

ISO 9001 certification and corporate performance of Italian companies

ISO 9001
certification

Maurizio Galetto, Fiorenzo Franceschini and Luca Mastrogiacomo
*Department of Management and Production Engineering,
Politecnico di Torino, Torino, Italy*

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Abstract

Purpose – The purpose of this paper is to verify a possible relationship between quality management system certification according to ISO 9001 standard and risk of failure of Italian companies.

Design/methodology/approach – A synthetic index which summarize the most crucial economic/financial aspects of the studied companies is assumed as the response variable of a statistical model for studying the effects of four specific factors: certification, company size, regional development and manufacturing sub-sector. The analysis is conducted on a sample of Italian companies belonging to different manufacturing sub-sectors. The used data are obtained from the database Aida[®] by Bureau van Dijk and from the database of the Italian accreditation body Accredia. The study is based on analysis of variance (ANOVA) and contingency tables.

Findings – Preliminary results of ANOVA show that only company size, regional development and manufacturing sub-sector can be considered fully significant. Furthermore, the major conclusion from the analysis of contingency tables is that ISO 9001 certification is connected to the legal status (active, not active) of a company only for a portion for the studied manufacturing sub-sectors. Hence, the scenario is quite variegated and a significant positive interaction between certification and corporate performance is not always confirmed.

Research limitations/implications – Although the research shows some interesting results, it is liable to extensions and improvements. In particular, at the current exploratory level, it is limited to a specific period of time and considers only the Italian sector, but it could be extended to a wider number of years and to European and international level.

Practical implications – The study opens a way for a number of important questions about the meaning, usefulness and effectiveness of ISO 9001 certification. In particular, it may be time to ask whether the paradigm of certification actually needs a radical rethink.

Originality/value – This work represents a first exploratory attempt to correlate the risk of failure with the achievement of ISO 9001 certification. There are several similar works in literature which, however, focus mainly on sectorial aspects of the corporate background.

Keywords ISO 9001, Corporate performance, ISO 9000 standards, Quality certification, Risk of failure

Paper type Research paper

1. Introduction

The evolution of the concept of “quality” in company management systems has encouraged the development of several models that focus on the various aspects of the organizational process with different levels of involvement (Withers *et al.*, 1997). Quality certification has become a common practice, in particular ISO 9000 standards are one of the most diffused models in the world for the design, implementation, maintaining and certification of quality management system (QMS) (Franceschini *et al.*, 2006; Marimon *et al.*, 2009; Sampaio *et al.*, 2009, 2011a; Marimon *et al.*, 2010). Promoted by International Organization for Standardization, ISO 9000 series are a set of policies, rules and activities necessary for quality assurance of products and services provided by an organization, and may be applied to any kind of small, medium or large organizations either in the manufacturing or service (private or public) field. (ISO 9000, 2005; ISO 9001, 2008; ISO 9004, 2009; ISO 19011, 2011).

Organizations that operates according to ISO 9000 standards may obtain a “certification,” that is a formal acknowledgment that their QMS satisfies standards’ requirements.



Since the introduction of quality standards, many researchers and scholars have tried to find a link between certification and business performance, obtaining conflicting results. The question has been largely discussed in the scientific literature, an interesting cross-section of the situation referring to the old and new release of the standards has been depicted in the last surveys proposed by Dick *et al.* (2008), Sampaio *et al.* (2009), Karapetrovic *et al.* (2010), Rusjan and Alič (2010) and Kim *et al.* (2011).

The present work takes its origin from the need of verifying the existence of a possible relationship between the QMS certification according to ISO 9001 standard and the risk of failure (bankruptcy, liquidation, arrangement) of Italian companies in the period 2008/2010, marked by the beginning of a severe economic crisis.

The research is based on a statistical approach. A set of economic/financial indexes extracted from the balance sheet of the studied companies is used in order to give an aggregate expression of the performance profile of a company. Five macro-aspects of a company are analyzed: liquidity, profitability, leverage, solvency and activity.

Assuming as the response variable of the statistical model a synthetic index which summarize all these aspects, the effects of a specific set of multiple factors is studied. Certification, company size, regional development and manufacturing sub-sector are used as possible causes (factors) which contribute systematically to the variability of this response variable.

The analysis is conducted on a sample of Italian companies belonging to the manufacturing sector. The used data are obtained from the database Aida® by Bureau van Dijk (www.bvdinfo.com/) and from the database available on the website of the Italian accreditation body Accredia (www.accredia.it/). The process of analysis is developed in two phases: analysis of variance (ANOVA) and analysis of connection between qualitative variables through the use of contingency tables (Everitt and Dunn, 2010).

The paper is organized as follows: Section 2 presents a literature review and the main findings of the most recent studies of the field; Section 3 describes the proposed methodology, with particular attention to the explanation of the econometric model and the statistical tools used for the analysis; Section 4 is dedicated to the presentation and discussion of the obtained results; Conclusion and future work are reported in Section 5.

2. Literature review

Data published on “The ISO Survey of Management System Standard Certifications – 2013” show that, up to the end of December 2013, at least 1,129,446 certificates had been issued all over the world (ISO, 2014). The 2013 total represents an increase of 3 percent (+32,459) over 2012. Even if the global situation is close to reach a saturation level, for many countries the diffusion trend is still increasing. In particular, Italy, USA, Eastern-European and Asian countries (these latter introduced quality certification only in the recent years) are among the ones in continuous rising for number of certificates. The top three countries for the total number of certificates issued up to the end of 2013 were China, Italy and Germany, while the top three for growth in the number of certificates from 2012 to 2013 were Italy, India and USA.

Considering this wide diffusion of certification, which involves 187 countries in the world and every kind of organization, it does not surprise that a considerable number of researches is focused on the study of the causes and effects related to these standards. An accurate review of the current scientific literature has confirmed that many studies and researches have been conducted with reference to ISO 9000 standards.

By analyzing the most recent scientific publications concerning ISO 9000 standards and certification, it has been noticed that the most investigated topics are (Dick *et al.*, 2008;

Sampaio *et al.*, 2009; Karapetrovic *et al.*, 2010; Rusjan and Alič, 2010; Srivastav, 2010; Kim *et al.* 2011; Bell and Omachonu, 2011; Wu and Chen, 2012; de Vries *et al.*, 2012):

- the current diffusion of quality certification and its future trend;
- the reasons that drive an organization toward the acquisition of a certificate;
- the benefits and the obstacles/drawbacks; and
- the impact of the certification on the economic/financial performance and on the organizational process.

The research studies, focused on these topics, have been supported by different specific approaches, such as surveys, questionnaires, statistical analyses, financial and economic analyses, case studies, bibliographical reviews, etc.

Concerning the aim of the present work, particular attention has been dedicated to those researches related to the impact of quality certification on the performance of corporate companies.

The effectiveness of ISO 9001 certification in terms of improvement of organizational performance is still highly debated. Many researchers have tried to individuate with different empirical approaches the possible relationship between these two aspects. Some analyses demonstrated, by comparing the results obtained by certified and not certified companies, that the formers succeed in reducing defectiveness, reworking and guarantee costs, as well as showing high levels of customer satisfaction, profitability and productivity. Specifically, Yahya and Goh (2001) reported that certified companies take profits higher than not certified ones and a major awareness about quality and improvement of measuring systems. More recently, Koc (2007), studying a sample of certified and not certified companies, observed significant differences on the results obtained in some of the phases of the production process (product design, production planning, control, use of machinery and instrumentation, working and waiting times, lot sizing, raw materials inventory) and on some competition advantages (delivery results, volume flexibility, product variety and quality).

Teixeira Quirós and do Rosário Fernandes Justino (2013) in their comparative analysis of a sample of certified and not certified Portuguese companies showed that the sole significant differences between the two sets of companies are played by variables such as, customers relations, human resource management, strategic quality planning and even quality costs.

Conflicting conclusion have been obtained by an exiguous fringe of researchers: in particular Terziovski *et al.* (2003) reported that ISO 9001 certification is not positively correlated with customer satisfaction, while Rahman (2001) has not observed any different results between certified and not certified companies, in terms of organizational and financial variables.

If, according to the majority of the studies, a positive relationship between the implementation of quality management practices and organizational performance improvement may be proven, the conclusions reached about the effect of quality certification over business performance are still contradictory (Sampaio *et al.*, 2009).

A first study about this question was proposed by Hendricks and Singhal (1996), that empirically investigates the impact of winning a quality award on the market value of firms. The approach was based on the estimation of the mean abnormal change in the stock prices of a sample of firms on the date when information about winning a quality award was publicly announced. They noted that the abnormal returns generated by the quality award winning announcements provide a lower bound for the impact of implementing an effective quality award improvement program and their results showed that the stock market reacts positively to quality award announcements.

The studies that compare the economical/financial results of certified and not certified companies present very different and contradictory results. For example, Heras *et al.* (2002) demonstrated that the companies certified according to ISO 9001 standard obtain better results in comparison to not certified ones. On the contrary, Lima *et al.* (2000), in a comparative study of the two typology of companies, did not individuate any significant difference according to most of the analyzed financial/economic indicators.

An interesting conclusion is proposed by the work of Dick *et al.* (2008), according to which, although there is some evidence to indicate that QMS certification has some causal influence on business performance, there is also evidence for the existence of a substantial mechanism whereby better performing firms self-select to adopt certification. This has profound implications for interpreting business performance achievements associated with quality certification because the benefits found may well be inflated by the presence of this self-select mechanism.

Feng *et al.* (2008), even if demonstrated a positive and significant relationship between certification practices and operational performance in Australia and New Zealand-based manufacturing and service companies, did not find any significant relationship between these practices and business performance. Based on the analysis of a public database of Portuguese companies' financial information, Sampaio *et al.* (2011b) observed that companies with higher financial performance present a greater propensity to implement and certify their QMS. However, for some financial indicators, not certified companies present, on average, higher performance than those that are certified.

Similar results about business performance have been obtained by Martínez-Costa *et al.* (2008, 2009) concerning Spanish companies. On the contrary, Marín and Ruiz-Olalla (2011), by analyzing a sample of Spanish companies from the furniture sector, and using a different approach considering not only financial indicators but also the results of other activities that may eventually help the managers in improving the financial results of their companies, demonstrated the existence of a positive relationship between ISO 9000 quality certification and both quality results and operative results.

Downstream of this literature review, it can be affirmed that up to now the research about relationship between ISO 9001 certification and economic/financial performance has not lead to definitive results. The various methods used for conceptualizing and measuring the involved variables are one of the major causes that obstruct the univocality of the conclusions. The contradiction may also be due to the difficulty to establish a clear relationship between the certification effects and business results, because of the presence of other intermediate factors, such as, for example, productivity, image, customer satisfaction, etc., that in turn are affected by many variables and may influence the direct relationship between quality and financial results (Hardie, 1998).

In their survey, Sampaio *et al.* (2009) concluded that there are a multitude of variables that could influence a company's business financial performance, and thus it is very important to define a group of variables which must reflect the impact of QMS implementation over a company financial performance. Other important factors that may mislead the conclusions concerning the real impact of quality certification over financial results are activity sectors, size, geographical location, etc.

The goal of this work rises from the requirement of defining a role, in terms of economic/financial benefits, of ISO 9001 certification in the three-year period 2008/2010, that, have demonstrated by national databases, has been negatively marked by a very high percentage of "mortality" of Italian companies (www.infocamere.it).

Excluding from this study the analysis of the relationship cause/effect between certification and corporate success, the question to which the research tries to give an answer is: in what way did the companies that in the examined three-year period hold a certified QMS differentiate themselves from not certified ones?

3. The methodology

In order to produce an objective response to the risen questions a statistical approach has been implemented. The Altman indicator *Z*-score (Altman and Hotchkiss, 2005) has been used to give an aggregate expression of the economic/financial profile of a company. This index summarizes, through a single numerical value, five macro-aspects of a company: liquidity, profitability, leverage, solvency and activity. High values of *Z*-score indicate that the company is in a situation of stability and economic security, conversely, low values of *Z*-score signal that the company is at risk of failure.

Assuming as response variable of the statistical model the risk of failure associated to the *Z*-score, the effects of a specific set of multiple factors (certification, company size, regional development and manufacturing sub-sector) have been studied.

The analysis has been conducted according to five distinct steps reported in Table I.

3.1 The *Z*-score as response variable of the statistical analysis

Z-score index is generally used for representing the economic/financial “health” of a company on the basis of a set of specific independent variables (“financial ratios”). This index represents a simple but powerful instrument for predicting the probability of success or failure of a company in the following two years after its computation (Altman and Hotchkiss, 2005).

A first version of the previsional model *Z*-score have been developed in 1968 by E.I. Altman using an approach based on multiple discriminant analysis (Lebart *et al.*, 1984). According to this method, a linear discriminant function, which transforms the individual variables into a single discriminant score (specifically, the *Z*-score), can be defined and used to classify companies.

Altman set and analyzed the economic/financial characteristics of two groups, respectively, constituted by bankrupt and active companies. He individuated five independent variables that were significant for the model and classified them into five standard categories: liquidity, profitability, leverage, solvency and activity.

The discriminant function obtained by Altman in the first edition of his model was (Altman, 1968; Altman and Hotchkiss, 2005):

$$Z = 0.012X_1 + 0.014X_2 + 0.033X_3 + 0.006X_4 + 0.999X_5 \quad (1)$$

where X_1 , working capital/total assets; X_2 , retained earnings/total assets; X_3 , earnings before interest and taxes/total assets; X_4 , market value equity/book value of total liabilities; X_5 , sales/total assets; Z , overall index (*Z*-score).

Phase	Description	Aim
Phase 1	Definition of the risk of failure associated to Altman's <i>Z</i> -score as the response variable for the statistical analysis	Summarizing in a unique index the economic/financial profile of a company
Phase 2	Data extraction	Extract an opportune set of data for the required statistical analysis
Phase 3	Preliminary descriptive analysis	Obtain a cross-section of certified companies in Italy subdivided by manufacturing sub-sector
Phase 4	ANOVA applied to the risk of failure (associated to the <i>Z</i> -score) as response variable and use of certification, company size, regional development and manufacturing sub-sector as influencing factors	Verifying if certification has a relationship with the risk of failure of Italian companies, out of the other three factors
Phase 5	Contingency tables applied to the legal status of a company and its condition of certification.	Verifying if the legal status is connected to the presence of the certification or not.

Table I.
Scheme of the steps followed for performing the present analysis

Variables X_1 through X_4 are expressed as absolute percentage values, while variable X_5 is expressed in a relative manner (Altman, 1968; Altman and Hotchkiss, 2005).

Since the original model was only applicable to publicly traded entities, in 1993 Altman revised his model and substituted in X_4 the “market value of equity” with the “book value of equity” (Altman, 1993; Altman and Hotchkiss, 2005). As a consequence of this correction, all the coefficients resulted to be changed. The obtained discriminant function was:

$$Z' = 0.717X_1 + 0.847X_2 + 3.107X_3 + 0.420X'_4 + 0.998X_5 \quad (2)$$

where X'_4 = book value equity/book value of total liabilities.

Further revisions of Z-score have been introduced during the years by Altman, but they are not considered in the present study since they do not fit the characteristics of the analyzed corporate sector (Altman *et al.*, 1995, 1977; Altman and Hotchkiss, 2005).

In general, according to the Z-score model, it is possible to classify a company on three different zones of risk: bankrupt zone, zone of ignorance (gray zone) and non-bankrupt zone. Furthermore, in the gray zone, a cutoff score between the two groups of companies (bankrupt and active companies) may be identified. Table II reports the different zones obtained with Z-score and Z'-score.

It is important to highlight that, even if the first introduction of the Z-score dates back to 1968, many successive studies have demonstrated the robustness and effectiveness of the model so that it is still widely applied in many contexts for the analysis of a company risk of bankruptcy (Altman and Hotchkiss, 2005). Recent studies have demonstrated good predictive effectiveness of Z'-score when applied to Italian market, though Italian peculiarities could require the development of ad hoc parameters (Altman *et al.*, 2013). In the statistical approach implemented in the present work, the analysis is specifically focused on the Italian manufacturing sector. Owing to that, for this exploratory study, the Z'-score is used, which is most representative for this commodity sector and represents an appropriate variable for the statistical analysis.

In order to better interpret the Z'-score meaning and to avoid heteroscedasticity effects due to the significant non-linearity of this variable, the obtained values have been transformed in the corresponding values of risk of failure. The transformation has been obtained by applying a binomial logistic regression between Z'-score and the legal status (active, not active) of the analyzed companies (Hosmer and Lemeshow, 2000; Minitab®, 2014).

3.2 Factors considered for the statistical analysis

The goal of the analysis presented in this paper is to verify if the ISO 9001 certification may be considered one of the possible factors that systematically influence the risk of failure of a company. As well as certification, company size, regional development and manufacturing sub-sector have been investigated as three other possible factors that may affect company economic/financial performance. Hereafter there is a description of these four factors and the definition of the corresponding levels of variation.

Table II.
Representation of the classification zones according to Z-score and Z'-score, and corresponding values of cutoff

	Bankrupt zone	Grey zone	Non-bankrupt zone
Z-score (for publicly traded entities)	$Z \leq 1.81$	$1.81 < Z < 2.99$ (cutoff = 2.67)	$Z \geq 2.99$
Z'-score (for firms in the private sector)	$Z' \leq 1.23$	$1.23 < Z' < 2.90$ (cutoff = 2.67)	$Z' \geq 2.90$

Note: Representation of the classification zones according to Z-score and Z'-score, and corresponding values of cutoff

Source: Altman *et al.* (2013)

3.2.1 Certification. With certification it is intended that a company is in possession of a valid (i.e. not expired) ISO 9000 quality certificate. Three levels are defined for this factor:

- (1) not certified: companies that have never obtained a quality certification or that had it in the past, but it expired and has not been renewed in the triennium 2008/2010;
- (2) certified for less than three years: companies that obtained the certification for the first time in 2008, 2009 or 2010; and
- (3) certified for more than three years: companies that obtained certification before 2008 and that in the triennium 2008/2010 had a still valid certificate.

This classification aims at distinguish between certified and not certified companies in the considered triennium, making a further distinction for long run (i.e. for more than three years) and short run certified companies.

3.2.2 Company size. With factor company size it is intended the dimension of the company in terms of headcount and annual turnover (or annual balance sheet total). Four levels are defined for this factor:

- (1) micro;
- (2) small;
- (3) medium-sized; and
- (4) large.

The classification for the first three levels (see Table III) has been defined in accordance with the European Commission recommendation number 1,422 of May 6, 2003 (2003/361/EC). The two classification criteria are cumulative, that means that both of them must be satisfied. It is assumed that a large company is a company which does not fulfill any of the reported criteria.

3.2.3 Regional development. Company classification according to the regional development is obtained on the bases of Qualità Regionale dello Sviluppo (QUARS) indicator, which is a composite indicator specifically constructed for measuring the level of development of Italian regions (Gnesi *et al.*, 2010).

The variables concurring to the definition of QUARS are 41 and are grouped in seven dimensions: environment, economy and work, health, education and culture, rights and citizenship, equality of opportunity, and involvement. According to these dimensions, seven macro-indicators are defined, obtained by synthesizing the 41 original variables. QUARS is a single indicator obtained through a further synthesis of the seven macro-indicators and is used for region comparison. It is periodically calculated and compared with other indicators (such as Human Development Index, Gender Equity Index, Basic Capabilities Index, Footprint Index, etc.) produced by United Nations, ISTAT (Istituto Nazionale di Statistica), World Bank and Banca d'Italia (Gnesi *et al.*, 2010).

Referring to the scores reported in QUARS report 2010, and considering that positive values represent a score higher than the regional mean, while the negative ones corresponds

Company size	Headcount: annual work unit (AWU)		Annual turnover (€ million)		Annual balance sheet total (€ million)
Micro	< 10	And	< 2	Or	< 2
Small	< 50	And	< 10	Or	< 10
Medium-sized	< 250	And	< 50	Or	< 43

Source: European Commission (2003)

Table III.
Criteria for SME
(small-medium
enterprises) definition

to a lower score, in the present analysis the regional development factor has been defined according to two levels (Gnesi *et al.*, 2010):

- (1) positive: values higher than the mean; and
- (2) negative: values lower than the mean.

3.2.4 *Manufacturing sub-sector*. This last factor includes 23 levels corresponding to the sub-sectors of ATECO 2007 classification for manufacturing sector (see Table IV).

3.3 Data collection

Data collection for the statistical analysis presented in this work has been conducted in two different phases: as a first step a sample of Italian companies has been extracted considering general corporate information (register, economic, financial), in a second step for each company of the sample the presence of a ISO 9001 (2008) certification has been verified.

Data have been acquired from two sources: the database Aida® by Bureau van Dijk (www.bvdinfo.com) for general corporate information and the database of the Italian accreditation body Accredia (www.accredia.it) for certification information.

In the first phase of data collection, in order to select an appropriate and representative set of companies, the two following filters have been fixed (www.infocamere.it):

- (1) type of company: corporation (Srl, Srl unipersonale, Spa); and
- (2) commodity sector: manufacturing (according to ATECO 2007 codification).

The option of focalizing this first exploratory work on a single commodity sector (i.e. manufacturing) has been motivated by the fact that this sector has the widest presence

Sub-sector	Code
Manufacture of food products and Manufacture of beverages	C10/C11
Manufacture of tobacco products	C12
Manufacture of textiles	C13
Manufacture of wearing apparel	C14
Manufacture of leather and related products	C15
Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	C16
Manufacture of paper and paper products	C17
Printing and reproduction of recorded media	C18
Manufacture of coke and refined petroleum products	C19
Manufacture of chemicals and chemical products	C20
Manufacture of basic pharmaceutical products and pharmaceutical preparations	C21
Manufacture of rubber and plastic products	C22
Manufacture of other non-metallic mineral products	C23
Manufacture of basic metals	C24
Manufacture of fabricated metal products, except machinery and equipment	C25
Manufacture of computer, electronic and optical products	C26
Manufacture of electrical equipment	C27
Manufacture of machinery and equipment n.e.c.	C28
Manufacture of motor vehicles, trailers and semi-trailers	C29
Manufacture of other transport equipment	C30
Manufacture of furniture	C31
Other manufacturing	C32
Repair and installation of machinery and equipment	C33

Table IV.
Manufacturing sub-sectors according to ATECO 2007 classification

of factories in Italy. Hence it represents a significant area to be investigated. Future research will be extended also to other sectors.

The data extracted from Aida® are:

- legal status (active, not active);
- sub-sector (according to ATECO 2007 codification, 23 sub-sectors have been defined);
- register data (name of the company and legal address);
- complete balance sheet according to the scheme defined by the Fourth European Directive (European Council, 1978) and related financial indexes; and
- headcount.

Aida® database includes all the companies with a minimum turnover of €250,000, hence, according to this constraint, companies with an annual turnover lower than this threshold have not been considered in the present analysis. This condition excludes from the present analysis a set of micro enterprises of which the economic/financial profile is too weak for being considered significant for the study.

According to these constraints (turnover > €250,000, balance sheet registered in 2010, corporations and manufacturing sector), the considered sample was formed by 63,400 Italian companies.

In the second phase, the goal was to individuate, among all the companies in the sample, those having a valid quality certification according to ISO 9001 (2008) standard. In order to obtain this information, data have been extracted from Accredia database fixing the following filters:

- standard: ISO 9001 (2008);
- date of issue of the certificate: till the end of year 2010;
- commodity sector: manufacturing; and
- registered office: Italy.

The obtained sub-sample was composed by 12,082 certified companies. Data have then been matched with the information included in the sample extracted from Aida® database, obtaining the complete set of input data for the statistical analysis.

4. Results of the analysis and discussion

From a first rough descriptive analysis of the obtained data, it is possible to see that among the 63,400 companies with registered offices in Italy, that have been detected and analyzed, 19.06 percent of these are certified and, in particular, 5.27 percent attained a quality certification in the period from 2008 to 2010, while the remaining 13.79 percent got it before 2008.

In order to give a synoptic cross-section of the considered sector, a preliminary statistical analysis, based on frequency tables, has been performed considering data shared among the 23 sub-sectors of ATECO 2007 classification for manufacturing sector (see Table IV). This preliminary analysis has shown that these sub-sectors present many differences in terms of certification and risk of bankruptcy.

Table V reports the sub-sectors ordered according to the percentage of certified companies in 2010. For each sub-sector, this percentage is given by the ratio of certified companies over the total of companies included in the sub-sector. From Table IV it is possible to say that C24, C20 and C26 were the most certified sub-sectors in 2010.

Deepening the analysis, Table V also reports, for each sub-sector, the percentages of companies resulting certified in year 2010 that in year 2007 were, respectively, not certified, certified for less than three years and certified for more than three years, while Table VI reports the increase of the percentage of certified companies during the period of analysis.

Table V.

Italian manufacturing sub-sectors ordered according to the percentage of certified companies in year 2010 and their state of certification in 2007

Sub-sector (code)	Certified (in 2010) (%)	Not certified (%)	State of certification in 2007	
			Certified (< 3 years) (%)	Certified (> 3 years) (%)
C24	31.69	6.53	25.16	68.31
C20	31.31	6.31	25.00	68.69
C26	29.71	7.45	22.22	70.33
C22	27.48	7.21	20.21	72.58
C27	26.99	5.87	21.13	73.00
C29	26.28	6.89	19.39	73.72
C25	22.06	6.55	15.45	78.00
C23	19.99	6.94	13.02	80.04
C28	19.21	5.43	13.78	80.79
C10/C11	18.77	5.50	13.27	81.23
C33	17.38	5.90	11.49	82.61
C17	17.14	4.52	12.63	82.85
C19	15.69	3.92	11.76	84.32
C30	15.55	5.30	10.25	84.45
C21	14.36	2.27	12.09	85.64
C16	14.16	5.22	8.84	85.94
C31	12.58	3.65	8.90	87.45
C32	10.77	3.36	7.41	89.23
C18	10.30	2.63	7.67	89.70
C13	8.33	2.00	6.33	91.67
C12	5.56	5.56	0	94.44
C15	5.00	0.84	4.16	95.00
C14	3.13	1.20	1.93	96.87

Table VI.

Increase of the percentage of certified Italian companies in manufacturing sub-sectors in 2010

Sub-sector (code)	Certified (> 3 years) (%)	Certified (< 3 years) (%)	Net increase of certificates (%)
C12	0.00	5.01	5.01
C23	4.46	6.25	1.79
C16	3.03	4.70	1.67
C33	3.93	5.31	1.38
C30	3.51	4.77	1.26
C25	5.29	5.90	0.61
C32	2.54	3.03	0.49
C14	0.66	1.08	0.42
C10/C11	4.54	4.95	0.41
C31	3.05	3.29	0.24
C28	4.72	4.89	0.17
C17	4.32	4.07	-0.25
C18	2.63	2.37	-0.26
C13	2.17	1.80	-0.37
C22	6.92	6.49	-0.43
C29	6.64	6.20	-0.43
C19	4.03	3.53	-0.50
C15	1.42	0.76	-0.67
C26	7.61	6.71	-0.90
C27	7.23	5.29	-1.95
C21	4.14	2.04	-2.10
C24	8.61	5.88	-2.73
C20	8.56	5.68	-2.88

From Tables V and VI some important differences emerge. For example, looking to the comparison in Table VI, the sub-sectors showing an increase of certifications in comparison to the past are C12, C23, C16, C33, C30, C25, C32, C14, C10/C11, C31 and C28. The result obtained for C12 is conditioned to the very low number of companies in this sub-sector.

While the sectors showing the greatest number of new certificates in the investigated period are C26 (6.71 percent), C22 (6.49 percent) and C23 (6.25 percent).

Table VII reports the Italian manufacturing sub-sectors ordered according to the percentage of bankrupt companies. Apart from sub-sector C12, which cannot be considered significant since it includes a scant number of companies, the most suffering sectors (showing percentages over the global average, 2.55 percent) are C16, C15, C23, C32, C31, C18, C13, C26, C29, C30, C21 and C14.

The principal results observed in Tables V-VII are summarized in the bubble diagram in Figure 1. Specifically, the x-axis reports the percentage of certified companies in year 2010, the y-axis the increment in certification between 2007 and 2010, and the bubble size represents the percentage of bankrupt companies in the observed period.

4.1 Analysis of influence factors

After the early exploratory analysis, a four factors ANOVA has been performed. The large amount of available information and the unbalanced distribution of the acquired data over the levels of the four considered factors have suggested to adopt the General Linear Model, which is an extension of the balanced ANOVA and serves to perform univariate ANOVA with unbalanced as well as balanced designs. In such a model some fundamental assumptions, namely, the linearity of the dependency model, normality and homoscedasticity of the observations are less restrictive (Everitt and Dunn, 2010; Minitab®, 2014). Nevertheless, the normality and homoscedasticity of the observations have been positively tested, respectively, by an Anderson-Darling and a Bartlett's test at a significance level $\alpha = 5$ percent.

ANOVA allows to analyze, in a comprehensive manner and according to a rigorous scheme, the information contained in the sample of examined companies. The goal is to study the effects of one or more of the four factors (certification, company size, regional development and manufacturing sub-sector) or their interactions on the response variable risk of failure.

The analysis has been performed using statistical software Minitab® 17 (Minitab®, 2014).

Sub-sector (code)	% of bankrupt companies
C19	1.54
C10/C11	1.75
C20	1.93
C27	2.04
C17	2.05
C24	2.12
C25	2.13
C22	2.44
C33	2.50
C28	2.51
C16	2.68
C15	2.72
C23	2.73
C32	2.74
C31	2.94
C18	3.14
C13	3.21
C26	3.34
C29	3.70
C30	3.89
C21	4.06
C14	4.08
C12	11.76

Table VII.
Italian manufacturing
sub-sectors ordered
according to the
percentage of
bankrupt companies
in the observed period

In a first step, all the four factors have been considered. However, due to the specificity of the considered data, it has been only possible to perform the analysis of the main effects, excluding all the interactions. The reason is that some sub-sectors are poorly populated and do not include an adequate number and variety of companies for performing the complete analysis. All the four factors resulted significant and, as expected, most of the variability was explained by the manufacturing sub-sectors.

In a second step, the analysis has been concentrated on the three factors (certification, company size and regional development) which allowed the complete analysis. Table VIII reports the obtained results.

Company size and regional development have a *p*-value equal to 0, so they can be fully considered significant. On the contrary, certification is not significant (*p*-value higher than 5 percent). It can be considered significant only if a level of significance equal or lower than 73.2 percent is accepted (*p*-value equal to 6.8 percent). On the light of these results, from the practical point of view, it is not possible to say that certification is fully connected to the risk of failure without the shadow of doubt.

The main effects plots display individually the influence of each factor on the response when it is changed from one level to another. The main effects plot of Figure 2 shows that

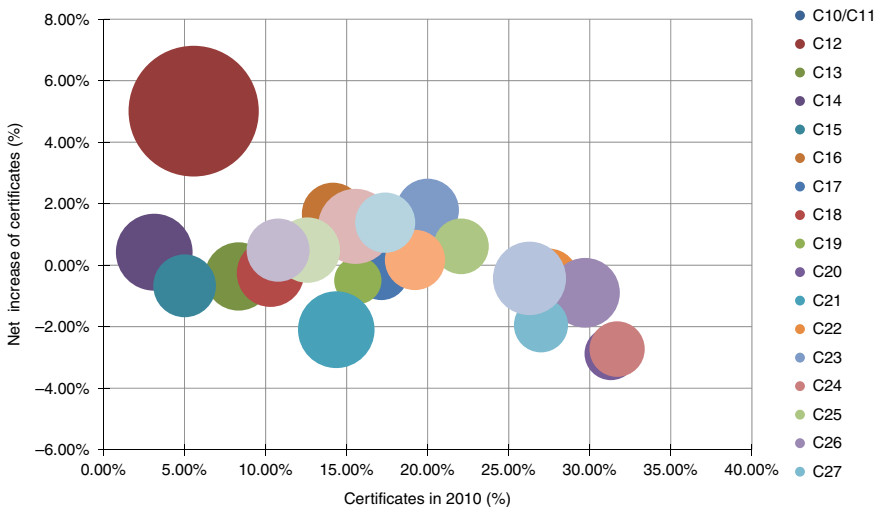


Figure 1. Bubble diagram expressing for each manufacturing sub-sector: the percentage of certified companies in year 2010 (x-axis), the increment in certification between 2007 and 2010 (y-axis), and the percentage of bankrupt companies in the observed period (bubble size)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
A	2	0.011079	0.002775	0.001387	2.69	0.068
B	3	0.067701	0.011061	0.003687	7.15	0.000
C	1	0.179035	0.011729	0.011729	22.75	0.000
A × B	6	0.007419	0.006955	0.001159	2.25	0.036
A × C	2	0.000474	0.000488	0.000244	0.47	0.623
B × C	3	0.004134	0.001133	0.000378	0.73	0.533
A × B × C	6	0.001592	0.001592	0.000265	0.51	0.798
Error	63,377	32.680011	32.680011	0.000516		
Total	63,400	32.951445				

Notes: A, certification; B, company size; C, regional development
Source: Minitab® (2014)

Table VIII. ANOVA result table as in Minitab® 17 output

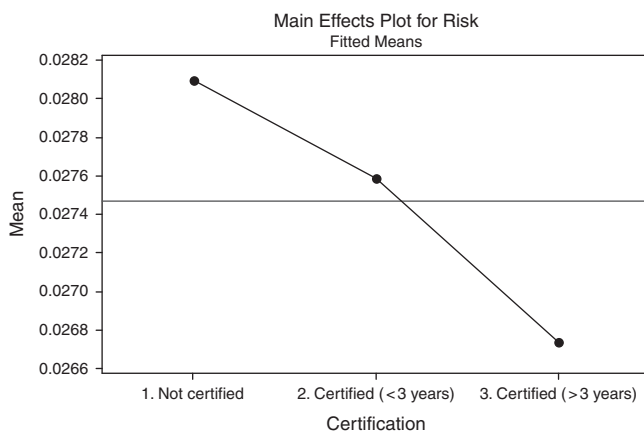


Figure 2.
Main effects plot
for certification

not certified companies are related to the higher risk of failure, while the certified ones are associated to lower levels of risks, especially if they have obtained certification for more than three years. This was the expected result, even if conditioned by a low level of significance (lower than 95 percent, which is typically accepted).

Furthermore, according to Figure 3, it may be also noted that the risk of failure is maximal for micro and medium-sized companies, while it is minimal for small and large companies. This is largely justified by the particular corporate structure of the Italian market, especially during the analyzed period (www.infocamere.it).

Figure 4 shows the risk of failure related to regional development when it varies from negative to positive. The observed difference in favor of the developed regions was rather predictable on the bases of the used criterion.

The only highly significant interaction revealed in Table VIII (p -value equal to 3.6 percent) is among the factors certification and company size. The effects of these two factors on the response are not additive and independent, but show a combined action. Interaction plot in Figure 5 clarifies the situation: it can be observed that the effect of certification is different at different levels of company size, especially if comparing micro and small companies with medium-sized and large ones.

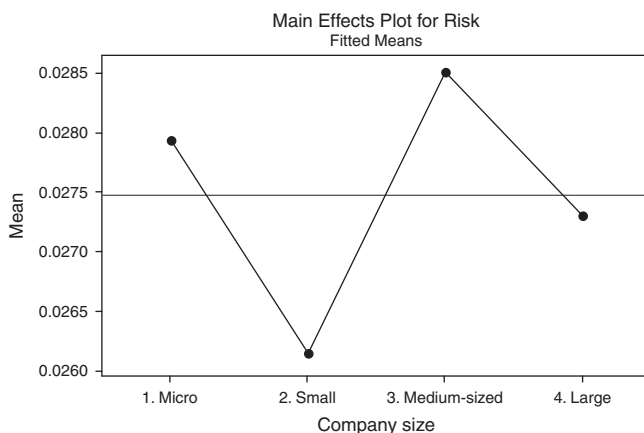


Figure 3.
Main effects plot
for company size

Figure 4.
Main effects plot for regional development

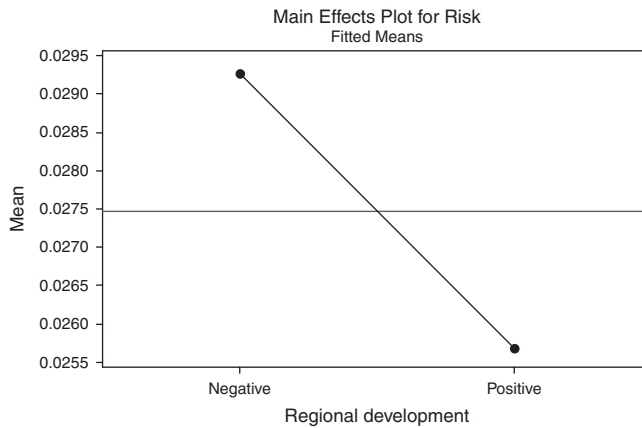
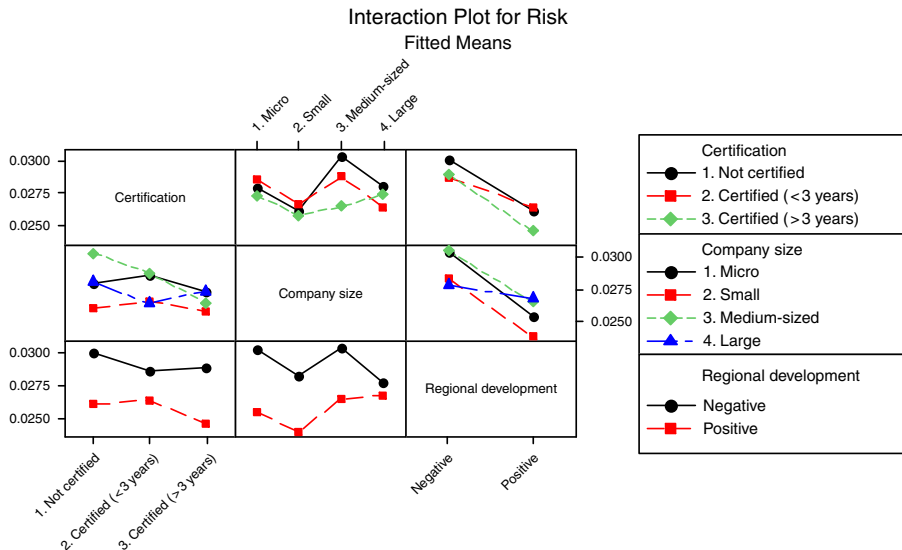


Figure 5.
Interaction plot



In order to achieve a less generalized result and highlight possible similar behaviors for rational subgroups of the population, the above ANOVA has been split in three different analysis referring, respectively, to the three zones of risk of bankruptcy according to Z -score. The obtained p -values for the three different ANOVAs are reported in Table IX.

For all the three analysis certification is significant (p -value lower than 1 percent), regional development is significant only for companies appertaining to grey zone, while company size is significant for companies appertaining to bankrupt and grey zones, no interaction is significant with a significance higher than 97.5 percent. This result is unsurprising and can be justified by the fact that companies appertaining to non-bankrupt zone are so robust that do not suffer any other external effect, companies appertaining to grey zone are very variegated in terms of size because they operate in a very spread market,

and many companies appertaining to bankrupt zone are mostly affected by their fragile structure (also related to their size) than by the regional development.

The study has been further detailed by splitting the ANOVA according to the different commodity sub-sectors. The results confirm the general analysis. Certification factor results statistically significant for many of them. Although certification has different effects for each sub-sector, it is confirmed that, for most of the sub-sectors characterized by a high level of risk of failure, not certified companies reach the maximum levels of risk while companies certified for more than three years stand on the lower level. A separate application of ANOVA for micro, small, medium-sized and large companies, produced an acceptable level of significance (higher than 95 percent) for certification only for medium-sized companies.

4.2 Connection between qualitative variables

In order to further investigate a possible connection between legal status (active, not active) of a company and ISO 9000:2008 certification (certified, not certified), a connection analysis between these two qualitative variables has been conducted. This analysis is based on the use of two ways contingency tables and χ^2 (or Pearson) contingency test for qualitative variables (Everitt and Dunn, 2010).

As well as on the overall sample of companies, the analysis has been conducted according to two types of segmentations: the first one takes into account the four levels of company size (micro, small, medium-sized and large) associated to the three zones of risk of bankruptcy (bankrupt zone, grey zone, non-bankrupt zone), while the second one considers the 23 commodity sub-sectors. This classification has been decided in order to highlight any different behavior between company size, risk of bankruptcy and commodity sub-sector. Furthermore it should be noted that, although the sample size is important for the validity of the χ^2 test, on the other hand when using very large samples it is very easy to obtain factor significance even when the connection is very low, because the test tends to reject the hypothesis of independence (Everitt and Dunn, 2010).

The analysis of contingency tables and the χ^2 test have been conducted using the statistical software Minitab® 17. The main results are briefly summarized hereinafter.

As a first result, the analysis conducted on the whole set of companies has shown that certification and legal status are not independent (p -value of the χ^2 test is equal to 0), with a percentage of not active not certified companies which is three times bigger than the percentage of not active certified ones.

Regarding the company size, for all the considered typologies (micro, small, medium-sized and large), the same behavior has been observed: if companies appertain to bankrupt zone or gray zone, certification and legal status are not independent (p -value of the χ^2 test are equal to 0), if they appertain to non-bankrupt zone, the hypothesis of independence cannot be rejected with a level of significance lower than 97.5 percent.

Source	Bankrupt zone	Grey zone	Non-bankrupt zone
A	0.000	0.000	0.001
B	0.022	0.011	0.556
C	0.720	0.000	0.682
A × B	0.561	0.243	0.487
A × C	0.650	0.042	0.124
B × C	0.905	0.063	0.397
A × B × C	0.989	0.381	0.289

Notes: A, certification; B, company size; C, regional development

Table IX.
 p -values according to ANOVA results for companies appertaining to the three zone of risk of bankruptcy

As for the sub-sectors, three groups can be distinguished based on the value of the p -values of the χ^2 test. The first group is formed by C10/C11, C20, C22, C23, C24, C25, C26, C27, C28, C29 and C31. These sub-sectors are characterized by a strong dependence between certification and legal status (p -value lower than 1 percent). The second group, constituted by C16, C18, C21 and C33, includes those activities in which the dependence between the two qualitative variables is weak (p -value higher than 1 percent and lower than 10 percent), finally, the last group does not show any relationship between the variables (p -value higher than 10 percent). It is composed by C13, C14, C15, C17, C30 and C32. C12 and C19 cannot be analyzed because of the low number of companies for each category. This distribution is mainly related to the particular nature of Italian corporate sector, direct connections need to be further investigated in the future work (www.infocamere.it).

5. Conclusion

This study aimed at investigating whether there is a relationship between ISO 9001 quality certification and the risk of failure of Italian companies in the period 2008/2010, characterized by the beginning of a serious economic crisis. In this regard, a statistical analysis was performed on a sample of 63,400 Italian companies in the manufacturing sector. The risk of failure associated to Altman's Z' -score has been assumed as the response variable of a statistical model considering the following factors: certification, company size, regional development and manufacturing sub-sector.

ANOVA showed that the company size, regional development and manufacturing sub-sector factors are statistically significant. While, it is not possible to affirm with any certainty that quality certification has a direct connection with the risk of failure, since certification factor presents a low level of significance. This is a first important result. In fact, according to the present study, the risk of failure or, complementarily, the chance of success, of a company is not related to the presence of a QMS certification according to ISO 9001 standard. On the contrary, according to expectations, the influence of other factors, such as company size, regional development and manufacturing sub-sector is strongly significant on the economic/financial behavior of a company.

From this result, two main opposite consideration rise: either the principles of quality management prescribed by ISO 9001 standard seem do not have effectiveness on the economic/financial behavior of a company; or the certification mechanism is not able to recognize the companies which actually apply these principles. Given that quality management principles of ISO 9001 gained great reputation over the years and practical applications demonstrated their validity, the second consideration seems to be the most plausible.

Going deeper in the analysis of ANOVA results, if accepted that certification may be considered significant, it is possible to see that not certified companies present the higher risk of failure, while companies certified for more than three years seem to have the lower level of risk. Companies certified for less than three years are positioned between these two extreme levels. This was the expected result, considering that certification should produce a positive effect on company performance.

A further ANOVA was conducted by considering each single manufacturing sub-sector. It emerged that, for many of the 23 sub-sectors, certification is statistically significant. However, even if the certification is statistically significant on affecting the risk of failure of a company, it is necessary to highlight that different sectors presented a very variegated range of behaviors. Moreover, ANOVA, performed separately for micro, small, medium-sized and large companies, showed that certification is significant only for medium-sized companies.

This two last results produce further food for thought. Contrary to the expectation, the positive effect of certification is only observed for a fraction of the studied sub-sectors and only a precise category of companies is involved. Given the universal value of ISO 9001 standard, no difference between sectors and companies was expected before performing this study. This is another point that must be considered for a plausible review of the certification mechanism.

An additional aspect considered in the analysis was the connection between the qualitative variable certification (according to levels certified/not certified) and the qualitative variable legal status (according to levels active/not active).

Also in this case, contrasting results have been obtained. Segmenting data according to the 23 manufacturing sub-sectors, it results that some sub-sectors show a strong connection between the two variables, others present a weak connection, and some others do not give evidence of connection. In a future work-specific investigations involving the analysis of Z-score time variation can help in explaining these findings.

Summing up the results obtained in the present study, the conclusion is somehow contrasting with the affirmation that quality certification induces a positive effect on the overall performance of a company. This conclusion is in agreement with those authors (such as, e.g. Lima *et al.*, 2000; Feng *et al.*, 2008; Sampaio *et al.*, 2011b; Martínez-Costa *et al.*, 2008, 2009) who, through different approaches and studies, came to affirm that quality certification has no evident effects on the economic/financial performance of a company.

Since the statistical analysis cannot drive to the certain affirmation that ISO 9001 certification has a positive connection with the corporate profile of a company, the study opens a way for a number of important questions about the meaning, usefulness and effectiveness of ISO 9001 certification. In particular, it may be time to ask whether the paradigm of certification actually needs a radical rethink.

In addition to that, it must be said that the present work represents a preliminary study for a more extensive survey involving an all-round analysis of the Italian corporate sector and updated to current years. Z-score has been used for tracing the economic/financial profile of companies, but due to the fact that it takes its origin from the USA market it may not fit exactly the Italian situation. Currently the analysis is being reviewed by introducing a more advanced econometric model more suitable for Italian sector, and updating company profiles to a more recent period of time. Furthermore, a deeper analysis of the effect of certification will be investigated by extending the analysis to a wider interval of time and comparing the company values of the used econometric index before and after the acquisition of the certification.

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Corresponding author

Maurizio Galetto can be contacted at: maurizio.galetto@polito.it