products.

Table 4.2 Responsibility Management Index Framework

First class indicator	Second class indicators	Third class indicators
Responsibility management index	1.1 Responsibility strategy	(1)CSR concept (2) Key topics regarding CSR (3) CSR planning
	1.2 Responsibility governance	(1)Governing bodies (2)Organizational systems (3)Regulatory regime
	1.3 Responsibility integration	(1)Proceed with the subordinates (2) Advance CSR fulfillment in supply chain
	1.4 Responsibility performance	(1) Set up CSR indicator systems(2) Set up CSR evaluation systems (3) Internal selection for "doing-good"
	1.5 Responsibility communication	(1) Corporate responses to stakeholders' expectations (2) CSR activities that senior leaders attend (3) Whether a firm has CSR column on its website (4) Whether a firm has a CSR report or not
	1.6 Capacity of duties	(1) Trainings for CSR (2) Level of CSR-related research (3) Level of CSR research cooperation

(Source: CASS, 2013)

The environmental and social performance indexes are constructed under the Global Reporting Initiative (GRI) analytical framework using a hierarchical system, and are calculated with the following procedure:

(1) For the environmental performance measurement, a firm's material, energy, and water used, biodiversity, emissions, effluents and waste, and environmental issues of products and services are taken into account (Table 4.3). For the social performance measurement, this study focuses on stakeholders and social issues management dimension to demonstrate a firm's determination and capacity to be responsible for various stakeholders beyond its shareholders including the community, government, suppliers, customers, and employees (Table 4.4).

(2) The third class indicators encompass “whether the indicator is reported or not”, “whether the economic importance is reported or not”, “whether the quantitative indicator is available or not”, “whether a trend analysis is conducted or not”, “whether a positive trend exists or not”, and “whether a benchmarking is compared for the indicator or not”. Each third class indicator is denoted by a dichotomous variable (0 or 1), where 1 means yes and 0 means no;

(3) The second class indicator’s score is calculated by each third class indicator’s score;

(4) The final environmental/ social index is added by all the second class indicators’ scores;

(5) Finally, the environmental index and social index for each firm in a certain year is between 0 and 36, and 0 and 96, respectively, where the latter of each represents the possible highest corporate environmental and social performance.

Additionally, current active certification number and certification history from 2009 to 2012 are identified as independent variables to capture an organization’s certification status comprehensively.

Table 4.3 Environmental Performance Index Framework

First class indicator	Second class indicators	Third class indicators
Environmental performance index	1. Material (Materials used by weight or volume. Percentage of materials used that are recycled input materials.)	Reported (YES=1; NO=0); Economic importance reported (YES=1; NO=0); Quantitative Indicator (YES=1; NO=0); Trend analysis (YES=1; NO=0); Trend (positive=1, negative=0); Benchmarking (YES=1; NO=0)
	2. Energy (Direct energy consumption by primary energy)	Reported (YES=1; NO=0); Economic importance reported (YES=1; NO=0); Quantitative Indicator (YES=1; NO=0); Trend analysis (YES=1; NO=0); Trend (positive=1, negative=0); Benchmarking (YES=1; NO=0)
	3.Water (Total water withdrawal by source)	Reported (YES=1; NO=0); Economic importance reported (YES=1; NO=0); Quantitative Indicator (YES=1; NO=0); Trend analysis (YES=1; NO=0); Trend (positive=1, negative=0); Benchmarking (YES=1; NO=0)
	4. Biodiversity (Location and size of land owned, leased, managed in, or adjacent to, protected areas and areas of high biodiversity value outside protected areas. Description of significant impacts of activities, products, and services on biodiversity in protected areas and areas of high biodiversity value outside protected areas)	Reported (YES=1; NO=0); Economic importance reported (YES=1; NO=0); Quantitative Indicator (YES=1; NO=0); Trend analysis (YES=1; NO=0); Trend (positive=1, negative=0); Benchmarking (YES=1; NO=0)

	5. Emissions, Effluents and Waste (Total direct and indirect greenhouse gas emissions by weight. Other relevant indirect greenhouse gas emissions by weight. Emissions of ozone depleting substances by weight.NO, SO, and other significant air emissions by type and weight. Total water discharge by quality and destination. Total weight of waste by type and disposal method. Total number and volume of significant spills.)	Reported (YES=1; NO=0); Economic importance reported (YES=1; NO=0); Quantitative Indicator (YES=1; NO=0); Trend analysis (YES=1; NO=0); Trend (positive=1, negative=0); Benchmarking (YES=1; NO=0)
	6. Environmental Issues of Products and Services (Initiatives to mitigate environmental impacts of products and services, and extent of impact mitigation. Percentage of products sold and their packaging materials that are reclaimed by category.)	Reported (YES=1; NO=0); Economic importance reported (YES=1; NO=0); Quantitative Indicator (YES=1; NO=0); Trend analysis (YES=1; NO=0); Trend (positive=1, negative=0); Benchmarking (YES=1; NO=0)

Table 4.4 Social Performance Index Framework

First class indicator	Second class indicators	Third class indicators
Social performance indicator	1. Community (Percentage of operations with implemented local community engagement, impact assessments, and development programs. Operations with significant potential or actual negative impacts on local communities. Prevention and mitigation measures implemented in operations with significant potential or actual negative impacts on local communities.)	Reported (YES=1; NO=0); Economic importance reported (YES=1; NO=0); Quantitative Indicator (YES=1; NO=0); Trend analysis (YES=1; NO=0); Trend (positive=1, negative=0); Benchmarking (YES=1; NO=0)
	2. Corruption (Percentage and total number of business units analyzed for risks related to corruption. Percentage of employees trained in organization's anti-corruption policies and procedures. Actions taken in response to incidents of corruption.)	Reported (YES=1; NO=0); Economic importance reported (YES=1; NO=0); Quantitative Indicator (YES=1; NO=0); Trend analysis (YES=1; NO=0); Trend (positive=1, negative=0); Benchmarking (YES=1; NO=0)
	3. Public Policy (Public policy positions and participation in public policy development and lobbying.)	Reported (YES=1; NO=0); Economic importance reported (YES=1; NO=0); Quantitative Indicator (YES=1; NO=0); Trend analysis (YES=1; NO=0); Trend (positive=1, negative=0); Benchmarking (YES=1; NO=0)
	4. Compliance (Monetary value of significant fines and total number of non-monetary sanctions for noncompliance with laws and regulations.)	Reported (YES=1; NO=0); Economic importance reported (YES=1; NO=0); Quantitative Indicator (YES=1; NO=0); Trend analysis (YES=1; NO=0); Trend (positive=1, negative=0); Benchmarking (YES=1; NO=0)

	5. Human Rights in the Supply Chain (Percentage and total number of significant investment agreements and contracts that include clauses incorporating human rights concerns, or that have undergone human rights screening. Percentage of significant suppliers, contractors, and other business partners that have undergone human rights screening, and actions taken. Total hours of employee training on policies and procedures concerning aspects of human rights that are relevant to operations, including the percentage of employees trained.	Reported (YES=1; NO=0); Economic importance reported (YES=1; NO=0); Quantitative Indicator (YES=1; NO=0); Trend analysis (YES=1; NO=0); Trend (positive=1, negative=0); Benchmarking (YES=1; NO=0)
	6. Non-discrimination (Total number of incidents of discrimination and corrective actions taken.)	Reported (YES=1; NO=0); Economic importance reported (YES=1; NO=0); Quantitative Indicator (YES=1; NO=0); Trend analysis (YES=1; NO=0); Trend (positive=1, negative=0); Benchmarking (YES=1; NO=0)
	7. Human Rights - Freedom of Association and Collective Bargaining (Operations and significant suppliers identified in which the right to exercise freedom of association and collective bargaining may be violated or at significant risk, and actions taken to support these rights.)	Reported (YES=1; NO=0); Economic importance reported (YES=1; NO=0); Quantitative Indicator (YES=1; NO=0); Trend analysis (YES=1; NO=0); Trend (positive=1, negative=0); Benchmarking (YES=1; NO=0)
	8. Human Rights - Child Labour (Operations and significant suppliers identified as having significant risk for incidents of child labor, and measures taken to contribute to the effective abolition of child labor.)	Reported (YES=1; NO=0); Economic importance reported (YES=1; NO=0); Quantitative Indicator (YES=1; NO=0); Trend analysis (YES=1; NO=0); Trend (positive=1, negative=0); Benchmarking (YES=1; NO=0)

	9. Human Rights - Forced or Compulsory Work (Operations and significant suppliers identified as having significant risk for incidents of forced or compulsory labor, and measures to contribute to the elimination of all forms of forced or compulsory labor.)	Reported (YES=1; NO=0); Economic importance reported (YES=1; NO=0); Quantitative Indicator (YES=1; NO=0); Trend analysis (YES=1; NO=0); Trend (positive=1, negative=0); Benchmarking (YES=1; NO=0)
	10. Labour Practices - Occupational Health and Safety Management (Rates of injury, occupational diseases, lost days, and absenteeism, and total number of work-related fatalities, by region and by gender. Education, training, counseling, prevention, and risk-control programs in place to assist workforce members, their families, or community members regarding serious diseases.)	Reported (YES=1; NO=0); Economic importance reported (YES=1; NO=0); Quantitative Indicator (YES=1; NO=0); Trend analysis (YES=1; NO=0); Trend (positive=1, negative=0); Benchmarking (YES=1; NO=0)
	11. Labour Practices - Training and Education (Average hours of training per year per employee by gender, and by employee category.)	Reported (YES=1; NO=0); Economic importance reported (YES=1; NO=0); Quantitative Indicator (YES=1; NO=0); Trend analysis (YES=1; NO=0); Trend (positive=1, negative=0); Benchmarking (YES=1; NO=0)
	12. Labour Practices - Diversity and Equal Opportunity (Composition of governance bodies and breakdown of employees per employee category according to gender, age group, minority group membership, and other indicators of diversity.)	Reported (YES=1; NO=0); Economic importance reported (YES=1; NO=0); Quantitative Indicator (YES=1; NO=0); Trend analysis (YES=1; NO=0); Trend (positive=1, negative=0); Benchmarking (YES=1; NO=0)
	13.Product Responsibility - Customer Health and Safety (Life cycle stages in which health and safety impacts of products and services are assessed for improvement, and percentage of significant products and services categories subject to such procedures.)	Reported (YES=1; NO=0); Economic importance reported (YES=1; NO=0); Quantitative Indicator (YES=1; NO=0); Trend analysis (YES=1; NO=0);

		Trend (positive=1, negative=0); Benchmarking (YES=1; NO=0)
	14. Product Responsibility - Product and Services Labeling (Type of product and service information required by procedures, and percentage of significant products and services subject to such information requirements.)	Reported (YES=1; NO=0); Economic importance reported (YES=1; NO=0); Quantitative Indicator (YES=1; NO=0); Trend analysis (YES=1; NO=0); Trend (positive=1, negative=0); Benchmarking (YES=1; NO=0)
	15. Product Responsibility - Marketing Communications (Programs for adherence to laws, standards, and voluntary codes related to marketing communications, including advertising, promotion, and sponsorship.)	Reported (YES=1; NO=0); Economic importance reported (YES=1; NO=0); Quantitative Indicator (YES=1; NO=0); Trend analysis (YES=1; NO=0); Trend (positive=1, negative=0); Benchmarking (YES=1; NO=0)
	16. Product Responsibility - Product Compliance (Monetary value of significant fines for noncompliance with laws and regulations concerning the provision and use of products and services.)	Reported (YES=1; NO=0); Economic importance reported (YES=1; NO=0); Quantitative Indicator (YES=1; NO=0); Trend analysis (YES=1; NO=0); Trend (positive=1, negative=0); Benchmarking (YES=1; NO=0)

4.3 Sample and Data Source

We test our hypotheses on a sample of Chinese-listed firms from the manufacturing industry with the Standard Industrial Classification (SIC) code between 20 and 39 during 2009-2012 (Appendix III). The sample is derived by combining the following databases: the Research Report on Corporate Social Responsibility of China (2012) with the sample of "Top

100 series" firms and the main stock exchange markets (i.e., Shenzhen, Shanghai, and Hongkong exchange markets) in China.

First, the Research Report on Corporate Social Responsibility of China (2009-2013) provides us with a unique dataset with detailed and comparable information on multi-dimensional characteristics for the top 100 state-owned, foreign-invested, and private enterprises from a broad range of industries and locations in China. Since 2009, this study has been conducted by the research center for corporate social responsibility of the Chinese Academy of Social Science (CASS), and has built up a comprehensive appraisal system to evaluate the situation of CSR management and the level of CSR information disclosure by analyzing the information from their CSR reports, annual reports, and official websites (CASS, 2013).

Second, almost all certification-related initiatives and engagements are costly and need a long time period to get the feedback, which hinders firms from adopting and keeping the standards. Consequently, larger firms are more likely to invest in better CSR performance than small and medium sized enterprises (SMEs) are, due to their higher capacity to afford the costs of initial certification by utilizing their slack resources (Nishitani, 2009). Moreover, compared with non-listed firms, the frequency and quality of information disclosure and reporting activities in listed companies are relatively available, reliable, and accessible due to certain policies and requirements from the public and stock markets (Li et al., 2013).

Third, as a late-comer and adopter in the field of management system certification and corporate social responsibility (CSR), China's adoption activity has gained momentum but still

in its premature stage as the sustainability reporting and the Chinese socially responsible investing (SRI) fund were not officially launched until 2005 and 2008, respectively (Wang, Qin, & Cui, 2010). More importantly, the very first comprehensive and authoritative CSR ranking and scoring for hundred companies in China conducted by the Chinese Academy of Social Sciences (CASS) was not released until 2009[5] (Zhang et al., 2013).

Fourth, using data from a single industry (i.e., the manufacturing industry in this study) also helps us better control for heterogeneity and avoid other complications inherent in inter-industry analysis (Montgomery & Wernerfelt, 1988). The DEA approach gains high reliability and accuracy when homogeneous decision-making units are used.

Finally, China has been one of the biggest manufacturing hubs in the world, as well as an export-oriented economy, since the implementation of the "reforming and opening-up policy". With its significant environmental and social impacts and deep integration with the international market, the manufacturing industry has been challenged by both overseas requirements and domestic criticism. Studies have proven that environmentally sensitive industries (ESIs) are more committed to environmental information disclosure (Cho & Patten, 2007; Kuo, Yeh, & Yu, 2012), and they also show a higher tendency to address the interests of stakeholders and environmental issues than non-environmentally sensitive industries (NESIs) (Liu & Anbumozhi, 2009; Aerts & Cormier, 2009).

[5] The blue books (2009-2013) take top 100 state-owned enterprises, top 100 private enterprises and top 100 foreign-invested enterprises for objects, present the situation of CSR management and the level of CSR information disclosure, analyze the latest features of CSR in China, evaluate the CSR development level of 14 industries, such as power sector, banking, communications, special equipment manufacturing industry, electronic industry, real estate, automobile, retail and daily-used chemical industry etc.

A series of sources are selected carefully to measure all indicators in the study. Specifically, the firms' relevant corporate financial data are collected from the Compustat database [6] and their annual reports; the certification information is collected from the Certification and Accreditation Administration of the People's Republic of China (CNCA); the responsibility management data are collected from the Research Report on Corporate Social Responsibility of China (2010-2013), in which, the selected firms' ability and commitment to be "responsible" is evaluated by a comprehensive analytical framework; and the environmental and social information is collected from the firms' CSR reports and their annual reports.

In summary, our data set encompasses 73 Chinese-listed firms within the manufacturing industry spanning 2009- 2012, and consequently has 292 observations in total. This number also meets the requirement of DEA models as the number of DMUs (73 in this study) should no less than three times the sum of input and output numbers (21 in this study) (Cooper, Seiford, & Tone, 2000).

[6] Compustat is a database of financial, statistical and market information on active and inactive global companies throughout the world with its service began in 1962.

Chapter 5 Empirical Tests

Following the methodologies and techniques specified in Chapter 4, the empirical tests are conducted with the help of the professional software such as Maxdea 6.3 and STATA 13. Detailed results and comparisons are provided, followed by the initial analyses focus on the hypotheses proposed in Chapter 3.

5.1 Data Description and Processing

In order to provide a clear understanding of the sample, several initial summaries and analyses are conducted.

Based on the certification information for the firms obtained from the CNCA (the Certification and Accreditation Administration of the People's Republic of China), it can be noticed that ISO 9001 (i.e. quality management system standards), ISO 14001 (i.e., environmental management system standards), and OHSAS 18001 (i.e., safety management system standards), also the three most popular as well as the most time honored standards registered in the world (Karapetrovic & Casadesús, 2009), were the only ones registered by the firms over the 2009-2012 period.

Additionally, OHSAS 18001 were relatively ignored compared to ISO 9001 and ISO 14001, yet increased faster than the other two (Table 5.1, Figure 5.1).

Table 5.1 Number of the Three Certificates during 2009-2012

Certificate	2009	2010	2011	2012
ISO 9001	30	32	35	38
ISO 14001	27	31	33	34
OHSAS 18001	13	18	21	27

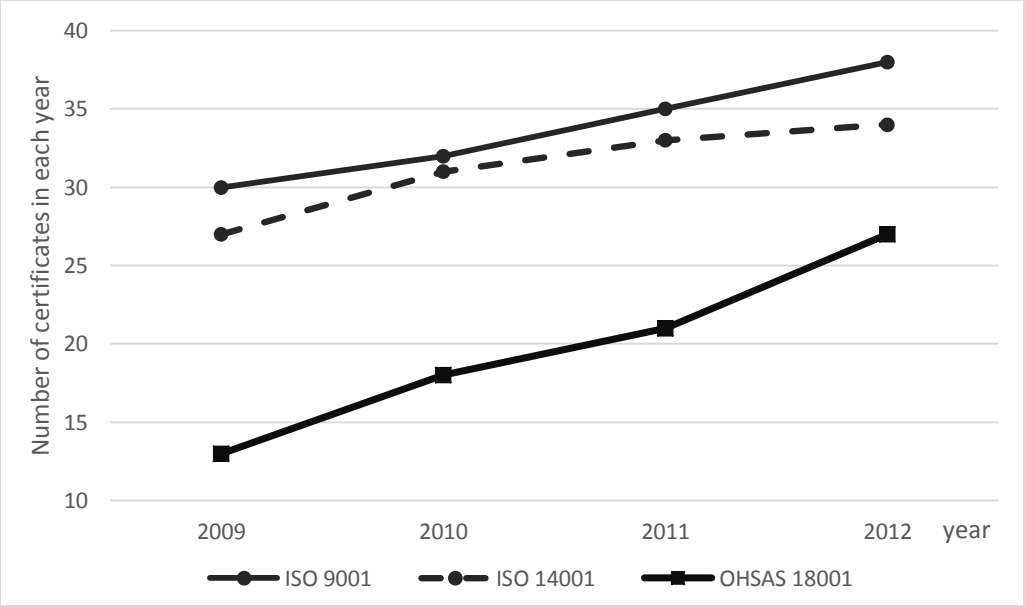

Figure 5.1 Number of the Three Certificates during 2009-2012

The firms, also seen as DMUs, are then categorized into three groups: the firms with integrated certifications (i.e., with dual- or multi-types of certification) are classified into category 1, firms with single certification (i.e., ISO 9001, ISO 14001, or OHSAS 18001) are

grouped into category 2, and firms with no certification are sorted as category 3 (Table 5.2-5.3).

Table 5.2 Categorical Information for Each Firm during 2009-2012

DMU	Category				DMU	Category			
	2009	2010	2011	2012		2009	2010	2011	2012
1	3	3	3	3	38	3	3	3	3
2	1	1	1	1	39	1	1	1	1
3	3	1	1	1	40	2	2	1	1
4	3	3	3	3	41	3	3	3	3
5	3	3	3	3	42	3	3	3	3
6	3	3	3	3	43	2	2	1	1
7	2	1	1	1	44	3	3	3	3
8	2	2	2	1	45	2	2	2	2
9	1	1	1	1	46	1	1	1	1
10	1	1	1	1	47	1	1	1	1
11	1	1	1	1	48	3	3	3	3
12	1	1	1	1	49	3	3	3	3
13	3	3	3	3	50	3	3	3	3
14	3	3	3	3	51	1	1	1	1
15	2	2	2	2	52	1	1	1	1
16	3	3	3	3	53	3	3	3	3
17	3	3	3	3	54	3	3	3	3
18	2	2	2	1	55	3	3	3	3
19	1	1	1	1	56	1	1	1	2
20	2	2	2	2	57	1	1	1	1
21	1	1	1	1	58	3	3	3	3
22	1	1	1	1	59	3	1	1	1
23	1	1	1	1	60	1	1	1	1
24	3	3	3	3	61	3	3	3	1
25	3	3	3	3	62	1	1	1	1
26	2	2	2	2	63	2	2	2	1
27	3	3	3	3	64	3	3	2	2

28	3	3	3	3	65	3	3	3	3
29	2	3	3	3	66	1	1	1	1
30	1	1	1	2	67	2	1	1	1
31	3	3	3	3	68	2	2	1	1
32	3	3	3	3	69	3	3	3	3
33	3	3	3	3	70	1	1	1	1
34	2	2	2	2	71	2	1	1	1
35	3	3	3	3	72	3	3	2	2
36	1	1	1	1	73	3	3	3	3
37	3	3	3	3					

Table 5.3 Number of the DMUs for Each Category during 2009-2012

Year	2009	2010	2011	2012
# of DMUs in cat. 1	22	27	30	32
# of DMUs in cat. 2	15	11	10	9
# of DMUs in cat. 3	36	35	33	32
Total	73	73	73	73

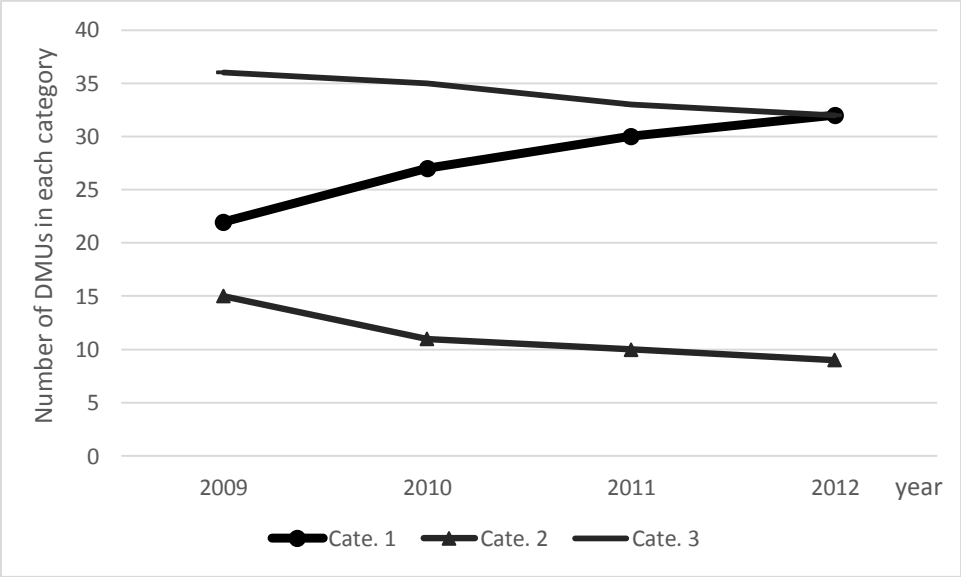

Figure 5.2 Number of the DMUs in Each Category during 2009-2012

The category columns provide the certification information for each firm during 2009-2012 (Table 5.2). As shown in Table 5.3 and Figure 5.2, a polarization trend appeared, as the industry saw a rapid growth in registering multi-certifications (i.e., two or more MSSs). At the same time, a sharp decline in registering single certification happened.

The result demonstrates that an increasing number of firms preferred to register and maintain ISO 9001, ISO 14001, and/or OHSAS 18001 throughout the years. This phenomenon also meets the theoretical expectation that organizations are likely to integrate their management systems based on the perceived synergetic benefits derived from multiple management systems standards (MSSs) (Zeng et al., 2007).

Table 5.4 Descriptive Statistics of the Outputs and Inputs

Variable	Obs	Mean	Std. Dev	Min	Max	Unit
Fixed	292	48136.5	192373.50	88.90	1754564.00	Million RMB
EMP	292	38412.75	80025.58	396.00	552810.00	People
SG&A	292	6025.95	21618.42	16.17	180881.00	Million RMB
Sales	292	84754.44	319728.50	121.34	2733618.00	Million RMB
EPI	292	4.32	5.52	0.00	23.00	-
SPI	292	5.26	5.94	0.00	22.00	-
RMI	292	23.01	23.89	0.00	93.50	-

Note: 27 missing data[⑦] have been imputed by the mean values (RMB stands for Renminbi)

[⑦] Missing data include 3 employee numbers and 24 responsibility management index.

In order to eliminate the imbalance in the data magnitudes, all the raw inputs and outputs data (Table 5.4) are mean normalized in line with the procedure proposed by Sarkis (2007) that has been widely applied in the similar situations (Talluri &Yoon, 2000; Tatari & Kucukvar, 2012; Egilmez, 2013). The process to mean normalize is taken in two steps: the mean of the data set for each input and output is calculated (Formula 5.1), and then each input or output is divided by the mean for that specific factor (Formula 5.2).

$$\bar{V}_i = \sum_{n=1}^{N} V_{ni} / N \quad (5.1)$$

where $\bar{V}_i$ is the mean value for column i (an input or output), N is the number of DMUs and V_{ni} is the value of DMU_n for a given input or output i.

$$Vnorm_{ni} = V_{ni} / V_i \quad (5.2)$$

where $Vnorm_{ni}$ is the normalized value for the value associated with DMU_n and input or output in column i.

Consequently, each input or output is divided by its respective mean based on its mean value calculation. The statistical descriptions for the normalized inputs and outputs are shown in Table 5.5.

Table 5.5 Descriptive Statistics of the Normalized Outputs and Inputs

Variable	Obs	Mean	Std. Dev	Min	Max
Fixed	292	1.000	3.996	0.002	36.450
EMP	292	1.000	2.083	0.010	14.391
SG&A	292	1.000	3.588	0.003	30.017
Sales	292	1.000	3.772	0.001	32.253
EPI	292	1.000	1.278	0.000	5.326
SPI	292	1.000	1.128	0.000	4.180
RMI	292	1.000	1.038	0.000	4.063

5.2 Corporate Sustainable Efficiency Evaluation

The efficiency evaluation for the firms is estimated based on the selected DEA approach, and related tests are conducted to support the significance of the outcomes.

5.2.1 The Isotonicity Test

The isotonicity premise of DEA requires that the increase of an input will not cause the decreased output of another item (Golany & Roll, 1989). Therefore, a Pearson correlation matrix is implemented to test the isotonicity of the model, where all inputs should have positive correlation coefficients with outputs of a DEA model.

As shown in the table 5.6, all the inputs have significant positive correlation coefficients with the outputs, implying that the indicators satisfies the isotonicity premise for the DEA model.

Table 5.6 Correlation Matrix between the Inputs and Outputs

	Fixed	EMP	SG&A	Sales	EPI	SPI	RMI
Fixed	1.000						
EMP	0.910***	1.000					
SG&A	0.979***	0.902***	1.000				
Sales	0.900***	0.843***	0.916***	1.000			
EPI	0.234***	0.219***	0.248***	0.217***	1.000		
SPI	0.244***	0.238***	0.274***	0.238***	0.851***	1.000	
RMI	0.305***	0.310**	0.286***	0.333***	0.282***	0.290***	1.000

*** $p \leq 0.01$; ** $p \leq 0.05$; * $p \leq 0.10$

5.2.2 Efficiency Evaluation

The Chinese manufacturing industry is generally characterized by non-decreasing returns to scale (NDRS) revealed by empirical studies (Liu, Gao, & Yang, 2011). The NDRS occurs when output increases by more than that the proportional change of inputs in the context of a firm's production function. Therefore, the output-oriented[⑧] non-decreasing returns-to-scale (NDRS) model (also identified as the Increasing Returns-to-Scale (IRS) model) is utilized to test our research hypotheses.

After running the model with the sample data (Table 4.1), this study draws all firms' sustainable efficiency scores during 2009-2012 (Table 5.7).

[⑧] Output-oriented aims at increasing the output amounts by as much as possible while keeping at least the present input levels.

Table 5.7 Efficiency Scores for Each Firm during 2009-2012

DMU	2009	2010	2011	2012	DMU	2009	2010	2011	2012
1	0.64418	0.74374	0.93225	1.00000	38	0.28081	0.32045	0.33845	0.33282
2	0.48266	0.47111	0.37303	0.44777	39	0.17599	0.19294	0.17289	0.17755
3	0.27828	0.43275	0.47216	0.53879	40	1.00000	1.00000	1.00000	1.00000
4	0.38182	0.46598	0.50695	0.55943	41	0.82569	0.91398	0.95817	0.77053
5	0.16893	0.21292	0.21734	0.17171	42	0.43306	0.53100	0.54708	0.54482
6	0.37919	0.34672	0.37997	0.31747	43	0.27390	0.39409	0.32596	0.39857
7	0.37347	0.51098	0.48302	0.59950	44	0.89790	1.00000	1.00000	1.00000
8	0.58056	0.65250	0.72157	0.82968	45	0.18801	0.19138	0.17587	0.18368
9	0.59192	0.60754	0.66871	0.73802	46	0.24927	0.32642	0.36167	0.29909
10	0.41513	0.59004	0.52922	0.53473	47	0.56401	0.65264	0.66709	0.75082
11	0.13589	0.16211	0.20018	0.23422	48	0.44901	0.54690	0.43175	0.24826
12	0.45742	0.52425	0.74876	0.68409	49	0.44287	0.44991	0.43144	0.46247
13	0.51658	0.57429	0.62902	0.71439	50	0.29384	0.26362	0.24901	0.22228
14	0.31391	0.34554	0.46563	0.52960	51	0.68576	0.36177	0.47750	0.31631
15	1.00000	1.00000	1.00000	1.00000	52	0.63835	0.51259	0.44860	0.29459
16	0.40557	0.41364	0.40792	0.38038	53	1.00000	1.00000	1.00000	1.00000
17	1.00000	1.00000	1.00000	1.00000	54	0.28931	0.26997	0.25241	0.27555
18	0.40232	0.30554	0.35353	0.32069	55	0.29666	0.39923	0.38679	0.34042
19	0.20217	0.19761	0.16295	0.10461	56	0.20531	0.19948	0.22493	0.20149
20	0.27737	0.28154	0.24317	0.24228	57	0.59498	0.56959	0.56025	0.42233
21	0.27215	0.30886	0.29515	0.22780	58	1.00000	1.00000	0.66469	0.47494
22	0.16484	0.22871	0.30216	0.50782	59	0.31085	0.32441	0.34514	0.34402
23	0.36218	0.31261	1.00000	0.38029	60	0.84750	1.00000	1.00000	0.89549
24	0.08612	0.08986	0.08855	0.08775	61	0.18748	0.25765	0.74719	0.77629
25	0.45752	0.52852	0.43888	0.38736	62	0.83108	0.87601	0.66404	0.41451
26	0.55761	0.70626	0.75453	0.75744	63	0.27709	0.32623	0.30181	0.31036
27	0.28557	0.26078	0.27014	0.38234	64	0.34560	0.43916	0.39137	0.35176
28	0.26389	0.25668	0.21658	0.25292	65	0.62058	0.52045	0.57009	0.87508
29	0.11398	0.12125	0.16995	0.11619	66	0.18829	0.24981	0.16425	0.16249
30	0.24709	0.42325	0.51144	0.54346	67	0.17108	0.18030	0.17329	0.19301
31	1.00000	1.00000	1.00000	1.00000	68	0.43261	0.44501	0.47087	0.53249
32	0.38055	0.38849	0.40894	0.31790	69	1.00000	1.00000	0.74322	0.73060
33	0.27719	0.27357	0.25961	0.28218	70	0.13538	0.23012	0.18822	0.46304
34	0.70647	0.84928	0.60771	0.60973	71	0.20950	0.25960	0.23635	0.36395
35	0.54062	0.58421	0.58720	0.69174	72	1.00000	0.58198	0.62668	0.53083
36	0.11206	0.14802	0.11316	0.11843	73	0.87744	0.96627	1.00000	1.00000

37	0.43064	0.41211	0.43305	0.39331	

Each firm's efficiency score in different years are calculated and listed in Table 5.7. A firm can be seen as efficient and a good performer when its efficiency score reached 1, whereas it is identified as inefficient if its score was lower than 1. Additionally, the lower a score is, the worse a firm performed in a certain year.

Further, the mean value of the CSE for each group from 2009 to 2012 are calculated and listed below (Table 5.8).

Table 5.8 Average Mean for each Category during 2009-2012

Year	Cat.1	Cat.2	Cat. 3
2009	0.830954	0.575773	0.518407
2010	0.791405	0.656171	0.535311
2011	0.809605	0.657187	0.539593
2012	0.786969	0.56033	0.532633

5.2.3 Comparison between the Firms with and without Certification(s)

In order to observe the difference in the CSE between firms with and without certification, this study compares the mean value of the CSE of category 1 and 2 and category 3 (Figure 5.3).

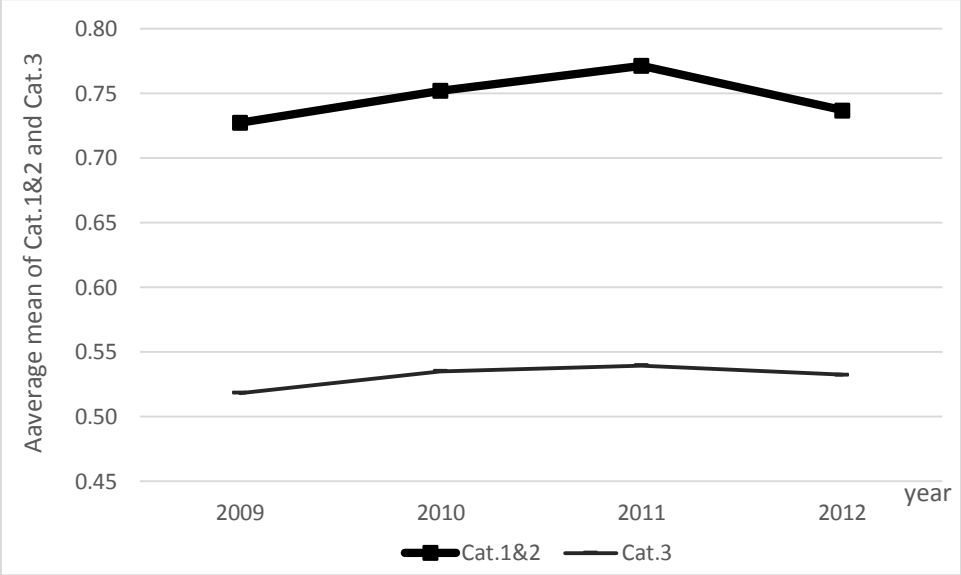

Fig 5.3 Average Mean of the CSE for Cat. 1 &2 and Cat. 3

Figure 5.3 suggests that the mean value of the CSE for firms in category 1 and 2 (i.e., the firms with one or more certificates) is much higher than that of category 3 that is consisted of firms without certificate.

Table 5.9 Summary Statistics of the CSE for the Firms with and without Certification during 2009-2012

Year	Cat.	Obs	Mean	Std. Dev.	Min	Max	Rank sum	Prob > |z|
2009	Cat. 1&2	37	0.727502	0.297547	0.231708	1	1637	0.0027***
	Cat.3	36	0.518407	0.282789	0.142555	1	1064	
2010	Cat. 1&2	38	0.752259	0.294639	0.210788	1	1645	0.0073***
	Cat.3	35	0.535311	0.284480	0.120041	1	1056	

2011	Cat. 1&2	40	0.77150	0.267046	0.220997	1	1767.5	0.0012***
	Cat.3	33	0.530266	0.279925	0.092093	1	933.5	
2012	Cat. 1&2	41	0.737219	0.269892	0.181394	1	1767	0.0049***
	Cat.3	32	0.532633	0.295249	0.108288	1	934	

H_0: no sig difference between samples

*** $p \leq 0.01$; ** $p \leq 0.05$; * $p \leq 0.10$

As Table 5.9 shows, the Wilcoxon-Mann-Whitney rank sum statistic with p-value of 0.0027, 0.0073, 0.0012, and 0.0049 in 2009, 2010, 2011, and 2012, respectively. This outcome rejects the null hypothesis that there is no significant difference between two samples at the 1% significance level.

Therefore, the differences between the CSE for the firms with and without certification throughout the years under the study are all significant.

5.2.4 Differences among the Three Categories

In order to observe the differences among the three levels of certification, this study draws the figure of efficiency distribution for each group during 2009-2012 (Figure 5.4).

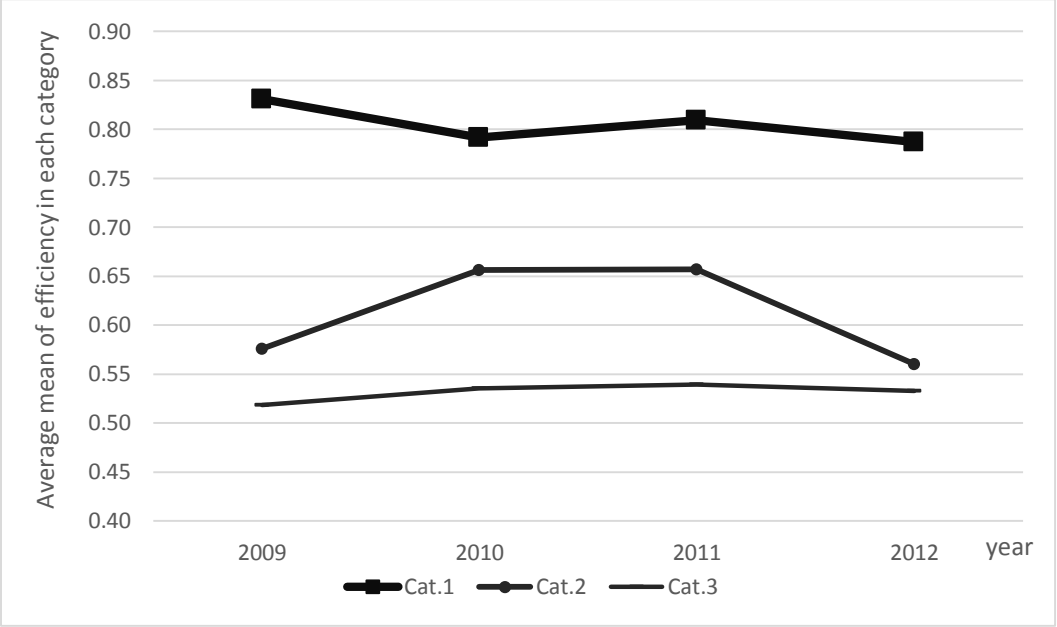

Fig 5.4 Average Mean of the CSE for Cat. 1, 2, and 3

It can be noted in Figure 5.4 that (1) the mean of the CSE in category 1 was the highest over 2009-2012; (2) the mean of CSE for category 2 ranked second in general, yet dropped greatly between 2011 and 2012; and (3) the mean of CSE in category 3 was much lower than the other two groups throughout the years under the study.

In order to demonstrate the significance of the difference among category 1, 2, and 3, the Kruskal-Wallis equality-of-populations rank test (K-W test), a non-parametric multi-sample rank sum test, is utilized to fulfill the task (Table 5.10).

As can be seen from Table 5.10, the differences among groups were all remarkable at the 5% significance level throughout the years, indicating that the efficiency differences among groups (i.e., cat.1, 2. and 3) are valid.

Table 5.10 K-W Test Result

Year	Cat.	Obs.	Mean	Std. Dev.	Min	Max	Rank Sum	Prob. (Ho: Cat.1==Cat.2 ==Cat.3)
2009	Cat.1	22	0.83096	0.26428	0.29619	1	1126	0.00055***
	Cat.2	15	0.57577	0.28532	0.23171	1	511	
	Cat.3	36	0.51841	0.28551	0.14256	1	1064	
2010	Cat.1	27	0.79141	0.27816	0.23695	1	1244	0.01199**
	Cat.2	11	0.65617	0.32518	0.21079	1	401	
	Cat.3	35	0.53531	0.28448	0.12004	1	1056	
2011	Cat.1	30	0.80961	0.24601	0.30498	1	1415.5	0.00158***
	Cat.2	10	0.65719	0.30766	0.2210	1	352	
	Cat.3	33	0.53960	0.27992	0.09209	1	933.5	
2012	Cat.1	32	0.78697	0.25814	0.18139	1	1484	0.00322***
	Cat.2	9	0.56033	0.24678	0.23351	1	283	
	Cat.3	32	0.53263	0.29525	0.10829	1	934	

H_0: no sig difference among samples

*** p≤0.01; ** p≤ 0.05; * p≤0.10

In order to demonstrate the significance of the difference among category 1, 2, and 3, the test of multiple comparisons between groups is further conducted and the results are listed below (Table 5.11)

Table 5.11 Multiple Comparisons between Categories

	Ho: Cat.1==Cat.2	Ho: Cat.1==Cat.3	Ho: Cat.2==Cat.3
2009	0.007997***	0.000083***	0.244517
2010	0.102485	0.001716***	0.195799
2011	0.060961*	0.000208***	0.183396
2012	0.031086**	0.000597***	0.388999

*** p≤0.01; ** p≤ 0.05; * p≤0.10

As shown in Table 5.11, the result between category 1 and 2 was significant in 2009, yet was not remarkable in 2010 when four firms moved from category 2 to category 1 and subsequently caused the "congestion effects" in category 1. However, the significant level between category 1 and 2 gradually increased and was significant in 2012, indicating that the firms with two or more certificates gained higher CSE than the firms with single certificate over time.

The results between category 1 and 3 during 2009-2012 all rejected the null hypotheses that the populations were the same at 1% significant level, whereas the differences between category 2 and category 3 were not significant throughout the years under the study. The results indicate that the firms with integrated certifications gained the highest CSE on average, yet the firms with single certification failed to differentiate their advantages from the firms without certifications notably. The findings can also explain the phenomena that an increasing number of firms moved from category 2 to category 1 over time.

5.3 Regression Estimation

A regression technique is employed to test hypotheses 3 and 4 by detecting the relationships among the corporate efficiency score, certification number, and certification history during 2009-2012.

The panel Tobit regression model is built up to observe the relationships among corporate sustainable efficiency, certification status, and certification history.

$$y_{it} = \beta_0 + \beta_1 x1_{it} + \beta_2 x2_{it} + v_i + u_{it} \qquad (5.3)$$

$$y_{it} = y_{it}^* \quad if\ 0 < y_i^* \leq 1$$

$$y_{it} = 0 \quad if \quad y_i^* \leq 0$$

$$y_{it} = 1 \quad if \quad y_i^* > 1$$

$$u_{i,}\ \varepsilon_{it} \sim (0, \sigma^2)$$

where y_{it} , $x1_{it}$, and $x2_{it}$ stand for the corporate sustainable efficiency score, number of active certification, and cumulated certificated term for DMU_i in year t; the individual specific effect v_i and the error term u_{it} are normally distributed.

5.3.1 Panel Unit Roots Tests

All variables of a model should be estimated as stationary without any unit roots before a regression process can be conducted. A variety of tests for unit roots (or stationary) for panel dataset are available, and the Harris-Tzavalis (1999) and Hadri (2000) Lagrange multiplier (LM) techniques are selected in this study to test the existence of unit roots in the model.

The Harris-Tzavalis (1999) test with the null hypothesis that all the panels contain a unit root, whereas the Hadri (2000) Lagrange multiplier (LM) test with the null hypothesis that all the panels are (trend) stationary (Table 5.12).

As can be seen in Table 5.12, the null hypothesis in the Harris-Tzavalis model is rejected as p values for the variables at their original levels or first differences are all lower than 0.01. Meanwhile, the null hypothesis in the Hadri LM model cannot be rejected as the p values are not significant for all first-difference of the variables. Therefore, all variables in the dataset are significantly stationary at their ordinary or the first order difference level.

Table 5.12 Results of the Panel Unit Roots Tests

Harris-Tzavalis unit-root test		
Ho: Panels contain unit roots		Number of panels = 73
Ha: Panels are stationary		Number of periods = 4
var.	Statistic	p-value
y	0.1397	0.0001
x1	0.0127	0.0000
x2	1.0080	1.0000
d.x2	0.0000	0.0015
Hadri LM test		
Ho: All panels are stationary		Number of panels = 73
Ha: Some panels contain unit roots		Number of periods = 4
var.	Statistic	p-value
y	3.5913	0.0002
d.y	-1.3901	0.9177
x1	2.1526	0.0157
d.x1	-1.3932	0.9182
x2	8.6457	0.0000
d.x2	1.0614	0.1443

*** p≤0.01; ** p≤ 0.05; * p≤0.10

5.3.2 Hausman Test

Theoretically, the fixed-effects panel Tobit model is affected by the incidental parameters problem and can be easily biased (Neyman & Scott, 1948; Lancaster, 2000). Therefore, a Hausman test is conducted before the Tobit estimation is fulfilled to improve the validity of the result (Table 5.13).

Table 5.13 Hausman Test Result

Coefficients	(b)	(B)	(b-B)	sqrt(diag(V_b-V_B))
	fe	re	Difference	S.E.
x1	0.0214585	0.0249207	-0.0034622	0.0036685
x2	0.0018531	0.0085029	-0.0066498	0.0055264

b = consistent under Ho and Ha; obtained from xtreg
B = inconsistent under Ha, efficient under Ho; obtained from xtreg
Test: Ho: difference in coefficients not systematic
chi2(2) = (b-B)'[(V_b-V_B)^(-1)](b-B)= 2.49
Prob>chi2 = 0.2885

*** p≤0.01; ** p≤ 0.05; * p≤0.10

The Hausman tests the null hypothesis that the coefficients estimated by the efficient random effects estimator are the same as the ones estimated by the consistent fixed effects estimator. Therefore, the result in table 5.13 indicates that the null hypotheses cannot be rejected at a significant level as the p value is 0.2885 and is much larger than 0.05. Thus, a random-effects panel Tobit regression is suitable to finish the further estimation.

5.3.3 Panel Tobit Estimation

The statistical description of the data is conducted before running the Tobit model to present a basic configuration of the regression sample (Table 5.14).

Table 5.14 Data Description for the Regression Variables

Variable	Obs	Mean	Std. Dev.	Min	Max
y	292	0.6467082	0.3009397	0.092093	1
x1	292	1.8595890	2.332530	0.000000	13
x2	292	3.0616440	2.980400	0.000000	10

The random-effects panel Tobit estimation result is listed below (Table 5.15).

Table 5.15 Panel Random-Effects Tobit Estimation

y	Coef.	Std. Err.	Prob > chi2
x1	0.0299777***	0.0109946	0.0010***
x2	0.0118826	0.0109618	
cons	0.6284284***	0.0530145	
sigma_u	0.3510011***	0.0364152	
Sigma_e	0.1621785***	0.0095363	
rho	0.8240720	0.0338100	
0 left-censored observations			
203 uncensored observations			
89 right-censored observations			

*** p≤0.01; ** p≤ 0.05; * p≤0.10

All the coefficients except *x2* are significant at the 1% significance level, and the model is significant at the 1% significance level (Prob. = 0.001), indicating a high explanation power of the model (Table 5.15). The sign of the correlation coefficient of *x1* denotes a positive relation between *x1* and *y*, and it is similar to the *x2*. Nevertheless, the former coefficient is significant at the 1% level (p=0.006), whereas the latter is not significant with a p value of 0.278.

As a result of the regression, a firm's active number of certifications and its cumulated certified years both exerted positive effects on a firm's its sustainable efficiency throughout the years under study. In other words, firms with more current active certifications gained

higher sustainable efficiency than others, and firms with longer certification history had higher sustainable efficiency on average as well.

Additionally, the positive link between the CSE and the active number of certifications was significant, whereas the link between the CSE and the certified history was not remarkable during 2009-2012. This outcome indicates that the synergetic and cumulative effects of certification on the improvement of CSE both appeared, yet the former was strong while the latter was weak.

Chapter 6 Conclusions and Implications

This study demonstrates a comprehensive and clear understanding of the efficiency of management system certification by developing and testing a multi-dimensional evaluation framework. The main hypotheses in the study have been supported to a great extent based on empirical tests conducted using the statistical data from 73 Chinese-listed manufacturing firms in Chapter 5. The key findings, related conclusions, further implications, and certain limitations of the study are summarized in this chapter.

6.1 Conclusions

With the help of the categorical DEA approach, the CSE scores for each firm from 2009 to 2012 are calculated, followed by the inter-group comparisons and analyses. In summary, the mean value of category 1 and 2 was significant higher than that of category 3, indicating that the firms with certification gained higher sustainable efficiency than firms without certification on average throughout the years under the study. Meanwhile, the mean value of category 3 is the highest and significant higher than that of category 2 and category 3 during 2009-2012, suggesting that the firms with integrated certifications obtained the highest sustainable efficiency on the whole.

Moreover, the random-effects panel Tobit regression technique is conducted to estimate the relationship between the firms' sustainable efficiency scores and their certification statuses. As shown in the outcome, both the active certification number and accumulative certified years exerted positive impacts on the improvement of the CSE, yet the former impact was significant whereas the latter was not. These results imply that a remarkable synergetic

effect of certification on the CSE formed in the sample, however, the cumulative effect was not distinct.

By discussing the fulfillment of the objectives defined in the beginning, several key findings and the corresponding conclusions are summarized below.

6.1.1 The Characteristics of Certification in Chinese Firms

An increasing trend appeared in certifying and integrating MSs in the sample as more and more firms that used to have single certification or did not have any decided to undertake two or more certifications throughout the years under the study.

During the observation period, an increasing number of firms chose to certify their quality, environmental, and/or occupational health & safety MSs. Meanwhile, more and more firms preferred having integrated standard management systems (i.e., with two or three certifications) rather than keeping a single standard due to the perceived benefits related to certification and/or pressures coming from various stakeholders.

This phenomenon in the sample demonstrates and is consistent with the current macro trends in the country, indicating that Chinese firms are not only becoming aware of their impacts on divergent stakeholders but also recognizing certifications as effective management approaches to simultaneously achieve economic growth, environmental protection, and social equity.

6.1.2 The Assimilation Effects of Certification Formed in Improving the CSE

From the outcome of the relative efficiency evaluation, the mean values of the CSE for firms in category 1 and 2 were significantly higher than that of the firms in category 3 during 2009-2012, indicating that firms with certified management system(s) are more efficient and sustainable than firms without certification on average. In other words, with improved internal management and pressures from external inspection, the implementation and certification of such management standards contribute to the improvement of CSE through optimizing their responsibility, as well as their social, environmental, and market management capacity, which, in turn, helps organizations foster a competitive edge.

Certifications can serve as resources to foster a more efficient transformation in a firm and lead to higher corporate sustainable efficiency in the Chinese context. Multiple MSSs that address different aspects of CSD, especially when the standards are fully and smoothly integrated, will benefit a Chinese firm with extra advantages in terms of cost-savings and continuous improvements.

Certification activities demonstrate a firm's concern about the sustainability of internal and external stakeholders' benefits. In particular, the motivation and effort of people in an organization are important factors in the successful implementation of an (integrated) management system (Wilkinson & Dale, 2001; Asif et al., 2010; Lo ́pez-Fresno, 2010). In this regard, firms that certify their (integrated) management systems tend to be more responsible in terms of employee training and treatment, quality, and/or environmental engagement.

6.1.3 The Integration Effects of Certification Formed in Improving the CSE

The result also shows that firms with multiple MSSs (i.e., dual- and multi-certification) had higher CSE than firms with single-certification and without any certification on average, indicating that a firm can gain much higher sustainable efficiency through registering multiple MSSs instead of single MSS.

Meanwhile, the firms in category 2 failed to attain notable higher sustainable efficiency than the firms in category 3, suggesting that firms with single certification cannot be differentiated from firms without certification. This outcome is in accordance with and can explain the phenomenon that an increasing number of firms chose to register to multiple certifications instead of maintaining a single one during 2009-2012.

Therefore, integration of MSs will promote integration and cost savings for certified organizations. Integration as a strategic and inherent approach is a solution to problems related to addressing various stakeholders' expectations and achieving 'real' continuous improvement effectively, which in turn contributes to a firm's sustainable development eventually.

6.1.4 The Synergetic Effects of Certification Formed in Improving the CSE

According to the regression results, the CSE was positively related to the active number of certificates on a remarkable level. This finding implies that the synergetic effects among certifications were formed, and subsequently facilitated a certified firm to integrate, reconfigure, gain, and release its resources effectively to cogenerate maximum multi-level benefits with given expenses.

Therefore, Chinese firms should be encouraged to implement and certify as many MSSs as possible for their facilities and sites to gain the synergetic effects generated from the interaction, coaction, and alliances among systems.

6.1.5 The Cumulative Effects of Certification were not Significant in Improving the CSE

Positive relationships among corporate sustainable efficiency and years of certification have been found in the regression outcome, suggesting that the certification activities helped the firms to become more efficient.

However, the positive link between the years of certification and a firm's efficiency was not significant, partly because the standards of the MSs (i.e., ISO 9001, ISO 14001, and OHSAS 18001), especially ISO 9001, have been modified and updated over time to rectify their shortcomings and make them more effective. For example, the old versions of ISO 9001 have been criticized for being static, introducing too much paperwork and having too much focus on the system without actually contributing in value-creation (Barnes, 1998). The certifications themselves were not perfectly designed when first released decades ago, and are not perfect yet.

The second explanation is that it takes time for a management standard to be assimilated into an organization's every aspect and to come into play effectively. Such activities are relatively new for Chinese firms as the longest registration period in the sample was only ten years in 2012.

Another potential reason is that the interplay between registration history and CSE could be a "U-shape" or "N-shape" curve instead of a simple linear correlation. However, the

long-term effect is hard to observe in this study due to the limitation of the time span (i.e., from 2009 to 2012).

6.2 Implications

This study endorses the general positive effects of management system certifications in fostering large-size firms' sustainable development. It is one of the first studies to investigate the efficiency of certified management systems from a dynamic perspective by taking both temporal and spatial elements into account.

First, this study demonstrates the characteristics of certification activities in the Chinese manufacturing industry that meets the theoretical expectations set out in the beginning of the study.

Second, this study proposes the concept and framework of corporate sustainable efficiency (CSE) that can be utilized as an important indicator and framework for measuring an organization's dynamic capacity for future research.

Third, this study posits, summarizes, and tests the "four in one" certification-related effects (i.e., the assimilation, integration, synergetic, and cumulative effects) in addition to the effects of labelling. Such effects arising from the implementation and registration of management system standards can be seen as specific patterns that form and improve an organization's dynamic capabilities.

Last but not least, the practical implication of this study is that organizations in China and other developing countries with significant social and environmental concerns should be encouraged to obtain more certified management systems, especially the integrated ones.

6.3 Limitations

Despite the many efforts made in the study, certain limitations still exist, potentially weakening the validity of the research.

The sample firms in the study are all Chinese-listed large-size companies from the manufacturing industry. The features of implementation and certification activities vary according to different firms' sizes (e.g., small-medium enterprises, SMEs) and industries. Empirical results based on various samples (e.g., SMEs and other industries) may differ to some extent.

Furthermore, some objective challenges in data collection, may lead to certain biases in the results: incomplete information disclosure by firms, differences between Chinese firms' reporting guidelines and the GRI framework, and a lack of consensus in acknowledging social performance.

Finally, the certification activity is context-specific. The observations and conclusions may not be applicable to developed countries due to cultural distance.

6.4 Recommendations

Future studies in respect to this topic can be developed in various ways:

Comparative research could be conducted using a sample of SEMs or firms from non-manufacturing industries in China.

Other potential determinants and influencing factors related to certification activities can be further identified and tested to expand the scope of the topic.

In-depth interviews could be conducted to unveil the integration degree of certified firms and their certification statuses.

A long-term analysis between CSE and the firms' registration experience could be conducted to observe the accumulate effects of certification activities.

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Appendix I List of Abbreviations and Acronyms

3BL: Triple Bottom Line

CASS: the Chinese Academy of Social Sciences

CIP: Continual Improvement Process

CNCA: Certification and Accreditation Administration of the People's Republic of China

CSD: Corporate Sustainable Development

CSE: Corporate Sustainable Efficiency

CSR: Corporate Social Responsibility

DEA: Data Envelopment Analysis

DMU: Decision-Making Unit

EPI: Environmental Performance Index

ESIs: Environmentally Sensitive Industries

GRI: Global Reporting Initiative

IMS: Integrated Management System

ISO 14001: Certified Environmental Management System

ISO 9001: Certified Quality Management System

ISO: International Organization for Standardization

MS: Management System

MSS: Management System Standard

NDRS: Non-Decreasing Returns-to-Scale

OHSAS 18001: Certified Occupational, Health and Safety Management System

PDCA: Plan-Do-Check-Act

RMI: Responsibility Management Index

SIC: Standard Industrial Classification

SME: Small and Medium-sized Enterprises

SPI: Social Performance Index

Appendix II SIC Code for Manufacturing Industries

SIC code	Industry
20	Food and Kindred Products
21	Tobacco manufactures
22	Textile mill products
23	Apparel and other textile products
24	Lumber and wood products
25	Furniture and fixture
26	Paper and allied products
27	Printing and publishing
28	Chemicals and allied products
29	Petroleum and coal products
30	Rubber and Miscellaneous plastics products
31	Leather and leather products
32	Stone, clay, glass, and concrete products
33	Primary metal industries
34	Fabricated metal products
35	Industrial machinery and equipment
36	Electrical and electronic equipment
37	Transportation equipment
38	Instrument and related products
39	Miscellaneous manufacturing industries

Appendix III Responsibility Management Index

First class indicator	Second class indicators	Third class indicators
Responsibility management index	1.1 Responsibility strategy	(1)CSR concept (2) Key topics in CSR (3) CSR planning
	1.2 Responsibility governance	(1)Governing bodies (2)Organizational systems (3)Regulatory regime
	1.3 Responsibility integration	(1)Proceed with the subordinates (2) Advance CSR fulfillment in supply chain
	1.4 Responsibility performance	(1) Set up CSR indicator systems(2) Set up CSR evaluation systems (3) Internal selection for "doing-good"
	1.5 Responsibility communication	(1) Corporate responses to stakeholders' expectations (2) CSR activities that senior leaders attend (3) Whether a firm has CSR column on its website (4) Whether a firm has a CSR report or not
	1.6 Capacity of duties	(1) Trainings for CSR (2) Level of CSR-related research (3) Level of CSR research cooperation

Appendix IV Environmental Performance Index

First class indicator	Second class indicators	Third class indicators
Environmental performance index	1. Material (Materials used by weight or volume. Percentage of materials used that are recycled input materials.)	Reported (YES=1; NO=0); Economic importance reported (YES=1; NO=0); Quantitative Indicator (YES=1; NO=0); Trend analysis (YES=1; NO=0); Trend (positive=1, negative=0); Benchmarking (YES=1; NO=0)
	2. Energy (Direct energy consumption by primary energy)	Reported (YES=1; NO=0); Economic importance reported (YES=1; NO=0); Quantitative Indicator (YES=1; NO=0); Trend analysis (YES=1; NO=0); Trend (positive=1, negative=0); Benchmarking (YES=1; NO=0)
	3.Water (Total water withdrawal by source)	Reported (YES=1; NO=0); Economic importance reported (YES=1; NO=0); Quantitative Indicator (YES=1; NO=0); Trend analysis (YES=1; NO=0); Trend (positive=1, negative=0); Benchmarking (YES=1; NO=0)
	4. Biodiversity (Location and size of land owned, leased, managed in, or adjacent to, protected areas and areas of high biodiversity value outside protected areas. Description of significant impacts of activities, products, and services on biodiversity in protected areas and areas of high biodiversity value outside protected areas)	Reported (YES=1; NO=0); Economic importance reported (YES=1; NO=0); Quantitative Indicator (YES=1; NO=0); Trend analysis (YES=1; NO=0); Trend (positive=1, negative=0); Benchmarking (YES=1; NO=0)

	5. Emissions, Effluents and Waste (Total direct and indirect greenhouse gas emissions by weight. Other relevant indirect greenhouse gas emissions by weight. Emissions of ozone depleting substances by weight.NO, SO, and other significant air emissions by type and weight. Total water discharge by quality and destination. Total weight of waste by type and disposal method. Total number and volume of significant spills.)	Reported (YES=1; NO=0); Economic importance reported (YES=1; NO=0); Quantitative Indicator (YES=1; NO=0); Trend analysis (YES=1; NO=0); Trend (positive=1, negative=0); Benchmarking (YES=1; NO=0)
	6. Environmental Issues of Products and Services (Initiatives to mitigate environmental impacts of products and services, and extent of impact mitigation. Percentage of products sold and their packaging materials that are reclaimed by category.)	Reported (YES=1; NO=0); Economic importance reported (YES=1; NO=0); Quantitative Indicator (YES=1; NO=0); Trend analysis (YES=1; NO=0); Trend (positive=1, negative=0); Benchmarking (YES=1; NO=0)

Appendix V Social Performance Index

First class indicator	Second class indicators	Third class indicators
Social performance indicator	1. Community (Percentage of operations with implemented local community engagement, impact assessments, and development programs. Operations with significant potential or actual negative impacts on local communities. Prevention and mitigation measures implemented in operations with significant potential or actual negative impacts on local communities.)	Reported (YES=1; NO=0); Economic importance reported (YES=1; NO=0); Quantitative Indicator (YES=1; NO=0); Trend analysis (YES=1; NO=0); Trend (positive=1, negative=0); Benchmarking (YES=1; NO=0)
	2. Corruption (Percentage and total number of business units analyzed for risks related to corruption. Percentage of employees trained in organization's anti-corruption policies and procedures. Actions taken in response to incidents of corruption.)	Reported (YES=1; NO=0); Economic importance reported (YES=1; NO=0); Quantitative Indicator (YES=1; NO=0); Trend analysis (YES=1; NO=0); Trend (positive=1, negative=0); Benchmarking (YES=1; NO=0)
	3. Public Policy (Public policy positions and participation in public policy development and lobbying.)	Reported (YES=1; NO=0); Economic importance reported (YES=1; NO=0); Quantitative Indicator (YES=1; NO=0); Trend analysis (YES=1; NO=0); Trend (positive=1, negative=0); Benchmarking (YES=1; NO=0)

	4. Compliance (Monetary value of significant fines and total number of non-monetary sanctions for noncompliance with laws and regulations.)	Reported (YES=1; NO=0); Economic importance reported (YES=1; NO=0); Quantitative Indicator (YES=1; NO=0); Trend analysis (YES=1; NO=0); Trend (positive=1, negative=0); Benchmarking (YES=1; NO=0)
	5. Human Rights in the Supply Chain (Percentage and total number of significant investment agreements and contracts that include clauses incorporating human rights concerns, or that have undergone human rights screening. Percentage of significant suppliers, contractors, and other business partners that have undergone human rights screening, and actions taken. Total hours of employee training on policies and procedures concerning aspects of human rights that are relevant to operations, including the percentage of employees trained.	Reported (YES=1; NO=0); Economic importance reported (YES=1; NO=0); Quantitative Indicator (YES=1; NO=0); Trend analysis (YES=1; NO=0); Trend (positive=1, negative=0); Benchmarking (YES=1; NO=0)
	6. Non-discrimination (Total number of incidents of discrimination and corrective actions taken.)	Reported (YES=1; NO=0); Economic importance reported (YES=1; NO=0); Quantitative Indicator (YES=1; NO=0); Trend analysis (YES=1; NO=0); Trend (positive=1, negative=0); Benchmarking (YES=1; NO=0)
	7. Human Rights - Freedom of Association and Collective Bargaining (Operations and significant suppliers identified in which the right to exercise freedom of association and collective bargaining may be violated or at significant risk, and actions taken to support these rights.)	Reported (YES=1; NO=0); Economic importance reported (YES=1; NO=0); Quantitative Indicator (YES=1; NO=0); Trend analysis (YES=1; NO=0); Trend (positive=1,

		negative=0); Benchmarking (YES=1; NO=0)
	8. Human Rights - Child Labour (Operations and significant suppliers identified as having significant risk for incidents of child labor, and measures taken to contribute to the effective abolition of child labor.)	Reported (YES=1; NO=0); Economic importance reported (YES=1; NO=0); Quantitative Indicator (YES=1; NO=0); Trend analysis (YES=1; NO=0); Trend (positive=1, negative=0); Benchmarking (YES=1; NO=0)
	9. Human Rights - Forced or Compulsory Work (Operations and significant suppliers identified as having significant risk for incidents of forced or compulsory labor, and measures to contribute to the elimination of all forms of forced or compulsory labor.)	Reported (YES=1; NO=0); Economic importance reported (YES=1; NO=0); Quantitative Indicator (YES=1; NO=0); Trend analysis (YES=1; NO=0); Trend (positive=1, negative=0); Benchmarking (YES=1; NO=0)
	10. Labour Practices - Occupational Health and Safety Management (Rates of injury, occupational diseases, lost days, and absenteeism, and total number of work-related fatalities, by region and by gender. Education, training, counseling, prevention, and risk-control programs in place to assist workforce members, their families, or community members regarding serious diseases.)	Reported (YES=1; NO=0); Economic importance reported (YES=1; NO=0); Quantitative Indicator (YES=1; NO=0); Trend analysis (YES=1; NO=0); Trend (positive=1, negative=0); Benchmarking (YES=1; NO=0)

	11. Labour Practices - Training and Education (Average hours of training per year per employee by gender, and by employee category.)	Reported (YES=1; NO=0); Economic importance reported (YES=1; NO=0); Quantitative Indicator (YES=1; NO=0); Trend analysis (YES=1; NO=0); Trend (positive=1, negative=0); Benchmarking (YES=1; NO=0)
	12. Labour Practices - Diversity and Equal Opportunity (Composition of governance bodies and breakdown of employees per employee category according to gender, age group, minority group membership, and other indicators of diversity.)	Reported (YES=1; NO=0); Economic importance reported (YES=1; NO=0); Quantitative Indicator (YES=1; NO=0); Trend analysis (YES=1; NO=0); Trend (positive=1, negative=0); Benchmarking (YES=1; NO=0)
	13.Product Responsibility - Customer Health and Safety (Life cycle stages in which health and safety impacts of products and services are assessed for improvement, and percentage of significant products and services categories subject to such procedures.)	Reported (YES=1; NO=0); Economic importance reported (YES=1; NO=0); Quantitative Indicator (YES=1; NO=0); Trend analysis (YES=1; NO=0); Trend (positive=1, negative=0); Benchmarking (YES=1; NO=0)
	14. Product Responsibility - Product and Services Labeling (Type of product and service information required by procedures, and percentage of significant products and services subject to such information requirements.)	Reported (YES=1; NO=0); Economic importance reported (YES=1; NO=0); Quantitative Indicator (YES=1; NO=0); Trend analysis (YES=1; NO=0); Trend (positive=1, negative=0);

		Benchmarking (YES=1; NO=0)
	15. Product Responsibility - Marketing Communications (Programs for adherence to laws, standards, and voluntary codes related to marketing communications, including advertising, promotion, and sponsorship.)	Reported (YES=1; NO=0); Economic importance reported (YES=1; NO=0); Quantitative Indicator (YES=1; NO=0); Trend analysis (YES=1; NO=0); Trend (positive=1, negative=0); Benchmarking (YES=1; NO=0)
	16. Product Responsibility - Product Compliance (Monetary value of significant fines for noncompliance with laws and regulations concerning the provision and use of products and services.)	Reported (YES=1; NO=0); Economic importance reported (YES=1; NO=0); Quantitative Indicator (YES=1; NO=0); Trend analysis (YES=1; NO=0); Trend (positive=1, negative=0); Benchmarking (YES=1; NO=0)

Appendix VI Efficiency Scores and Categories of the Firms

DMU	2009		2010		2011		2012	
	Cat.	CSE	Cat.	CSE	Cat.	CSE	Cat.	CSE
1	3	0.64418	3	0.74374	3	0.93225	3	1.00000
2	1	0.48266	1	0.47111	1	0.37303	1	0.44777
3	3	0.27828	1	0.43275	1	0.47216	1	0.53879
4	3	0.38182	3	0.46598	3	0.50695	3	0.55943
5	3	0.16893	3	0.21292	3	0.21734	3	0.17171
6	3	0.37919	3	0.34672	3	0.37997	3	0.31747
7	2	0.37347	1	0.51098	1	0.48302	1	0.59950
8	2	0.58056	2	0.65250	2	0.72157	1	0.82968
9	1	0.59192	1	0.60754	1	0.66871	1	0.73802
10	1	0.41513	1	0.59004	1	0.52922	1	0.53473
11	1	0.13589	1	0.16211	1	0.20018	1	0.23422
12	1	0.45742	1	0.52425	1	0.74876	1	0.68409
13	3	0.51658	3	0.57429	3	0.62902	3	0.71439
14	3	0.31391	3	0.34554	3	0.46563	3	0.52960
15	2	1.00000	2	1.00000	2	1.00000	2	1.00000
16	3	0.40557	3	0.41364	3	0.40792	3	0.38038
17	3	1.00000	3	1.00000	3	1.00000	3	1.00000
18	2	0.40232	2	0.30554	2	0.35353	1	0.32069
19	1	0.20217	1	0.19761	1	0.16295	1	0.10461
20	2	0.27737	2	0.28154	2	0.24317	2	0.24228
21	1	0.27215	1	0.30886	1	0.29515	1	0.22780
22	1	0.16484	1	0.22871	1	0.30216	1	0.50782
23	1	0.36218	1	0.31261	1	1.00000	1	0.38029
24	3	0.08612	3	0.08986	3	0.08855	3	0.08775
25	3	0.45752	3	0.52852	3	0.43888	3	0.38736
26	2	0.55761	2	0.70626	2	0.75453	2	0.75744
27	3	0.28557	3	0.26078	3	0.27014	3	0.38234
28	3	0.26389	3	0.25668	3	0.21658	3	0.25292
29	2	0.11398	3	0.12125	3	0.16995	3	0.11619
30	1	0.24709	1	0.42325	1	0.51144	2	0.54346
31	3	1.00000	3	1.00000	3	1.00000	3	1.00000

32	3	0.38055	3	0.38849	3	0.40894	3	0.31790
33	3	0.27719	3	0.27357	3	0.25961	3	0.28218
34	2	0.70647	2	0.84928	2	0.60771	2	0.60973
35	3	0.54062	3	0.58421	3	0.58720	3	0.69174
36	1	0.11206	1	0.14802	1	0.11316	1	0.11843
37	3	0.43064	3	0.41211	3	0.43305	3	0.39331
38	3	0.28081	3	0.32045	3	0.33845	3	0.33282
39	1	0.17599	1	0.19294	1	0.17289	1	0.17755
40	2	1.00000	2	1.00000	1	1.00000	1	1.00000
41	3	0.82569	3	0.91398	3	0.95817	3	0.77053
42	3	0.43306	3	0.53100	3	0.54708	3	0.54482
43	2	0.27390	2	0.39409	1	0.32596	1	0.39857
44	3	0.89790	3	1.00000	3	1.00000	3	1.00000
45	2	0.18801	2	0.19138	2	0.17587	2	0.18368
46	1	0.24927	1	0.32642	1	0.36167	1	0.29909
47	1	0.56401	1	0.65264	1	0.66709	1	0.75082
48	3	0.44901	3	0.54690	3	0.43175	3	0.24826
49	3	0.44287	3	0.44991	3	0.43144	3	0.46247
50	3	0.29384	3	0.26362	3	0.24901	3	0.22228
51	1	0.68576	1	0.36177	1	0.47750	1	0.31631
52	1	0.63835	1	0.51259	1	0.44860	1	0.29459
53	3	1.00000	3	1.00000	3	1.00000	3	1.00000
54	3	0.28931	3	0.26997	3	0.25241	3	0.27555
55	3	0.29666	3	0.39923	3	0.38679	3	0.34042
56	1	0.20531	1	0.19948	1	0.22493	2	0.20149
57	1	0.59498	1	0.56959	1	0.56025	1	0.42233
58	3	1.00000	3	1.00000	3	0.66469	3	0.47494
59	3	0.31085	1	0.32441	1	0.34514	1	0.34402
60	1	0.84750	1	1.00000	1	1.00000	1	0.89549
61	3	0.18748	3	0.25765	3	0.74719	1	0.77629
62	1	0.83108	1	0.87601	1	0.66404	1	0.41451
63	2	0.27709	2	0.32623	2	0.30181	1	0.31036
64	3	0.34560	3	0.43916	2	0.39137	2	0.35176
65	3	0.62058	3	0.52045	3	0.57009	3	0.87508
66	1	0.18829	1	0.24981	1	0.16425	1	0.16249
67	2	0.17108	1	0.18030	1	0.17329	1	0.19301

68	2	0.43261	2	0.44501	1	0.47087	1	0.53249
69	3	1.00000	3	1.00000	3	0.74322	3	0.73060
70	1	0.13538	1	0.23012	1	0.18822	1	0.46304
71	2	0.20950	1	0.25960	1	0.23635	1	0.36395
72	3	1.00000	3	0.58198	2	0.62668	2	0.53083
73	3	0.87744	3	0.96627	3	1.00000	3	1.00000