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Does ISO 9000 Certification Benefit Service Firms?

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Abstract: This paper examines whether ISO 9000 certification benefits service firms in terms of their financial performance and promotes sustainable improvement. We argue that in a developing country setting such as China, the massive benefits brought by the signalling effect of the certification can discourage firms' motivation to fully implement the standard of certification and lead to the decline of investment on productivity-improving activities. In other words, the certification may have negative effects on the productivity of certified firms. We investigate 89,024 firms in Chinese service industries to assess the impacts of the certification on sales, productivity and profitability of these firms. To address the potential selection bias of ISO 9000 certification, the Propensity Score Matching method and Coarsened Exact Matching method were used. Our key findings are that the ISO 9000 certification does help to increase the total amount of sales, but it decreases the productivity and profitability of these certified service firms. We also find that earlier certifiers seem to gain larger advantage in sales but more reduction in productivity, and firms with higher level of technology intensity seem to obtain a larger increase in sales and less productivity loss after receiving their ISO 9000 certification.

Keywords: ISO 9000 certification; financial performance; service firms; signalling; productivity

1. Introduction

The ISO 9000 standard has been widely applied since its introduction in 1987 to promote continuous improvement around the world. It has been the most prevalent management standards applied in a variety of industries, including both manufacturing and service industries. According to the International Organization of Standardization, by the end of 2016, there were over 1.1 million organizations world-wide that had adopted ISO 9000. A total of 45.6% of the certificates were issued to service firms [1]. Due to its importance in practice, there are a large number of studies that have been accumulated. However, the financial effects of ISO 9000 certification on service firms, especially the service firms in developing countries, have not received much attention in the existing literature.

Unlike manufacturing firms facing more external pressure to be certified for exporting goods to foreign markets, most service firms serve local customers. Service firms receive limited benefit from the certification as the process adjustment in service firms involves more complexity than manufacturing firms do and it is difficult to improve the productivity of service firms through compliance with the standard. However, the standard is still increasing in popularity in service industries. In 1998, the proportion of ISO 9000 certificates issued to service firms is 36.0% and it increased to nearly 50% in recent years [1]. This raises some questions: What drives service firms to be certified? Does the ISO 9000 certification benefit these certified firms? Chinese firms have achieved great progress in ISO 9000 certification since the 1990s. In 2008, more than 333,000 certificates of ISO 9000 were issued to Chinese firms, accounting for nearly 30% of all the new certificates issued around the world. Among these new certificates in China, about 40% of the certified firms were from the service sector. This provides us an

ideal scenario to examine the financial influence of the certification on service firms in a developing country and answer the above questions.

The ISO 9000 standard was designed to improve the performance of firms by following its managerial guidelines. Studies suggest that process improvements, and expected boosts in profitability and marketing benefits, are key drivers behind the widespread diffusion of the certification [2]. To assess the effects of ISO 9000 certification on financial performance, our study employed matching methods and regression analysis to address the problem of selection bias. We used information gathered from 89,024 Chinese service firms across eight producer service industries. Among these 89,024 service firms, 6071 of them obtained their initial certification between 2005 and 2008. This study compares the financial performance of certified service firms to the non-certified firms. We also contrast the financial effects of earlier certification on firms to those with later certification. Differences in financial effects of the certification on firms in service industries with different level of technological intensity are also investigated in the paper. Our analysis indicates that, apart from its positive effect on sales, certification also has a negative effect on the productivity of service firms due to the crowding-out effect of certification signalling.

This study aims at filling the gap within existing literature concerning the financial effects of ISO 9000 certification on service firms in developing countries. The rest of this paper is structured as follows: Section 2 reviews the literature on ISO 9000 certification. In Section 3, we focus on the conceptual framework of the crowding-out effect of signalling and posit the hypotheses for testing. In Section 4, the description of data is provided, and the empirical methodology of our study is explained. The empirical results are presented in Section 5. Section 6 is the conclusion, consisting of a discussion of the results, the implications of findings, and suggestions for future research.

2. Literature Review

Two categories of benefits lead to the popularity of the ISO 9000 series of quality management systems around the world: the external benefits and the internal benefits [3]. Firms can obtain external benefits when ISO 9000 certification plays a signalling role and delivers additional sales to the firm by addressing information asymmetry in the market. When adopting the ISO 9000 standard, firms need to transform their existing operations to comply with the standard's requirements [4]. Meeting these requirements is more costly for lower-quality suppliers, which often do not possess the skills and management systems required [5]. The certification can serve as a credible signal to buyers as an effective screen of suppliers' quality [6]. It provides the certified firms a set of rewards including price premium, preferred supplier status and a more consistent supply of orders, which assists firms in gaining more sales [7]. Terlaak and King (2006) suggest that the certification in product or service markets is similar to having a college diploma in a job market, which helps buyers selecting qualified suppliers [8]. In other words, its signalling effect can develop a sales advantage for the certified firms.

Apart from the increase in sales, firms can also improve productivity through applying and maintaining the certification. Firstly, guidelines for quality management practices such as planning effective processes, setting goals by clearly assigning tasks and distributing responsibilities, can improve firm's operating efficiency and reduce operating costs and waste [9]. Secondly, implementing the ISO 9000 standard imposes discipline and forces firms to design procedures to improve quality [7]. Thirdly, it helps to generate operational learning, which is important for the improvement of productivity [10]. Training activities related to ISO 9000 certification enable staff to acquire knowledge regards to the operating processes and generate incremental benefits associated with learning-by-doing within the firm [11–13]. In summary, if the ISO 9000 standard is successfully implemented within a firm, such a certification should help to improve the firm's productivity since it has implemented better management systems. Goedhuys and Sleuwaegen (2013) also argue that as an international standard, ISO 9000 certification can entail significant productivity improvements by codifying management routines and providing firms with proven global efficiency benchmark model in developing countries [14].

It seems that the ISO 9000 certification is not only an effective signal of firms' commitment to quality but also a meaningful component of total quality management in improving productivity. If both mechanisms that generate benefits mentioned above hold, ISO 9000 certification should foster financial benefits of the certified firms. However, existing empirical evidence has shown that the financial impacts of certification on certified firms are mixed. We study the previous literature on the financial performance of ISO 9000 certification and list the main findings concerning sales, productivity/efficiency and profitability in Table 1.

Table 1. Empirical literature examining the financial performance of ISO 9000 certification.

Studies	Sales	Productivity	Profitability	Industrial Context
Simmons and White (1999)	Positive	Negative	Positive	M (US)
Heras, Dick, and Casadesus (2002)	Positive		Ambiguous	M and S (Spain)
Tsekouras, Dimara, and Skuras (2002)			Ambiguous	M and S (Greek)
Chow-Chua, Goh, and Boon Wan, (2003)			Positive	M and S (Singapore)
Corbett et al.(2005)	Positive		Positive	M (US)
Sharma (2005)	Positive		Positive	M (Singapore)
Terlaak and King (2006)	Positive			M (US)
Martínez-Costa and Martínez-Lorente (2007)	Ambiguous		Negative	M (Spain)
Benner and Veloso (2008)			Ambiguous	M (US)
Capistrano (2008)	Positive			M and S (Philippines)
Dick, Heras, and Casadesús (2008)	Positive		Positive	M and S (Spain)
Yeung, Lo, and Cheng (2011)			Negative	M (US)
Starke et al. (2012)	Positive	Positive	Positive	M and S (Brazil)
Goedhuys and Sleuwaegen (2013)	Positive	Positive		M (Mexico, Colombia, Chile et al.)
Iyer et al. (2013)		Positive		M (India)
Llach, Perramon, del Mar Alonso-Almeida, and Bagur-Femenias (2013)	Positive		Ambiguous	S (Spain)
Chatzoglou, Chatzoudes, and Kipraios (2015)	Positive	Positive	Positive	M (US)
Aba, Badar, and Hayden (2016)			Positive	M (US)
Javorcik and Sawada (2018)	Positive	Positive	Positive	M and S (Slovenia)

Note: In the "industrial context" column, "M" stands for manufacturing industries and "S" for service industries.

Table 1 illustrates some key aspects of existing literature on sales, productivity or efficiency, profitability and their industrial contexts. Many studies have examined the financial effects of ISO 9000 certification in the manufacturing industries of developed countries [7,8,15–21]. There are a few studies that concern its impacts on service firms [22,23], but they all focus on service firms in developed countries (Spain). Our study targets this void in the ISO 9000 literature by focusing on financial effects of ISO 9000 certification in developing countries. Most empirical studies have found the increase of sale after the certification in both developing and developed countries. However, it does not necessarily lead to productivity/efficiency improvement, and we have found one study shown that the certification decreases the productivity of the firms [20]. We also found a large number of studies that the relationships between ISO 9000 certification and the profitability of the certified firms are ambiguous or even negative [16,18,21,22,24,25]. Based on the existing literature, it is necessary to clarify the question of whether the certification benefits firms in financial performance.

3. Hypothesis Development

3.1. Stories in Service Industries of China

For Chinese service firms, the ISO 9000 can help significantly increase their sales in China. Services marketing is called "selling the invisible", which means that a service provider delivers an intangible service as a core "product" offering. Invisibility, inseparability, heterogeneity and perishability are the four characteristics of services marketing that distinguish it from product marketing. A service buyer would not know how good the service is until he receives it, so information asymmetry is more serious in service industries [26–28]. Bharadwaji and Menon (1993) suggest that in terms of the performance of service firms, market image of a service firm and customer's perception of its service can contribute more than the actual quality of its service [29]. As an international standard, the ISO 9000 standard is expected to be trustworthy in developing countries such as China. Buyers would expect that firms with ISO 9000 certification to be more reliable than the non-certified ones. The certification of ISO 9000 standards helps to build trust between buyers and their service providers as a quality signal, common language and even conflict-settling properties given the fact that ISO 9000 has been the most popular standard [30]. The certification is considered a more effective instrument for signalling superior quality in service industries. China's service market is a market with serious information asymmetry and, in such a market, service firms with ISO 9000 certification can gain more sales through quality signalling of the certification.

The productivity improvements from ISO 9000 certification is more difficult to reap compared to the increased sales from signalling. The certification includes analysing, evaluating, adjusting and codifying daily management practices, and the processes are timely and costly for the adopting firms [31]. To gain productivity improvement, requirements of the standard should be fully implemented. In the short term, compliance with the ISO 9000 standard often leads to an increase of operating costs because of organizational inflexibility [32,33]. Thus, there is a time lag between investment and productivity improvement, as well as a trade-off between short-term cost and long-term benefits. Increased sales from quality signalling can be easily realized as long as the firm is certified with ISO 9000 standard. However, productivity improvement derived from the certification is more difficult to achieve and consumes time. Moreover, the rechecking processes after the certification are often lax, and certification bodies are more likely to be captured in developing countries. Firms in developing countries, such as China, are often myopic and, compared to long-term gains, they prefer short-term benefits due to the lack of institutionalization [14]. It is conceivable that, in such circumstances, service firms in developing countries tend to fulfil minimum requirements and the ISO 9000 certification may become purely paperwork having little positive effect on productivity improvement.

From a firm's point of view, the investment in some activities, such as technical escalation, human capital enhancement and research and development would help to improve the quality of their service and raise sales in the long-term. However, service firms having the certification can easily obtain additional sales through quality signalling in a short time. Service firms which focus on short-term benefits may invest less on productivity-improving activities since such investment is more time consuming and uncertain. Since firms have limited sources and funds, investment between productivity-improving activities and other activities within a firm are substitutes rather than complements [34]. As a result, if a firm decides to invest in getting a certification, it is very likely to be at the expense of productivity improvement. ISO 9000 certification is particularly expensive in developing countries since the access to certification bodies is limited, and the managerial infrastructure is insufficiently developed to implement the right procedures [14]. Chinese service industries are still at the early stage of development. Most Chinese service firms suffer from financial constraints because Chinese banks still prefer to lend money to manufacturing firms. A service firm may not be able to devote enough resources for the long-term productivity improvement when it decides to go for the ISO 9000 certification. Thus, we expect that firms' reduced unwillingness for long-term investment

and the squeezed resources for productivity improvement may result in lower productivity for the certified firms. Therefore, we posit the following hypothesis:

H1: *Service firms in with ISO 9000 certification gain larger sales and have lower productivity.*

The failure of certification on improving the productivity of Chinese service firms can be attributed to the reduction of firms' motivation to fully implement the ISO 9000 standard and the declines of investment on productivity improving activities. Compared to their non-certified counterparts, Chinese service firms with ISO 9000 certification may suffer some productivity losses, which are caused by massive benefits from signalling of the certification, which we call "the crowding-out effect of signalling" on productivity in this paper. We expect that the larger the additional sales obtained from the certification, the greater the productivity loss.

3.2. The Influence of the Time of Certification

We first address the issue of whether a Chinese service firm obtaining ISO 9000 "earlier" or "later" can influence the financial effects of the certification. For the serious information asymmetry situation in the Chinese service industries, it is difficult for firms to find reliable service providers due to the lack of institutional support in the environments. Since first movers are more likely to enable effective adoption of the standard, firms obtaining the certification later probably do so in response to external pressures [35] and buyers would expect earlier certifiers to be more likely to be a qualified service provider in the market. Therefore, firms with earlier certification can obtain a larger sales advantage from quality signalling. Certification is a useful instrument for quality signalling but its effectiveness of vertical differentiation decreases when the number of certified firms increases [36]. In our study, the annual number of certified firms grew rapidly from less than 144,000 in 2005 to more than 224,000 in 2008 in China. As the ISO 9000, certification has become more and more common in the Chinese market, the effectiveness of quality signalling declines with the increasing popularity of the certification. Therefore, later ISO 9000 certification generates fewer additional sales than the earlier ones.

Due to the crowding-out effect of signalling, the larger the sales advantage received from signalling of the certification, the greater the loss of productivity. Based on the arguments above, we have the following hypothesis:

H2: *Service firms with earlier certification of ISO 9000 standard have larger sales advantage and larger reduction in productivity.*

3.3. Technological Intensity

According to Terlaak and King (2006), the signalling effect is stronger if buyers have greater difficulty in acquiring information on the quality attributes of a product or service [8]. As service with higher technology intensity generally involves more knowledge that is advanced and has more complicating procedures, the quality of high-tech service is more difficult to observe since more advanced knowledge and complicated procedures are required and the information asymmetry between providers and buyers is more serious. Therefore, we expect ISO 9000 certification has a more pronounced signalling effect in generating additional sales in service industries that are more high-tech intensive.

The crowding-out effect on the other hand is larger since the problem of asymmetric information is more serious in high-tech related service industries. While the potential improvements of productivity are likely to be greater for service firms that can gain more synergies in daily operations when the ISO 9000 standard is successfully implemented. Escanciano et al. (2002) suggest high-tech firms are more used to manipulating complex techniques and it is easier for them to accommodate their working procedures to the requirements of ISO 9000 standard [37], which indicate that ISO 9000 certification can provide lager productivity improvement in industries of higher technology intensity. For service firms from a more technologically intensive environment, they are likely to obtain higher level of synergies

by adjusting their quality management system according the ISO 9000 standard, which derives a higher level of potential productivity improvement. Therefore, we posit the following hypothesis to be tested:

H3: *ISO 9000 certified service firms with higher level of technological intensity have larger sales advantage and smaller productivity loss.*

In H1 and H2, the signalling effect of the certification brings additional sales and can assist in increasing profits. However, productivity loss due to the crowding-out effect of signalling may lead to a decrease of firms' profitability. Moreover, the certification and compliance of the ISO 9000 standard is costly in developing countries [38]. Therefore, the relationship between the profitability of Chinese service firms and their ISO 9000 certification remains unclear. We have no idea which effect dominates. Therefore, we propose the following hypotheses:

H4A: *Service firms certified with ISO 9000 standard have higher profitability.*

H4B: *Service firms certified with ISO 9000 standard have lower profitability*.

In the following sections, we will verify the proposed hypotheses.

4. Empirical Strategy

4.1. Data

We combined two sources to obtain firm-level data for the empirical analysis: (1) the Second Economic Census Survey of China on Service Industries in 2008 and (2) the information query platform on the website of Certification and Accreditation Administration of China (CAAC). Though The National Bureau of Statistics of China conducted the Third National Economic Census survey in 2013, firm-level data were not accessible at the time we conducted this research. Thus, the database from 2008 is the most updated one we could access to study the large sample of service firms in China. The dataset of the census provides detailed information of 411,154 service firms, which includes names, addresses, number of employees, four-digit SIC code of each service firm and a series of financial indicators. By searching with firm names and crawling data with a Java-based program, we obtained certificate numbers and other relevant information (such as expiry date, the issuing agencies, and coverage of the certificates) of each service firm that voluntarily participated in the certification (including ISO 9000, ISO 14001 and so on) from the information query platform. In our study, service firms with the certificates labelling "ISO 9000" and "ISO 90001" are both regarded as "ISO 90000 certified". To eliminate noise from respective certification, former studies generally examined the effects of initial certification on firms [7]. Similarly, we kept 9253 firms that obtained their initial ISO 9000 certification during 2005–2008 as the treatment group, and 394,624 firms that have no records of certification as our control group.

In this study, we employ the Propensity Score Matching approach to find suitable matches of the certified service firms in the control group. In order to be able to find suitable matches for all exposed subjects, the number of controls available needs to be greater than the number of exposed subjects, and the ratio of such differences is typically in the range of 2–20. To achieve that, we selected firms from 35 major cities across China as 59.6% of Chinse service firms are from these cities, and these 35 major cities are home of 82.2% of the certified service firms. We also deleted firms that have less than eight employees from our dataset because such firms often operated without reliable accounting records. After eliminating firms with missing values and outliers, we obtained a firm-level dataset consisting of 89,024 service firms, and 6071 (6.82%) of them were certified with ISO 9000 standard. Our final dataset can be regarded as a massive survey on ISO 9000 certification. Most firms in the sample are small- and medium enterprises (SMEs). Ninety percent of them hired no more than 70 employees, and nearly 75% of them had total assets valued less than 8 million RMB in 2008. Table 2 presents the composition of the sample according to their subsectors.

Table 2. Distribution of the service firms after selection by industry.

Industry Code	Sector Description	After Selection	Certified Firms	Certification Coverage
58	Warehousing	2651	134	5.05%
60	Telecommunications services	2532	143	5.65%
61	Computer services	6713	655	9.76%
62	Software	8920	1194	13.39%
74	Business Services	45,538	936	2.06%
75	Research and Experiment Services	2557	265	10.36%
76	Professional Technique Services	14,174	2152	15.18%
77	Technology exchange and promotion	5939	592	9.97%
Total	8 service sectors	89,024	6071	6.82%

4.2. Analytical Approach

Randomized controlled trials (RCTs) are considered the gold standard approach for estimating the effects of treatments, interventions and exposures on outcomes and random treatment allocation ensures that treatment status will not confounded with either measured or unmeasured baseline characteristics [39]. If there are selection bias concerning the certification, the results of ordinary regression estimation may also be biased. By constructing a comparison group that shares common characteristics of the certified group, the new sample of service firms can be used to form a near-to-randomized experiment. In this study, we use Propensity Score Matching to conduct a counterfactual experiment and investigate the financial effects of certification. The goal of using it is to approximate a random experiment and estimate the average treatment effect on the treated (ATET), eliminating many of the problems such as selection bias and endogeneity with RCTs in data analysis.

Given a sample of subjects and a treatment, each subject has a pair of potential outcomes: $Y_i(0)$ for outcome under control treatment and $Y_i(1)$ for outcome of active treatment. Let Z be the indicator denoting the treatment received. The observed outcome can be expressed as: $Y_i = Z_i Y_i(1) + (1 - Z_i) Z_i(1)$. For each subject, the average treatment effect (ATE) is defined as $E[Y_i(1) - Y_i(0)]$, while the average treatment effect on the treated (ATET) is defined as $E[Y_i(1) - Y_i(0) \big| Z_i = 1]$. The ATE is the average effect, at the population level, of moving an entire population from untreated to the treated and The ATET is the average effect of treatment on those subjects who ultimately received the treatment. In estimating the financial effect of ISO 9000 certification, the ATT is more effective for us as we are interested in firms certified with the standard.

The Propensity Score Matching method unitize the probability of treatment assignment conditional on observed baseline covariates to simulate the random assignment of treatment and control groups by matching treated subjects to untreated subjects that were similarly likely in the same group. So it is effective in estimating ATET and underlying the causal effect of treatment variable and it has also been applied to a number of studies with cross-sectional data [40,41]. In our case, the propensity scores of each firm is estimated using the logit model:

$$p(X) = P[certification = 1|X] = E[certification|X] \tag{1}$$

where $p(X)$ denotes the probability of a firm being certified, and X is a vector of observable characteristics that affect the firm's certification. *Certification* is a dummy variable denoting the certification status, and it equals to 1 if a firm is certified, otherwise the number is zero. The Average Effect of Treatment on the Treated (ATET) of ISO 9000 certification on financial performance can be expressed as:

$$\begin{aligned} ATET &= E[Y_{1i} - Y_{0i} \big| certification_i = 1] \\ &= E\{E[Y_{1i} - Y_{0i} \big| certification_i = 1, p(X_i)]\} \\ &= E\{E[Y_{1i} \big| certification_i = 1, p(X_i)] - E[Y_{0i} \big| certification_i = 0, p(X_i)]\} \end{aligned} \tag{2}$$

where Y_{1i} and Y_{0i} represent financial performances of firms in the treatment group and control group respectively. We form matched sets of certified and uncertified firms when they share similar value of propensity score. We use four approaches: the nearest neighbors matching, the radius matching, the kernel matching, and the local linear regression matching to generate the control groups matched. Denote that the matched control group for the certified firm i with characteristics x_i as the set $A_j(X) = \left\{j \middle| X_j \in c(X_i)\right\}$, where $c(X_i)$ is the characteristics neighborhood of X_i. Let N_T denote the number of certified firms in the treatment group and let $w(i,j)$ denote the weight given to jth firm in making a comparison with the ith certified firm,$\sum_j w(i,j) = 1$,where $0 \le w(i,j) \le 1$ and $\{Z = 1\}$ is the set of treated certified firms, and i is an element of the set of matched comparison units. Different matching estimators are generated by varying the choice of $w(i,j)$. Then the general formula for the matching ATET estimator is:

$$ATET = \frac{1}{N_T} \sum_{i \in \{Z=1\}} [y_{1,i} - \sum_j w(i,j) y_{0,j}] \quad (3)$$

Jalan and Ravallion (2003) suggest that the Propensity Score Matching method can allow an assessment of behavioural responses without pre-intervention baseline data and conduct randomization on a condition that both treatment and comparison groups come from the same environment and are given same survey instrument [42]. Our dataset satisfies this condition. In this study, we have three outcome variables: sales (*lnsale* for logarithm of gross sales), productivity (*lp* for labor productivity) and profitability (*ros* for return on sales). We measure labour productivity with the logarithm of value added per employee. The control group is created based on the estimated propensity score, and the variable vector includes the factors that affect both the treatment and outcome variables [39,43]. Existing studies find that including variables that only affect exposure, but not outcome, would increase the variance of the estimated treatment effect [44,45]. Following the procedures suggested by Austin (2011), we include variables that affect both the treatment exposure and the performance outcomes to estimate the propensity score [39]. Another underlying principal is that these variables should not be influenced by the ISO 9000 certification. We also select variables reflecting relatively stable characteristics of the service firms.

The decision for a service firm to be certified is influenced by the characteristics of the firm. As larger firms face a lower cost of certification in terms of the unit of output [46,47], we expect that ISO certification be positively related to the size of the firms. The certification with ISO 9000 standard requires substantial financial resources to acquire and maintain the standard of certification [48]. Therefore, firms' capabilities to handle finance debt and meet long-term financial obligations are critical for certification. Thus, the likelihood for a firm to be certified is inversely related with the debt–asset ratio of the firm. Moreover, the success of certification is dependent on how employees perceive, accept, and communicate the new practices [49]. Liu et al. (2010) also reveal that firms' learning capacity can also affect a firm's ability to implement the requirements of international certification [50]. Since human capital is an important factor for learning capacity, we expect that firms with more employees who have college degrees would have a better understanding on ISO 9000 standard and more likely to adopt the certification. As the propensity of being certified is also positively related to the age of firms [51], we also introduce firm age in our propensity score estimation model. Moreover, firms with high management efficiency tend to apply for the certification [25]. In this study, management efficiency is measured by management cost divided by total sales, which is negatively related to the management efficiency of the firms.

The external pressures from the operating environment can also affect firms' decisions to go for certification. We have three variables concerning the operating environment of service firms in China. The first one is the level of industrial competition in the city—which is measured by the Herfindahl–Hirschman index at the 2twodigit SIC industry level in every city. The second variable is the regional market scale of the firms and we measure it with the proportion of manufacturing production in GDP of each city. The third variable is industrial openness, which is estimated by the

proportion of foreign ownership in total equity of each four-digit SIC industry. Moreover, we also use dummy variables to capture the two-digit industry fixed effects and provincial fixed effects. Table 3 reports the descriptive statistics for the variables in the empirical analysis.

Table 3. Descriptive statistics of entire sample.

	Variable	Coding of Variables	Min	Max	Mean	S.D.
Individual	*lnsale*	Sales: Natural logarithm of the main business revenue	3.584	9.953	7.9256	1.4229
	lp	Productivity: Labour productivity measured by logarithm of value added per employee	−4.801	10.963	4.0786	1.0190
	ros	Profitability: Return on sale	−0.399	0.554	0.0993	0.1843
	certification	ISO 9000 certification: The incidence of certification in the firm	0.000	1.000	0.0682	0.2521
	size	Firm size: Natural logarithm of the total assets	0.000	18.156	8.0092	1.8558
	lev	Financial condition: Asset-debt ratio	0.000	0.913	0.4068	0.3101
	resource	Employee involvement: Proportion of employees with college diploma	0.000	1.000	0.2955	0.2437
	management	management efficiency: Management cost divided by total sales	0.023	0.901	0.3911	0.3144
	ownership	Ownership: 1 if owned by foreign capital	0.000	1.000	0.0421	0.2008
	age	Age: Natural logarithm of the survival length of the firm	0.000	4.094	1.6512	0.7601
	div	Business diversification: Natural logarithm of active operating units of the firm	0.000	5.656	0.0599	0.2948
Industrial	*open*	Industrial openness: Foreign capital to total equity ratio in the industry	0.000	0.687	0.1636	0.1175
	HHI	Competition Level: Herfindahl–Hirschman Index based on sales by two-digit industries within each city	0.007	1.000	0.0756	0.1156
	intel	Technology Intensity: Proportion of intermediate inputs from high technology industries	0.051	0.365	0.2785	0.0554
Regional	*rms*	Regional market size: Proportion of secondary industry output value	25.600	57.840	42.83	9.114

Note: Technology intensity is calculated based on the Input-output Table of China 2007. We will use it to define higher technology intensity industries and lower technology intensity industries. S.D.: stands for standard deviation.

Along with the Propensity Score Matching, the Coarsened Exact Matching (CEM) and OLS regression are used as robustness checks. The Coarsened Exact Matching works well without requirements on assumptions about the data generation process. It dominates the existing commonly-used matching methods in its ability to reduce imbalance, model dependence, estimation error, selection bias and some other criteria [52,53]. Similar approaches have been applied in previous studies on quality management program and financial performance [54], ISO 9000 certification and firm process compliance [35]. In this study, we match each of the certified firms with one non-certified firm for comparison. Then we conduct the OLS regression analysis for the robustness test.

5. Results and Discussion

5.1. Estimation Results Based on the Propensity Score Matching Method

Table 4 reports the estimated results of firms' propensity of certification. The estimated results show the probability of being certified positively relate to the size of a firm. This finding suggests that larger firms are more willing to adopt the certification. Management efficiency is also positively related to the propensity of certification. There is also a positive relationship between firm age and the certification. Human resource endowment is an important determinant for certification with the ISO

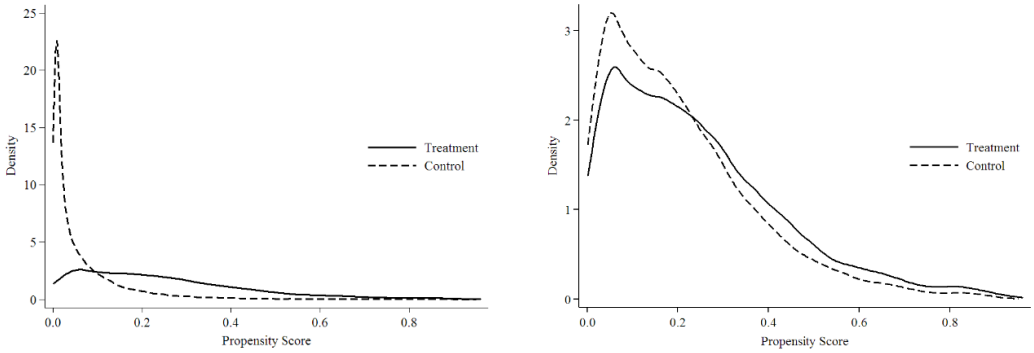
9000 standard. In contrary to our expectation, foreign ownership (*foreign*) seems to have a significantly negative relation with the certification. A possible explanation is that foreign ownership can also be a signal for the superior quality in China. Using the results of the logit model in Table 4, we then calculate the propensity score of each firm to compose a matched sample for comparison study.

Table 4. Predicting propensity of ISO 9000 certification (logit model).

Variables	Estimates	Z-stat
size	0.4288***	52.84
lev	−0.3684***	−7.32
resource	0.5855***	9.34
management	−0.4499***	−8.67
ownership	−0.7341***	−10.23
age	0.6285***	27.86
div	0.0406	1.05
rms	−0.0224***	−14.46
open	−1.0144***	−4.32
HHI	−0.0688	−0.38
Two-digit industry fixed effect	Yes	significant
Region fixed effect	Yes	significant
Constant	−6.8944***	−42.87
Pseudo R^2	0.2314	
N	89024	

Note: *, ** and *** represent significance at 10%, 5% and 1% level, respectively.

Before applying the matching procedures, we need to ensure that the common observable characteristics shared by firms in our treatment and control groups are the same. Figure 1 shows the distribution of propensity scores in both control and treatment groups before and after matching. The two groups are substantially different in terms of the distribution of their propensity scores before matching, but become more similar after matching. Such a change indicates that the Propensity Score Matching method is effective in reducing selection bias.



(**a**) Pre-matching (**b**) post-matching

Figure 1. Kernel density of treatment and control groups.

Following Dehejia and Wahba (2002) and Smith and Todd (2005), we also examine whether the Propensity Score Matching is able to balance the covariates [55,56]. Table 5 reports the results of the balancing test. All of the covariates except for *foreign* of the treatment group and the comparison group were significantly different in means before the matching process but they are very similar after matching. For the variable *foreign*, it has become more unbalanced. However, the increased unbalance is tiny as it increased from 0.8% to −2.4% and the two group are still balanced in *foreign* (absolute value of mean difference test estimator increased from 0.62 to 1.30, and no significant difference was

found), which means that the matching method is capable of building a counterfactual experiment for treatment effect estimation.

Table 5. Balancing tests for propensity score matching.

Variable	Unmatched	Mean		Reduced Bias		T-Test
	Sample	Treated	Control	%Bias	Absolute Bias%	
size	Pre-matching	9.5776	7.8944	96		70.08
	Post-matching	9.5776	9.6617	−4.8	95	−2.32
lev	Pre-matching	0.4199	0.4059	4.8		3.39
	Post-matching	0.4199	0.4222	−0.8	83.4	−0.45
resource	Pre-matching	0.3363	0.2926	18.6		13.51
	Post-matching	0.3363	0.3372	−0.4	97.8	−0.22
management	Pre-matching	0.3380	0.3950	−19.4		−13.67
	Post-matching	0.3380	0.3426	−1.6	91.9	−0.92
foreign	Pre-matching	0.0437	0.0420	0.8		0.62
	Post-matching	0.0437	0.0486	−2.4	−199.4	−1.30
age	Pre-matching	2.0858	1.6194	65.5		46.72
	Post-matching	2.0858	2.0866	−0.1	99.8	−0.06

Based on the estimated propensity scores, we apply four approaches to generate the control group matched. We match each firm in the treatment group with firms in the control group according to the closeness of their propensity scores, and the Average Treatment Effect is estimated with difference in means between the two groups. Table 6 reports the financial effects of ISO 9000 certification on the three outcome variables (*lnsale* for sales, *lp* for productivity and *ros* for profitability). The results show that the ISO 9000 certification significantly improves the sales of service firms (on average 0.43 higher) indicating that service firms can gain some significant advantages of sales from the certification. At the meanwhile, the labour productivity of these certified firms seemed to decrease (on average 0.17 lower) compared to their non-certified counterparts. Thus, the estimated results in Table 6 support our H1, indicating the existence of productivity crowding-out effect of signalling. This result implies that firms cannot obtain long-term productivity advantage by implementing the standard.

Table 6. Average treatment effects estimated with different matching approaches.

Variables	Nearest Neighbors Matching		Radius Matching			Kernel Matching	Local Linear Regression Matching
	1 Neighbour	3 Neighbours	$r = 0.001$	$r = 0.005$	$r = 0.01$		
lnsale	0.4143***	0.4088***	0.4247***	0.4223***	0.4251***	0.4878***	0.4521***
	(14.54)	(17.82)	(21.52)	(21.58)	(21.84)	(25.46)	(15.87)
lp	−0.1707***	−0.1775***	−0.1752***	−0.1710***	−0.1731***	−0.1408***	−0.1609***
	(−7.68)	(−10.14)	(−11.83)	(−11.62)	(−11.81)	(−9.73)	(−7.24)
ros	−0.0328***	−0.0332***	−0.0329***	−0.0326***	−0.0331***	−0.0332***	−0.0339***
	(−9.17)	(−11.68)	(−13.18)	(−13.20)	(−13.500)	(−13.78)	(−9.48)

Note: *, ** and *** represent significance at 10%, 5% and 1% level, respectively. T statistics are in parenthesis.

We also find a reduction of profitability (on 0.033 average lower) associated with the certification, which supports H4B. It implies that the positive effect of additional sales brought by the certification cannot compensate for the negative effect of decreasing productivity, resulting in the reduction of overall profitability for the firms. It seems that firms' pursuit for signalling benefits leads to the undesirable result of profit reduction, which is not favourable for long-term development of certified firms. Vermeulen (2018) argues that a poor management practice can still prevail when it has a spurious association with success, ambiguous long-term effect on firms and a higher diffusion rate [57]. ISO 9000 certification experienced quick diffusion since its introduction in 1987 and it is widely believed

that implementing the certification can improve productivity of the adopting firm, which may cover the fact that the certification can do harm to the long-term growth of the firms.

5.2. Robustness Test

One of the ways to ensure the financial effects is to run a similar randomized experiment. We use the Coarsened Exact Matching and OLS regression to run a robustness test. To partially address our concerns on selection bias and create a matched control group with coarsened exact matching, we choose the following three classes of factors for coarsening: (1) The two-digit code of service industries, (2) regional areas, the 30 provinces in mainland China are divided into three regional groups: Eastern China, Central China and Western China. (3) Three variables (*size, foreign, age*). We select these three variables based on their outstanding significance in affecting the propensity of service firms to attain ISO 9000 certification. The matching process follows the Sturge's Rule [58], and each certified firm is matched with one firm in the control group.

In Table 7, we report the summary statistics on the three variables before and after matching. The results show that the comparison group shares similar characteristics with the certification group in terms of *firm size, foreign ownership* and *age*, suggesting that the Coarsened Exact Matching is effective in reducing selection bias.

Table 7. Balancing test after coarsened exact matching approaches.

Variables	Certified: *Certification* = 1			Non-Certified: *Certification* = 0		
	Mean	**S.D.**	**Obs.**	**Mean**	**S.D.**	**Obs.**
size	9.1965	1.4448	4805	9.1958	1.4452	4805
foreign	0.0258	0.1586	4805	0.0258	0.1586	4805
age	2.0092	0.5930	4805	2.0069	0.5926	4805

Note: S.D. for standard deviation and Obs. for number of observations.

We estimate the impacts of ISO 9000 certification with OLS regression and the model of specification can be expressed as follows:

$$Y_i = \beta_0 + \beta_1 certification_i + X_i'\gamma + \lambda_j + v_r + \varepsilon_i \quad (4)$$

where i,j and r are subscripts, representing the firm's two-digit SIC industry code and regional classification. Y_i stands for the dependent variables, such as sales, labour productivity and profitability. *Certification* is the key explanatory variable in this model. X_i represents a vector of control variables. The estimated results in Table 8 show that the coefficients of the variable certification are significant and they are consistent with results in Table 6.

Table 8. Robustness test on the financial effects of ISO 9000 certification.

	(1)	**(2)**	**(3)**
	Lnsale	***Lp***	***Ros***
certification	0.367***	−0.122***	−0.0290***
	(20.55)	(−7.15)	(−9.18)
size	0.541***	0.310***	0.0125***
	(81.36)	(48.72)	(10.62)
lev	0.158***	−0.274***	−0.0875***
	(5.06)	(−9.16)	(−15.78)
resource	0.159***	0.180***	0.00373
	(4.04)	(4.79)	(0.53)

Table 8. *Cont.*

	(1)	(2)	(3)
	Lnsale	***Lp***	***Ros***
management	−1.228*** (−38.82)	−0.672*** (−22.24)	−0.192*** (−34.34)
ownership	0.368*** (6.50)	0.308*** (5.69)	−0.0183* (−1.82)
age	0.0846*** (5.24)	−0.0680*** (−4.41)	−0.0154*** (−5.38)
div	0.214*** (7.89)	−0.186*** (−7.18)	−0.0113** (−2.35)
rms	−0.00580*** (−6.28)	−0.00443*** (−5.01)	0.00143*** (8.73)
open	−0.0987 (−0.69)	0.442*** (3.25)	0.0228 (0.90)
HHI	−0.285** (−2.27)	−0.302** (−2.52)	−0.0126 (−0.57)
constant	4.067*** (34.97)	2.057*** (18.51)	0.0647*** (3.14)
N	9610	9610	9610
R^2	0.552	0.273	0.168

Note: *, ** and *** represent significance at 10%, 5% and 1% level, respectively. T statistics are in parenthesis.

5.3. Further Investigation: Certification Time and Technology Intensity

In order to test H2, we divide the certified firms into two groups: the earlier certified group (2005–2006) and the later certified (2007–2008). Then, in order to form counterfactual experiments, we match comparative firm(s) to each certified firm from both the earlier and later certified groups. By applying the propensity score matching, we use seven different approaches to estimate treatment effects of certification. The estimation results are reported in Table 9.

Table 9. Treatment effects of earlier certification and later certification.

		Nearest Neighbors Matching		Radius Matching			Kernel Matching	Local Linear Regression
		1 Neighbor	3 Neighbors	*r* = 0.001	*r* = 0.005	*r* = 0.01		
lnsale	Later certifiers (2007–2008)	0.3829*** (9.83)	0.3826*** (12.51)	0.4028*** (15.62)	0.4064*** (15.79)	0.4153*** (16.20)	0.6109*** (24.29)	0.4482*** (11.51)
	Earlier certifiers (2005–2006)	0.4396*** (11.82)	0.4574*** (15.37)	0.4617*** (18.06)	0.4657*** (18.35)	0.4727*** (18.76)	0.584*** (23.67)	0.5128*** (13.790
lp	Later certifiers (2007–2008)	−0.1141*** (−3.86)	−0.1343*** (−7.06)	−0.1343*** (−7.06)	−0.1339*** (−7.01)	−0.1299*** (−6.81)	−0.0338* (−1.80)	−0.1192*** (−4.03)
	Earlier Certifiers (2005–2006)	−0.1517*** (−5.24)	−0.1637*** (−7.08)	−0.1781*** (−9.08)	−0.1745*** (−8.93)	−0.1713*** (−8.80)	−0.1165*** (−6.10)	−0.154*** (−5.32)
ros	Later certifier (2007–2008)	−0.0323*** (−6.70)	−0.0333*** (−8.73)	−0.0314*** (−9.76)	−0.0316*** (−9.88)	−0.0316*** (−9.94)	−0.0314*** (−10.10)	−0.0329*** (−6.82)
	Earlier certifiers (2005–2006)	−0.0298*** (−6.48)	−0.0317*** (−8.60)	−0.0328*** (−10.08)	−0.0327*** (−10.14)	−0.0327*** (−10.26)	−0.0327*** (−10.51)	−0.0334*** (−7.26)

Note: *, ** and *** represent significance at 10%, 5% and 1% level, respectively. T statistics are in parenthesis.

The estimation results based on the two subsamples shows certified firms' gain in sales and their reduction in productivity, which are consistent with H1 and H2. Moreover, the reduction associated with certification on profitability is also identified, which supports H4B. It does not matter which

one of the matching approaches is used, the results show that the earlier a firm attained ISO 9000 certification, the larger the increase on their sales, whereas, a larger reduction in productivity would also occur. Such results supports H2. The possible explanation may be that the earlier a firm attains certification, the easier it can develop vertical differentiation advantages through signalling. While the larger increase in sales from signalling, the larger the productivity reduction generated from the crowding-out effect.

In order to test H3, we conducted an investigation on whether industrial technology intensity can moderate the financial impacts of ISO 9000 certification. By using the Input–Output Table of China 2007, we match each service industry with a high-tech manufacturing industry by calculating their proportion of intermediate inputs as the indicator to distinguish high-tech service industries and low-tech service industries. Then we divide the entire sample into two subsamples according to the proportion: High-tech intensive service industries, which are service industries with the proportion of high-tech intermediate inputs higher than the average, and low-tech intensive service industries, which are the rest of the service industries. The financial effects of certification on each subsample are estimated via Propensity Score Matching methods similar to the previous section.

Table 10 reports the estimated results. The sales advantage associated with the certification is higher in high-tech intensive service industries. A possible explanation is that the problem of information asymmetry is more serious in these industries where the signalling effect plays a more important role. The reduction of productivity associated with the certification is smaller in the group of higher technology intensity. One of the possible explanations is that compliance with the ISO 9000 standard in high-tech intensive service industries can generate more potential productivity improvement, which compensates for the loss of productivity due to the crowding-out effect of signalling. With the results in Table 10, H3 is supported. It is also interesting to find that certified firms in high-tech service industries experience larger decline in profitability. It can be explained that the firms of higher technology intensity need to devote more resources to systemize their managerial procedures and adjust to the new practices, which leads to higher short-term operating costs.

Table 10. Treatment effects in higher and lower technology intensity industries.

		Nearest Neighbours Matching		Radius Matching			Kernel Matching	Local Linear Regression
		1 Neighbour	**3 Neighbours**	***r* = 0.001**	***r* = 0.005**	***r* = 0.01**		
lnsale	Higher	0.4725***	0.4682***	0.4909***	0.4922***	0.4999***	0.6396***	0.5600***
		(10.78)	(13.34)	(16.23)	(16.48)	(16.91)	(21.92)	(12.78)
	Lower	0.3578***	0.3631***	0.3688***	0.3645***	0.3625***	0.3961***	0.3803***
		(9.63)	(11.97)	(13.66)	(13.68)	(13.83)	(15.43)	(10.24)
lp	Higher	−0.1507***	−0.1726***	−0.1618***	−0.1533***	−0.1499***	−0.0752***	−0.1204***
		(−4.35)	(−6.35)	(−7.13)	(−6.80)	(−6.66)	(−3.38)	(−3.48)
	Lower	−0.1912***	−0.184***	−0.1706***	−0.1784***	−0.1759***	−0.1528***	−0.1613***
		(−6.84)	(−8.09)	(−8.54)	(−9.04)	(−9.04)	(−7.99)	(−5.77)
ros	Higher	−0.036***	−0.0381***	−0.0362***	−0.0356***	−0.0356***	−0.0348***	−0.0346***
		(−6.75)	(−9.05)	(−9.87)	(−9.84)	(−9.97)	(−9.92)	(−6.48)
	Lower	−0.0362***	−0.0334***	−0.031***	−0.0318***	−0.0317***	−0.0304***	−0.0310***
		(−7.47)	(−8.56)	(−8.76)	(−9.17)	(−9.33)	(−9.17)	(−6.40)

Note: Here, "Higher" for higher technology intensity industries and "Lower" for lower technology intensity industries. *, ** and *** represent significance at 10%, 5% and 1% level, respectively. T statistics are in parenthesis.

6. Conclusions

In this study, we examined the financial effects of certification from three different aspects: sales, productivity and profitability. We used a sample of 89,024 service firms in China and employed the Propensity Score Matching method to address the concerns of selection bias and the coarsened exact

matching for a robustness check. We demonstrated through the empirical evidence that the certification has a negative effect on the productivity of Chinese service firms due to the crowding-out effect of signalling, which has a negative effect on the sustainable development of the firms. In particular, the negative effect is stronger for the earlier certified firms, and it is weaker if the firms have a higher technology intensity. Our study also reveals that the profitability of Chinese service firms is negatively related to their application of certification. Our work enriches the existing literature of assessing the effects of ISO 9000 certification on firms' financial performance. By focusing on the Chinse service firms, it also fills the gap that very few studies have investigated the financial effects of the certification on service firms in developing countries before.

The findings of this study have important implications for public policies. Many existing studies have stressed the benefits of ISO 9000 certification, however, there is only one benefit, the sales advantage, identified in our study. Our findings reveal that ISO 9000 certification does not effectively improve every aspect of performance for its certifiers. The ISO 9000 standard was designed to improve productivity of its certified firms but, in developing countries, it may only be used as a signalling tool due to the institutional weakness in these markets. Therefore, the improvement of institutional infrastructure in developing countries is needed in order to fulfil the initial purpose of certification on improving firms' productivity as designed. The findings of this study also indicate that managers should be cautious when considering adopting the ISO 9000 certification since there are possible negative effects on firms' productivity and profitability.

Our study has limitations, and some of them offer some opportunities for future research. Firstly, as illustrated in Section 3, our dataset is constructed based on the Second Economic Census of China in service firms in 2008 and certification information from the CAAC website. Although we use matching methods to generate the comparison group that share similar observable characteristics with the certification group, the use of cross-sectional data may still weaken the conclusions. Secondly, the limited generalizability of our findings may be another potential shortage of our paper. Our results are based on dataset that only focuses on the service industries of one country (China). Due to different cultural characteristics and levels of economic development across the world, the impacts of the ISO 9000 certification may vary from country to country. In addition, if data from the Economic Census Survey in 2013 are available in the future, further comparative study can be conducted. Since the dataset only pertains the period of certification between 2005 and 2008, some more interesting findings may also be drawn by using panel datasets of different periods.

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